UNIVERSITY OF STRATHCLYDE

Modelling the System-wide Impact of Foreign Direct Investment (FDI) in Scotland: An Ownership-Disaggregated Regional Computable General Equilibrium (CGE) Analysis.

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Ph.D Thesis

March 2000.

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ACKNOWLEDGEMENTS

I would like to thank both my supervisors, Professors Peter G McGregor and J. Kim Swales of the Department of Economics and Fraser of Allander Institute for much advice and support through-out my period of study. The research topic for this thesis was in fact stimulated by both supervisors. Moreover, through out my period of study they devoted a considerable amount of time towards directing this research and providing opportunities for me to be involved in similar projects.

I would also like to thank participants at the Regional Science Association (UK and Irish Section), Falmouth, 1997 and the Scottish Economists Conference, April 1998, for comments and advice on parts of my research. I also benefited from the generous comments of participants at the Scottish Doctoral Programme Conferences, Crief Hydro, 1996 and 1997 and from seminar presentations in the Department of Economics at the University of Strathclyde.

In particular, I would like to personally thank the following individuals for their help and comments on this research: Ya Ping Yin, Professor Brian Ashcroft, Professor Steve Young (University of Strathclyde); Professor Brian Loasby (University of Stirling), Nigel Driffield (Cardiff Business School) and Jon Potter (PACEC).

I would also like to acknowledge the Economic and Social Research Council for funding both the taught MSc component, as well as the research component, of my thesis as part of the Scottish Doctoral Programme in Economics. Without which this research would not have been feasible.

Finally, I would like to acknowledge the support and help of my family and friends over this long period. In particular, Linda Haggarty, who has been a constant source of support and encouragement.

Many Thanks.

Gary Gillespie

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Abstract

The central aim of this thesis is to develop a modelling framework that is capable of analysing the system-wide impact of foreign direct investment (FDI) in Scotland. In 1996, foreign-owned plants accounted for around 40, 35 and 23 per cent of Scottish manufacturing output, gross value added and employment. Moreover, the attraction of FDI remains an important part of UK regional policy in Scotland with just under half of all Regional Selective Assistance (RSA) awarded to foreign-owned firms. A key concern of this type of discretionary regional policy is whether such assistance is warranted.

FDI is thought to have a range of potential demand and supply-side effects and foreign-owned manufacturing plants, in general, have quite distinct structural and behavioural characteristics, as compared with indigenous plants. Yet conventional regional system-wide evaluations of FDI typically focus on demand-side issues, using regional models that assume a passive supply-side and do not disaggregate by ownership.

In this thesis I construct ownership-disaggregated Scottish Input-Output and Computable General Equilibrium Models in order to illustrate both the potential demand and supply-side impacts of FDI. The construction of the ownership-disaggregated I-O database provides a unique snapshot of the structure and interaction of foreign and UK-owned plants in Scotland. This provides detailed information as

well as providing the basis for calibrating the ownership-disaggregated I-O and CGE models.

The analysis of the potential supply-side impacts of FDI, particularly labour market and 'efficiency spillover' effects, indicates that both can have a significant effect on the estimate of total FDI supported employment. Finally, I develop a simulation framework that is capable of separately identifying the importance of incorporating both 'structure' and 'behaviour' in regional models of FDI. The results indicate that incorporating the 'true' structure of foreign-owned plants is essential if one is to correctly estimate the system-wide impact of FDI.

Table of Contents

List of Tables and Figures.

Abbreviations.

Acknowledgements.

Overview of Thesis.

Page

Chapter 1: FDI in a Regional Context

1.1	Introduction	1
1.2	What is foreign direct investment (FDI)?	1
1.3.1	Stylised FDI Facts	2
1.4	FDI in a Scottish Context	4
1.5	Theoretical determinants of FDI	6
1.5.1	Transactions Cost Approach	7
1.5.2	Dunning's Eclectic Paradigm	9
1.5.3	Empirical Results and Findings	11
1.6	The impact of FDI on the host economy	19
1.6.1	Pattern of linkages	21
1.6.2	Efficiency and capital intensity of value added production	27
1.6.3	Behaviour in the labour market	31
1.6.3.1.	Foreign and UK-owned Wage Differentials.	32
1.6.3.2.	Labour Market Crowding Out	40
1.6.4.	Research and Development Activity	41
1.6.5.	Degree of export orientation	42
1.6.6.	Flow of profit income	43
1.6.7.	Agglomeration Economies	44
1.6.8.	Efficiency Spillovers	50
1.7.	Chapter Conclusions	53
1.8.	Chapter Bibliography	56

Chapter 2: Regional Impact Analysis of Foreign Direct Investment: Review and Critique of Existing Approaches.

2.1	Introduction	66
2.2	The Economic Base and Keynesian Local Income	

	Multiplier Approach.	66
2.2.1	Applications of this Approach to FDI.	68
2.2.2	Critique of the Economic Base Model.	68
2.3	Keynesian Local Income Multiplier Approach.	70
2.3.1	Extensions to the Basic Keynesian Multiplier Model.	73
2.3.2	Applications of the Model to Regional Impact Analysis.	74
2.3.3	Applications of this approach to FDI.	76
2.3.4	Critique of the Keynesian Regional Multiplier Approach.	80
2.4	Input-Output Modelling.	81
2.4.1	Introduction and Overview of the Input-Output Framework.	81
2.4.2	Implicit Assumptions Required for Input-Output Modelling.	88
2.4.3	Input-Output and the Measurement of Linkages.	89
2.4.4	Applications of I-O Analysis to the Impact of Foreign Direct Investment (FDI).	96
2.4.5	Critique of Regional I-O Models.	101
2.5.	Econometric Applications to FDI	104
2.5.1	Overview of Regional Econometric Models	104
2.5.2	Applications of Regional Econometric Models to FDI	106
2.5.3	Supply-side Impacts of FDI	113
2.6	Chapter Conclusion	133
2.7	Chapter Bibliography	134

Chapter 3 - The system-wide Impact of Foreign Direct Investment: A Computable General Equilibrium (CGE) Analysis.

3.1	Introduction.	142
3.2	AMOS: A Regional CGE Model For Scotland.	142
3.2.1	Introduction and Overview of Regional CGE Modelling	142
3.2.2	Overview of a Regional CGE	144
3.2.3	CGE Data Requirements and Calibration	149
3.2.4	AMOS CGE Model	152
3.3	The system-wide impact of FDI in Scotland	160
3.3.1	Introduction	160
3.3.2	Exogenous manufacturing Investment Shock.	160

3.3.3 Varying the Export Stimulus. 163
3.3.4 The 100% Export FDI Plant. 164
3.3.5 Product Market Displacement. 165
3.4 Labour Market Effects of FDI. 168
3.4.1 Layard, Nickell & Jackman Bargaining Real Wage Curve. 168
3.4.2 Bargained Real Wage and Migration Effects 170
3.5 Efficiency Spillover Effects 172
3.6 The Impact of the Combined Effects of FDI. 174
3.7 Chapter Conclusions. 177
3.8 Chapter Bibliography 179

Chapter 4: Construction on an Ownership-Disaggregated Input-Output Table for Scotland.

4.1 Introduction. 183
4.2 Overview of Methodology and I-O Model Construction. 183
4.2.1 Methodological issues relating to the construction of regional I-O Tables. 183
4.2.2 Overview of Model Construction. 186
4.3 Model Construction. 192
4.3.1 Value Added Matrix (V_m) 193
4.3.2 Final Demand Matrix (Fm). 199
4.3.4 Transactions Matrix. 205
4.4 Chapter Conclusions 208
4.5 Chapter Bibliography 210
4.6 Data Appendix 211
4.6.1 Scottish Input-Output and ACOP Data. 211
4.6.2 Manufacturing Trade Flow Survey (MTFS) Data. 212

Chapter 5: Interpretation of the Results from the Ownership-disaggregated Scottish I-O Database.

5.1 Introduction. 218
5.2 The Ownership-Disaggregated Accounting Results. 219

5.2.1 Composition of Gross Output 219
5.2.2 Relative Productivity. 222
5.2.3 Local Intermediate Purchases (Backward Linkages). 227
5.2.4 Trade Effects 229
5.3 Ownership-Disaggregated Scottish I-O Model for 1989. 231
5.3.1 Introduction to I-O Modelling 231
5.3.2 Sectoral I-O multipliers 231
5.3.3 Output Multipliers 233
5.3.4 Employment multipliers 236
5.3.5 Output and Employment Multipliers for Total Exports disaggregated by ownership. 239
5.3.6 Hypothetical Extraction Method 240
5.3.7 Chapter Conclusion 245
5.3.8 Chapter Bibliography 247
5.4 Chapter Appendix 249

Chapter 6: Construction of ownership-disaggregated CGE Models framework: AMOSFDI.

6.1 Introduction 250
6.2 The importance of 'structure and 'behaviour' in regional CGE's. 251
6.3 The AMOSFDI simulation framework and models. 254
6.3.1 AMOSFDI general simulation framework. 254
6.3.2 Simulation strategy: "hypothetical extraction" of the "structure" and "behaviour" of the foreign-owned sector 256
6.4 The specification and calibration of the simulation models 258
6.4.1 Differences in "behaviour": functional forms and key parameter values for each of the AMOSFDI models 258
6.5 Differences in "structure": the Social Accounting Matrix (SAM's). 264
6.5.1 The SAM's for Models 1 to 3. 264
6.5.2 Construction of ownership-disaggregated SAM for AMOSFDI Model 265
6.5.3 Model Calibration of AMOSFDI. 268
6.6 Summary of Model Characteristics. 273

6.7 Chapter 6 Conclusion. 274
6.8 Chapter 6 Bibliography 276
6.9 Chapter 6 Appendix. 278-

Chapter 7: Simulations Using the AMOSFDI CGE Model.

7.1 Introduction 279
7.2 Simulation Strategy: 100% Export FDI Plant. 281
7.3 Model 1 – No structural or behavioural differences between sectors within the Model. 285
7.3.1 Model 1 with National Bargaining labour market closure, no migration. 285
7.3.2 Model 1 with National Bargaining and Migration 289
7.3.3 Model 1 with Regional Bargaining labour market closure and no migration. 291
7.3.4 Model 1 with Regional Bargaining and LNJ Migration 296
7.3.5 Summary of model results where there are no structural or behavioural differences between the UK and foreign manufacturing sectors in the model. 298
7.4 Model 2: Incorporating the 'true' Structural Characteristics within the model. 299
7.4.1 Model 2 with National Bargaining and No Migration 300
7.4.2 Model 2 with National Bargaining and LNJ Migration 304
7.4.3 Model 2 with the LNJ regional bargaining labour market closure and no migration. 305
7.4.4 Model 2 with Regional Bargaining and Migration 308
7.4.5 Summary of model results where the 'true' structural characteristics of sectors are incorporated within the model. 309
7.5 Model 3 – Incorporating both Structural and Behavioural Characteristics within the Model. 311
7.5.1 Model 3 with National Bargaining and No Migration 312
7.5.2 Model 3 with National Bargaining and Migration 314
7.5.3 Model 3 with Regional Bargaining and no Migration 315
7.5.4 Model 3 with Regional Bargaining and LNJ Migration 320

7.5.5 Summary of Model 3 Results. 321

7.6 Comparison of Results from Models 1, 2 and 3. 321

7.7 Chapter Conclusions. 325

7.8 Chapter 7 Bibliography 329

Chapter 8: Overall Conclusions and Suggestions for Future Research.

8.1 Thesis Conclusions 330

8.2 Current and Future Developments 338

8.3 Conclusion Bibliography 340

Chapter 1 Tables and Figures **Page**

Table

Table 1.0 Global Foreign Direct Investment Stocks. 3

Table 1.1 Overseas-owned share of Scottish Manufacturing Industry, 1995. 5

Table 1.2 Selected economic indicators for UK-owned and overseas-owned firms in Scotland, 1989. 6

Table 1.3 Results from regression analysis of the determinants of FDI for the developed countries, the EU and other Developed Countries, 1972-88 (United Nations, 1993). 12

Table 1.4 Results from regression analysis of the determinants of FDI for developing economies (United Nations, 1992). 13

Table 1.5 Summary of the determinants of FDI into Europe based on based on the findings of Barrell & Pain, 1997. 15

Table 1.6 Results of the aggregate decomposition of GVA between indigenous and foreign-owned manufacturing sectors, as reported by Davies and Lyons (1991), and a comparison with Scottish manufacturing data for 1989 following the same procedure. 30

Table 1.7 A summary of the sample means for male full-time manual workers that are employed by externally and locally owned sectors, as estimated by Harris (1994). 35

Table 1.8	Summary of the estimates of the probability of employees working in an industry with a single union agreement or not, or whether the firm is externally or locally owned, as reported by Harris, 1994 (Table 2, Pg 488).	36
Table 1.9	Summary of the OLS estimates of the parameter coefficients for male full-time manuals by externally owned and locally owned sectors, as reported by Harris, 1994 (Table 3, Page 489).	37
Table 1.10	Comparison of wage equations for UK and foreign-owned sample, as reported by Driffield, 1995, Table 1, Pg 13.	39

Chapter 2 Tables and Figures

		Page
Table 2.1	A Comparison of key parameter values and results from a variety of impact studies using the Keynesian Income Multiplier Model.	75
Table 2.2	Estimated Linkage Multiplier for foreign-owned and 'in-moving' branch plants for Devon & Cornwall as reported by Potter (1995).	77
Table 2.3	Direct and indirect employment impacts of 'in-moving' branch plants as reported by Potter (1993).	79
Table 2.4.1	Basic Structure of an Input-Output Transactions Table.	82
Table 2.4.2	Direct and indirect effects associated with an incoming plant generating output worth £10 million per year, as reported by Hill and Roberts, 1995.	99
Table 2.4.3	The total output, income and employment impact Generated by a 1% increase in final demand in Wales (Hill & Roberts, 1995).	99
Table 2.5.1	Regression results for the determinants of Scottish GDP, for the period 1961-1984 as estimated by Foster and Malley, 1988a	107
Table 2.5.2	Regression results for the determinants of total Scottish manufacturing output, for the period 1962-1984, as estimated by Foster and Malley, 1988a	108

Table 2.5.3	Regression results for the analysis of Scottish manufacturing output disaggregated by ownership, for the period 1962-1984, as reported by Foster and Malley, 1988b	111
Table 2.5.4	Regression results for intra-industry spillovers from FDI, as reported by Blomstrom and Perssoni, 1983	115
Table 2.5.5	Regression results for efficiency spillovers from FDI, as reported by Kokko, 1994	117
Table 2.5.6	Determinants of endogenous labour productivity (value-added per employee), as reported by Kokko, 1994	118
Table 2.5.7	Regression results for 'efficiency spillovers', as reported by Haddad and Harrison, 1993	124
Table 2.5.8	Regression results of 'efficiency spillover' analysis, as reported by Haddad and Harrison, 1993	127
Table 2.5.9	Summary of the regression results for labour productivity (technical progress) in Germany and the UK, as reported by Barrow and Pain, 1997	131

Chapter 3 Tables and Figures

Page

Figure 3.1	General Structure of a Regional CGE Model.	145
Figure 3.2	General Structure of regional production within a Regional CGE model.	147
Table 3.2.1	Overview of the basic structure of a Social Accounting Matrix.	150
Table 3.2.2	A Condensed Version of AMOS 1989.	153
Table 3.3.1	20% Increase in Manufacturing Investment with National Bargaining.	160-
Figure 3.3.1	Total and sectoral employment change relative to the base year values, generated by a 20% increase in manufacturing investment.	160-
Figure 3.3.2	Sectorally disaggregated net investment flows as a percentage of the initial capital stock, generated by a 20% increase in manufacturing investment.	161-

Table 3.3.2	20% increase in Manufacturing Investment and 4.28% Export Shock with National Bargaining.	163-
Figure 3.3.3	Percentage changes in total employment and employment by sector, relative to the base year values, generated by a 100% export plant.	163-
Figure 3.3.4	Change in long-run total and sectoral employment, for the Range of plant export intensities.	165-
Table 3.4.1	20% increase in Manufacturing Investment and 4.28% Export Shock with LNJ Regional Bargaining.	168-
Figure 3.3.5	Percentage change in total employment and the real wage, relative to the base year values for a 100% export plant with National Bargaining and the LNJ bargained real wage labour market closures.	168-
Table 3.4.2	20% increase in Manufacturing Investment and 4.28% Export Shock with LNJ Regional bargaining and Migration.	170-
Figure 3.3.6	Percentage change in population, bargained real wage and employment, relative to base year values, for a 100% export plant with LNJ regional bargained wage and migration functions.	170-
Table 3.5.1	0.6% Hicks neutral increase in Manufacturing Efficiency With National Bargaining.	173-
Figure 3.3.7	Percentage changes in GDP, manufacturing exports, capital stocks and value added prices, relative to base year values, for a 0.6% Hicks-neutral increase in efficiency in manufacturing, with national bargaining.	173-
Figure 3.3.8	Absolute changes in total and sectoral employment, relative to the initial base values, for a 0.6% Hicks-neutral increase in efficiency.	173-
Table 3.6.1	Impact of the "Total Effects" Model: 100% Export FDI Plant and 0.6% Hicks Neutral Efficiency Shock with LNJ Regional Bargaining and Migration Functions.	174-
Figure 3.3.9	Absolute and sectoral employment change for the "total effects" (100% FDI export plant and 0.6%	

	efficiency stimulus with LNJ labour market closure and migration function) and I-O estimates.	174-
Figure 3.3.10	Discounted absolute employment change for the "total effects" (100% FDI export plant, a 0.6% efficiency stimulus, and LNJ labour market closures and migration function.	175-
Table 3.6.2	A comparison of the cumulative total discounted present value job years over a 10 year time horizon for a 100% export plant calculated using I-O and a CGE model with various labour market, migration and efficiency spillover assumptions.	176

Chapter 4 Tables and Figures

		Page
Table 4.1	Sectoral aggregation for the ownership-disaggregated Scottish I-O Table (1989).	187
Table 4.2	Outlay of the ownership-disaggregated Scottish I-O Table (1989).	189
Table 4.3	Value added (payments) sector of the ownership-disaggregated Scottish I-O Table.	193
Table 4.4	The I-O values for total output, wages and salaries and other value added for the indigenous and foreign divisions of the seven manufacturing sectors (£m).	195
Table 4.5	Disaggregation of total purchases for each manufacturing sector.	196
Table 4.6	Illustration of the method used to disaggregate total Purchases between the indigenous and foreign-owned division of each manufacturing sector.	197
Table 4.7	The estimated values for intermediate demand and imports generated following the adjustment method outlined in Table 4.5.	198
Table 4.8	Estimated I-O values for the value added matrix (V_m).	199
Table 4.9	Final Demand Matrix.	200
Table 4.10	The proportions of each source of final demand allocated to both components of each manufacturing sector,	

	based on the adjustment method outlined.	203
Table 4.11	Final Demand Matrix (F_m).	204
Table 4.12	Transactions Matrix.	205
Table 4.13	How the matrix of intermediate flows are generated for the indigenous and foreign-owned manufacturing divisions of the chemicals sector.	207
Table 4.14	Completed Transactions Matrix.	207
Table 4.15	Ownership-disaggregated Scottish Input-Output Table for Scotland (1989).	207-
Table 4.16	Comparison of I-O and ACOP data for gross Output and Gross Wages and Salaries for the manufacturing sectors in the ownership-disaggregated Scottish I-O Table.	212
Table 4.17	Comparison of total purchases I-O and ACOP data, and shares, for the manufacturing sectors in the ownership-disaggregated Scottish I-O table.	213
Table 4.18	Comparison with Census of Employment and ACOP Employment Data and sectoral wages using both I-O and ACOP data.	214
Table 4.19	The percentage of Total Purchases that are sourced from within Scotland, based on the MTFS data (Jackson & Patel, 1996).	215
Figure 4.1	Proportion of total purchases sourced from within Scotland (1989).	216
Figure 4.2	Proportion of total purchases sourced from within Scotland in ownership-disaggregated Scottish I-O Model (1989).	217

Chapter 5 Tables and Figures

		Page
Table 5.1	Composition of Gross Output for the manufacturing Sectors in Scotland, based on the ownership-disaggregated Scottish I-O Table for 1989.	220
Figure 5.1	Composition of Gross Output for the UK-and foreign-owned manufacturing divisions in the ownership-	

	disaggregated Scottish I-O Table.	220-
Figure 5.2	Value added and output per employee totals for the both the UK and foreign-owned manufacturing divisions.	221-
Table 5.2	The components of the output per employee differentials that exist between the foreign and indigenous-owned manufacturing sectors in the ownership-disaggregated Scottish I-O Table for 1989.	224
Figure 5.3	Gross Value Added/Gross Output ratios for the Manufacturing sectors in Scotland.	224-
Table 5.3	The components of the level of local intermediate linkages per employee for the foreign and indigenous-owned manufacturing sectors in the ownership-disaggregated Scottish I-O Table.	228
Figure 5.4	Exports by manufacturing sector in Scotland (1989).	229-
Figure 5.5	Balance of Trade for the manufacturing sectors in the ownership-disaggregated Scottish I-O Table.	229-
Table 5.4	Type I & II Output multipliers for the manufacturing Sectors based on the ownership-disaggregated Scottish I-O Model for 1989.	233
Table 5.5	Decomposition of Type II output multipliers for the UK and foreign-owned manufacturing divisions.	235
Table 5.6	Components of the type II sectoral I-O employment Multipliers for the manufacturing divisions in Scotland (1989).	237
Table 5.7	The components of the employment multiplier differential that exists between the foreign and indigenous-owned manufacturing sectors in the ownership-disaggregated Scottish I-O Table.	238
Table 5.8	Type I & II output and employment multipliers for the aggregate UK and foreign-owned manufacturing sectors following a 10 per cent in the exports of each manufacturing division (both UK and foreign-owned).	240
Table 5.9	Results from simulating the impact of the complete absence of each foreign-owned manufacturing	

	division in Scotland.	243
Table 5.10	Type I and II Sectoral Output, Income and Employment multipliers, for all sectors in the ownership-disaggregated Scottish I-O table (1989).	249

Chapter 6 Tables and Figures

		Page
Table 6.1	Functional Forms and Key Parameter Values for Model 3.	259
Table 6.2	A summary of the key equations altered by the Specification of the foreign-owned manufacturing Sector in the AMOSFDI model.	260
Table 6.3	Comparison of Leontief and CES Demand Functions for selected variables for the foreign and UK manufacturing sector in Model 3.	262
Table 6.4	Type I and II output multipliers associated with the Hypothetical (identical structure) and ownership-disaggregated SAM.	265
Table 6.4.1	Sectoral Classification of the four sectors in the AMOSFDI SAM.	267
Table 6.5	Ownership-disaggregated I-O Table re-aggregated to four sectors.	267
Table 6.6	Data and Parameters used in the calibration of the AMOSFDI CGE Model 3.	268
Table 6.7	How the key structural and behavioural characteristics of FDI are captured in the AMOSFDI model.	274
Appendix 1	SAM for Model 1.	278-
Appendix 2	SAM for Model 2.	278-

Chapter 7 Tables and Figures

Table 7.1	AMOSFDI Simulation Models	280

Table 7.2	The impact of the Export FDI shock in terms of foreign-owned capital stock, exports, output and direct employment across Models 1, 2 and 3.	283
Table 7.3	Key economic variables for 100% Export FDI with Model 1	285-
Figure 7.1	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 1.	285-
Table 7.4	The long-run increase in GDP, Household Disposable Income and Total Employment (including multiplier values) for an incoming 100% export FDI plant generating 5,162 direct jobs with the national bargaining wage closure.	288
Table 7.5	Key economic variables for 100% Export FDI with Model 1 with the national bargaining and migration.	288-
Figure 7.2	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 1.	288-
Table 7.6	The long-run increase in GDP, Household Disposable Income and Total Employment (including multiplier values) for an incoming 100% export FDI plant generating 5,162 direct jobs with the national bargaining and migration.	290
Table 7.7	Key economic variables for 100% Export FDI with Model 1 with the regional bargaining and no migration.	291-
Figure 7.3	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 1 with the regional bargaining and no migration.	291-
Table 7.8	The long-run increase in GDP, Household Disposable Income and Total Employment (including multiplier values) for an incoming 100% export FDI plant generating 5,162 direct jobs with the regional bargaining and no migration.	295
Table 7.9	Key economic variables for 100% Export FDI	

	with Model 1 with the regional bargaining and no migration.	296-
Figure 7.4	Change in total employment, real wage and population for a 100% Export FDI shock with Model 1 and the regional bargaining and LNJ migration.	296-
Figure 7.5	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 1 with the regional bargaining and LNJ migration.	296-
Table 7.10	The long-run increase in GDP, Household Disposable Income and Total Employment (including multiplier values) for an incoming 100% export FDI plant generating 5,162 direct jobs with regional bargaining and LNJ migration.	297
Table 7.11	Key economic variables for 100% Export FDI with Model 2 with national bargaining and no migration.	297-
Figure 7.6	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 2 with national bargaining and no migration.	298-
Table 7.12	Comparison of the long run impact on GDP, HHDY and total and sectorally disaggregated employment, by sector, for the national bargaining labour market closure using AMOSFDI Models 1 and 2.	301
Table 7.13	Comparison of the employment multipliers and employment/output multipliers per unit of final demand for a 100% Export FDI shock with national bargaining, using Models 1 and 2.	302
Table 7.14	Key economic variables for 100% Export FDI with Model 2 with the national bargaining and LNJ migration.	303-
Figure 7.7	Change in total employment and sectorally disaggregated employment for a 100% Export FDI with Model 2 with the national bargaining and LNJ migration.	303-

Table 7.15 Comparison of the direct employment and long run employment impact and multiplier values generated for a 100% Export FDI shock with national bargaining and migration, using AMOSFDI Models 1 and 2. 304

Table 7.16	Key economic variables for 100% Export FDI with Model 2 with regional bargaining and no migration.	304-
Table 7.17	Comparison of Total GDP, HHDY and employment by sector (and multiplier values) generated for a 100% Export FDI shock with regional bargaining using both AMOSFDI Models 1 and 2.	307
Table 7.18	Key economic variables for 100% Export FDI with Model 2 with regional bargaining and LNJ migration.	307-
Figure 7.8	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 2 with the regional bargaining and no migration.	308-
Table 7.19	Comparison of GDP, HHDY and the employment impact and multiplier values generated for a 100% Export FDI shock with regional bargaining and migration using both AMOSFDI Models 1 and 2.	309
Figure 7.9	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 2 with the regional bargaining and LNJ migration closure.	309-
Table 7.20	Key economic variables for 100% Export FDI with Model 3 with national bargaining and no migration.	311-
Figure 7.10	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 3 with the national bargaining and no migration.	311-
Table 7.21	Key economic variables for 100% Export FDI with Model 3 with national bargaining and LNJ migration.	313-
Figure 7.11	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 3 with the national bargaining and LNJ migration.	313-
Table 7.22	Key economic variables for 100% Export FDI with Model 3 with regional bargaining and no migration.	315-

Figure 7.12	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 3 with the regional bargaining and no migration.	315-
Table 7.23	Comparison of the long-run impact on GDP, HHDY and employment (including multiplier values) generated for a 100% Export FDI shock with the regional bargaining labour market closure using both AMOSFDI Models 1, 2 and 3.	318
Figure 7.13	Change in total employment and sectorally disaggregated Employment for a 100% Export FDI with Model 3 with the regional bargaining and LNJ migration.	319-
Table 7.24	Comparison of the long-run impact on GDP, HHDY and employment (including multiplier values) generated for a 100% Export FDI shock with the regional bargaining and LNJ Migration using both AMOSFDI Models 1, 2 and 3.	319-
Table 7.25	Summary of the long-run impact on GDP for the export FDI shock, for each of the four labour market closures, using AMOSFDI Models 1, 2 and 3.	322
Table 7.26	Summary of the long-run impact on household disposable income (HHDY) for the export FDI shock, for each of the four labour market closures, using Models 1, 2 and 3.	323
Table 7.27	Summary of the long-run employment impact of the export FDI shock, for each of the four labour market closures, using the three different models.	323
Figure 7.14	Period by period total employment impact for the regional bargaining labour market closure generated by Models 1, 2 and 3.	324-
Table 7.28	Total discounted present value job years (PVJY's) for periods 1 to 10, for an export FDI shock, for each of the four labour market closures using Model 1, 2 and 3.	325

Abbreviations.

ACOP	Annual Census of Production
AMOS	A micro-macro simulation framework for Scotland.
AMOSFDI	A micro-macro simulation framework for Scotland which disaggregates the manufacturing sector by ownership (ownership-disaggregated variant of the original AMOS model).
CGE	Computable General Equilibrium
CSO	Central Statistical Office
CoE	Census of Employment
EB	Economic Base
FD	Final Demand
FDI	Foreign Direct Investment
FTE	Full Time Equivalent Employment
GO	Gross Output
GDP	Gross Domestic Product
HMSO	Her Majesty's Stationary Office
IBB	Invest in Britain Bureau
I-O	Input-Output
MNE	Multinational Enterprise
OVA	Other Value Added
TID	Total Intermediate Demand
RSA	Regional Selective Assistance
SIC	Standard Industrial Classification
SEN	Scottish Enterprise National
TNC	Transnational Corporation

OVERVIEW OF THESIS.

The purpose of Chapter 1 is to provide both an outline of the structure of my research and provide some background and context for later chapters. Accordingly this chapter provides an introduction to inward investment and discusses what the main issues are. This incorporates both theoretical and empirical results concerning the determinants of FDI and a review of relevant literature relating to various impacts. In particular, discussion of both demand and supply-side issues related to FDI.

Chapter 2 provides a review of recent FDI impact studies and modeling approaches, which includes specific plant studies, Keynesian multiplier, I-O and regional econometric models. Many of these issues have been introduced in Chapter 1 but this section provides more detailed analysis. This Chapter also incorporates a review of selected empirical literature relating to FDI labour market effects, efficiency spillovers and 'spillover models'. The chapter conclusions acknowledge the existence of these type of effects and suggest the need to use a system-wide approach which can deal simultaneously with supply-side impacts, as well as, the more standard employment and linkage effects identified in Chapter 1, which are captured in the traditional modelling approaches. More specifically, the need to use a regional model or framework that encapsulates a fully specified supply side for evaluating FDI.

Chapter 3 provides an introduction to the AMOS CGE model and considers its application to the impact of FDI within Scotland. The first part of the Chapter provides an introduction to the AMOS model and other related CGE literature. The chapter focuses on the potential supply-side impacts of FDI, including both labour market and efficiency spillover effects. The CGE results for an FDI export shock are compared with I-O type results. The limitations of this approach are also discussed, highlighting the need to at least incorporate the different structural characteristics of foreign and indigenous plants within the model.

Chapter 4 outlines the construction of an ownership-disaggregated Scottish I-O Table for 1989. This section provides a detailed illustration of the construction of the Table as well as a brief review of other possible approaches. The chapter also discusses the data limitations for this type of modeling and the approach undertaken.

Chapter 5 reports results from the ownership-disaggregated Scottish I-O table (and model). The chapter considers the issue of 'embeddedness' in relation to foreign-owned manufacturing plants in Scotland, and highlights the use of an ownership-disaggregated Scottish Input-Output Table to inform discussion in this area. The results also include multipliers for the foreign and indigenous manufacturing divisions for each manufacturing sector.

Chapter 6 details the construction of the AMOSFDI CGE model, including both the model database and specification. Three different variants of the AMOSFDI CGE model are discussed in this chapter. The first considers a CGE model where the structural and behavioural characteristics of manufacturing sectors (foreign and UK) are identical. The second model incorporates the 'true' structural characteristics of the UK and foreign-owned sector but maintains the hypothesis of identical behaviour. The final model incorporates both different structural and behavioural characteristics in both the UK and foreign-owned manufacturing sectors.

Chapter 7 reports extensive simulations, using the AMOSFDI CGE models, for the impact of a 100 per cent export FDI plant using the three different variants of the model outlined in Chapter 6. The aim of this chapter is to highlight the impact of incorporating both structural and behavioural characteristics within a regional modeling framework.

Conclusion this summarises the main findings of my research and outlines policy implications and future research.

CHAPTER 1: Foreign Direct Investment (FDI) in a Regional Context.

1.1 Introduction.

The purpose of this introductory chapter is to provide both an outline of the structure of my research and some background and context for later chapters. This chapter provides an introduction to inward investment and discusses both the theoretical determinants of FDI and related empirical work. The review also incorporates literature relating to various FDI impacts, at the regional level. In particular, work considering both the potential demand and supply-side impacts of FDI.

1.2 What is foreign direct investment (FDI).

Foreign direct investment (FDI) arises mainly from the activities of firms that operate across national boundaries and invest in, or acquire, a lasting interest in an enterprise operating in a national economy other than that of the investor. FDI is not simply a transfer of capital or investment, across national boundaries, but the ownership and control of physical productive assets, by foreign plants, in locations outwith the host country. FDI is therefore different from portfolio investments, which lack the actual control of the investment or income generating asset.

However there is a number of quite different interpretations of what exactly constitutes FDI i.e. the ownership and control of productive assets based in a foreign country. For instance, the OECD use 10% of share capital to indicate that a company is overseas owned. Other definitions of ownership look to where the headquarters of the company is located (Harris, 1991). In this analysis I follow the definition of foreign ownership that is used by the Annual Census of Production (ACOP). This covers all types of foreign direct investment, i.e. greenfield, joint ventures and acquisitions of indigenous companies by overseas-owned companies. ACOP consider a manufacturing firm based in Scotland to be foreign-owned if an overseas owned company (non UK) holds more than 50% of its share capital. This is the definition I follow in this analysis. Note that UK-owned firms located in Scotland are treated as 'indigenous'.

FDI in Scotland and throughout the UK can take various forms. The mode of entry chosen by the incoming plant can vary. 'Pure' FDI is often thought to relate to greenfield site investment where the incoming plant sets up a new factory. Other modes of entry cover investment in a brown-field site, acquisition or takeover of an indigenous company or by joint venture. In this analysis I do not consider the mode of entry in relation to different types of FDI, instead I treat all foreign-owned companies based in Scotland as FDI. Although, recent research has indicated that the choice of entry mode can have a significant influence on both the range of activities the plant undertake and their impact within the host economy (Williams, 1997), these issues are not considered explicitly within this analysis.

1.3 Stylised FDI Facts.

Markusen (1995) notes the following "stylized facts" concerning foreign direct investment (FDI).

1. **Rapid growth:** FDI inflows between countries have increased substantially compared with earlier periods. For instance between 1984 and 1987 the growth in Worldwide FDI outflows tripled. In 1988 and 1989 Worldwide FDI flows increased by 27 per cent (United Nations, 1996). Overall, investment outflows over the period 1983 to 1989 grew by 29 per cent per anum, which was three times the growth of exports and four times the growth of output over the same period (United Nations, 1996). The relative growth and importance of FDI inflows/outflows for the World, OECD and EU, between the period 1980 and 1995 is illustrated by Table 1, which is constructed by Barrell and Pain, 1997.

Table 1.0 – Global Foreign Direct Investment Stocks – Source Barrell and Pain, (1997, Table 1, Pg. 1771).[1]				
Outward FDI:	**1980**	**1985**	**1990**	**1995**
World				
$ billion	513.7	685.5	1684.1	2730.1
GDP (% of)	4.9	5.9	8.1	9.7
OECD				
$ billion	501.9	657.4	1606.2	2503.2
GDP (% of)	6.8	6.1	10.6	13.2
Share of total (%)	(97.7)	(95.9)	(95.4)	(91.7)
EU_{-15}				
$ billion	213.2	286.5	777.2	1208.8
GDP (% of)	7.4	7.1	13.8	17.4
Share of Total (%)	(41.5)	(41.8)	(46.1)	(44.3)
Inward FDI:	**1980**	**1985**	**1990**	**1995**
World				
$ billion	418.9	734.9	1716.9	2657.9
GDP (% of)	4.6	6.3	8.3	9.4
OECD				
$ billion	356.4	526.3	1361.4	1922.0
GDP (% of)	4.8	4.9	9.0	10.1
Share of total (%)	(74.0)	(71.6)	(79.3)	(72.3)
EU_{-15}				
$ billion	185.0	226.5	712.2	1028.1
GDP (% of)	6.4	5.6	12.7	14.8
Share of Total (%)	(38.4)	(30.8)	(41.5)	(38.7)

2. **FDI flows are predominately between developed countries**: From Table 1, note that over 90 per cent of FDI outflows, between 1980 and 1995, are between OECD countries. Thus, foreign direct investment has largely tended to flow between capital rich countries. Moreover, the growth in FDI flows over this period is substantial. Outflows of FDI (in nominal terms) from OECD countries have grown by nearly 500 per cent over this period. Similarly, inflows of FDI have increased for OECD countries over this period by over 500 per cent in nominal terms.
3. **Much of the flows of FDI are essentially two-way**: Table 1 shows that both outward and inward FDI flows are predominately between OECD countries. In particular, the bulk of World FDI relates to flows between the US, EU and Japan.

4. **Nearly one third of world trade is now inter-firm:** With the internalisation of production, MNC's locate different production activities in various locations. Thus, to minimise transaction costs MNC's internalise important markets within the organisation. Therefore the co-ordination of these activities, through backward and forward linkage activity, means that much of world-trade relates to trade within and across firms. Global MNC's typically source their intermediate inputs from their own supply bases, which are located strategically in order to minimise production costs. Therefore inter-firm trade within large MNC's accounts increasingly for a large proportion of world trade, as these large organisations typically sell in global markets.

5. **The majority of FDI flows are typically concentrated in the same type of industries:** R&D intensive, high skill sectors or high tech products are the main group of products or sectors in which FDI is concentrated within. For instance, in Scotland, the bulk of inward investment is concentrated in the Scottish Electronics sector.

In summary, the importance of FDI, particularly intra-firm trade has increased significantly over the last 20 years. The bulk of all outward FDI originates from OECD countries. The destination of inward investment is largely between developed economies. For instance, FDI inflows into the EU were equal to nearly 15% of EU GDP in 1995. There is also increasing evidence that FDI inflows are typically concentrated in the same type of industries (Barrell & Pain, 1997).

1.4 FDI in a Scottish Context.

The attraction of FDI has become an important part of UK regional policy and two thirds of regional selective assistance in Scotland goes to foreign-owned manufacturing plants (PACEC, 1996). Over the period 1996 to 1997, 76 new projects were attracted to Scotland that generated 9,928 new jobs and safeguarded a further 2,069. Scotland received 16 per cent of all UK inward investment projects over this

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[1] Differences in national definitions of foreign direct investment (FDI) explain the discrepancy between total outward and inward investment.

period (Investment Bureau, 1997). FDI supports a wide range of economic activities within the Scottish economy and Table 1.1 provides an indication of its relative share of Scottish manufacturing in 1995 (Scottish Office, 1997).

Table 1.1 – Overseas-owned share of Scottish Manufacturing, 1995.		
Share of Scottish Manufacturing:	UK-Owned %	Overseas %
Employment	80	20
Gross Output	62	38
Gross Value Added	65	35
Net Capital Expenditure	51	49
Gross Wages & Salaries	76	24

Source – Scottish Office Statistical Bulletin Industry Series 1997.

In Scottish manufacturing, foreign-owned plants account for 20% of employment, 38% of gross output, and 35% of gross value added. They account for a further 49% of net capital expenditure and 24% of gross wages and salaries. They are particularly dominant in the Scottish electronics industry where they supply 77% of the net output of this industry (Electrical and Optical Equipment). However, inward investment in Scotland has not been confined to manufacturing and recent investments have included service sector FDI.[2] At the time of undertaking this research, 1989 was the most recent year for which a full Scottish Input-Output Table was published (HMSO, 1994). Accordingly, the modeling analysis (Input-Output and Computable General Equilibrium) undertaken in my thesis are based on this database. Table 1.2 provides an analysis of the structural characteristics of UK owned and Overseas owned firms in Scotland, 1989.

[2] More recently, Scotland has benefited from the location of service/call centres. This follows the increasing concentration of large call/services centres by MNC's to serve a particular market. However, the focus of this analysis concentrates primarily on the impact of foreign-owned manufacturing investment, as comparable data for service sector plants is not available.

Table 1.2 - Selected economic indicators for UK-owned and overseas-owned firms in Scotland, 1989			
	UK owned	Overseas Owned.	Foreign-owned as a percentage of UK-owned.
Number of units	9,256	464	4.8
Net output (millions)	7,219	3,057	29.8
GVA (millions)	5,820	2,490	30.0
Net Cap Expend (millions)	748	484	39.9
Gross Wages (millions)	3,081	980	24.1
			Ratio of Overseas to UK owned.
Employment per unit	32	165	5.2
Net output per employee	24,439	39,912	1.6
GVA per employee	19,703	32,505	1.6
Net Cap Exp. per employee	2,533	6,320	2.5
Gross Wages per employee	10,430	12,798	1.2

Note that foreign-owned plants are typically larger in terms of plant employment and more productive in terms of both net output and value added per employee. They typically invest more per employee and, on average, pay higher wages. In general, foreign-owned manufacturing plants in Scotland display quite distinct structural characteristics from indigenous plants. Before discussing the potential impact of inward investment in a regional economy such as Scotland, the following section provides a theoretical overview of the main determinants of FDI.

1.5 Theoretical Determinants of Foreign Direct Investment (FDI).

The starting point for the theoretical analysis of the determinants of FDI stem from the early general equilibrium trade models (MacDougal, 1960). These models essentially attempted to explain foreign direct investment purely in terms of relative factor endowments (Mundell, 1957), with capital-rich countries exporting capital (FDI) to poorer countries. Although inconsistent with the actual patterns of current FDI flows, these models provided important early insights. For instance, they recognised the importance of FDI, in the absence of trade, as a process for overcoming trade barriers and equilibrating capital returns between rich and poor economies. The major difficulty, though, with the relative factor endowment/cost approach is that they could not explain the motivation for FDI flows between countries with similar resource endowment and cost structure i.e. FDI between developed countries. Essentially, these trade models were based on a Hecksler-Ohlin (comparative advantage) type approach.

In contrast, modern theories of FDI flows encompass a range of factors and are typically captured within a wider eclectic framework (Dunning, 1980). This approach essentially points to three key factors that underpin the decisions of firms to invest abroad. These are that firms investing abroad may acquire or create assets that afford them an advantage over local firms in the host economy. Secondly, firms may choose to locate production facilities in particular countries to overcome trade restrictions, differences in factor costs (cheaper factor inputs) and government regulations. Thirdly, through the internationalisation of production multinational companies can maintain control over their foreign-ownership advantages (technical know-how), rather better than they could through licensing and other arrangements. In all cases, the host country characteristics are external to the firm whereas the ownership of production facilities and technologies are internal factors. A combination of these internal and external factors determines both the location patterns, and the regional impact, of FDI.

1.5.1 – Transactions Cost Approach.

The transactions cost approach is subject to many interpretations. Various authors have contributed to the concept of internalisation (Pitelis & Sugden, 1991). However, the general consensus of this group is that the investing firm needs no specific advantage over other firms, unlike the eclectic paradigm, to enter or set-up location in another country. The transactions cost approach instead focuses on the efficiency with which transactions between units of productive capacity are organised, given the existence of market imperfections. These market imperfections relate to both structural and natural factors.

Hymer's (1976) theory is referred to as one of structural-market-imperfections as he advanced this concept, though many of these structural market imperfections are of the type highlighted by Bain (1956).[3] Structural market imperfections are typically viewed as market characteristics that restrict the free access of a new firm entering that market. In contrast, natural market imperfections arise through the working of markets as knowledge is not perfect, and thus market exchange involves information enforcement and bargaining costs, which implies the existence of positive market transaction costs. Thus, these transactions are positive in an imperfect market and can be further characterised by problems of bounded rationality, opportunism and uncertainty on the part of productive units or agents.[4]

Thus, the firm will internalise itself efficiently to carry out transactions within the firm that are not now subject to the positive transaction costs of the market. As noted, around one third of worldwide trade is now intra-firm (Markusen, 1995). Moreover, an investing firm may prefer direct investment to licensing. By doing so they can have more control over prices and output, and through internal co-ordination of resources, they can reduce the transaction costs of the market. Therefore, any advantage the MNC gains is derived through the organisation and efficiency of its transactions, which are gained by removing these functions from the market.

In summary, the transactions cost approach focuses on the firm and its internal efficiency rather than other firms outwith the market. The bulk of FDI into Scotland arises from large multi-national plants. This approach would suggest that in these

[3] For example, Bain (1956) viewed economies of scale, the use of high technology equipment, managerial experience etc. as barriers that the incumbent firm must overcome in their transition into this market. Advertising costs can also be considered as structural market characteristics, or sunk costs, which new firms must overcome (Sutton, 1974).

[4] Bounded rationality refers to the fact that agents in markets, though rational, have limited information available to them. Thus, they are intently rational, but only limitley so. The importance of this is that the value of goods and services exchanged will never be perfectly measured at market prices. Essentially, the implicit cost of transacting through markets and agents is higher than the actual markets value of these goods and services. This causes difficulties in the preparation of satisfactory contracts for the coordination of transactions between agents. Opportunism refers to self-interested behaviour on the part of agents designed to give them an advantage over other agents. The combined problems of bounded rationality and opportunism causes difficulties in organising transactions between agents through markets. Thus, imperfections in the markets for intermediate goods such as human capital, knowledge and marketing and managerial experience gives rise to time lags and transactions costs in the process of linking these intermediate products with many activities of a firm's outside production.

instances, the investing firm might have no specific advantage over rival firms in the market. Their advantage, instead, stems from their ability to efficiently internalise important markets, with the specific location choice, an important part of this procedure.

1.5.2 – Dunning's Eclectic Paradigm.

Dunning's main contribution to the theories of FDI is that he draws on several important approaches to set up his own "general" paradigm (Dunning, 1980, 1988, 1991). He combines the idea of ownership advantages, based on the earlier work of Hymer (1976), with elements of the internationalisation theory (transactions cost approach). However, in contrast to the transactions cost approach, Dunning asserts that the investing firm needs a specific advantage. These advantages relate specifically to ownership, internalisation and location. The ownership advantage refers to the fact that some firms have ownership to assets or rights which other firms do not possess or which they cannot gain access to. These assets or rights could relate to new products or processes, technological intensity, product differentiation or scale economies. For instance, with the increase in knowledge-based assets, and with the use of such assets as joint inputs across various plants, MNC's can benefit from economies of scale at the level of the firm rather than at the level of the plant (Markusen, 1995; Barrell & Pain, 1997). Recall that much of current worldwide FDI flows are concentrated in R&D intensive, high skill or high technology products.

The internalisation advantage is that through having one of the ownership advantages, the firm, through the process of internalisation, can remove the costs of inefficient markets in certain transactions. Essentially, Dunning suggests MNC's will control their advantage, i.e. knowledge, production, marketing etc. within the sphere of the organisation rather than through the market. The existence of knowledge-based assets also encourages firms to undertake FDI rather than licensing existing foreign firms to undertake production. Thus, through FDI, the firm can better control product quality and the dissemination of their technological know-how (Horstmann & Markusen, 1987). Thus, the internalisation approach refers to the firm rejecting contractual agreements with other firms and instead keeping their specific advantage under unified ownership. This is because internalisation of a market refers to the replacement of an arm's-length contractual relationship (i.e. the external market) with unified ownership (i.e. the internal market). It is the firm's strategic choice on what option to pursue. However, although internationalisation can bring advantages, it is hard to say that these are advantages intrinsic to the nature of the firm (Lui, 1994).

The distinction between this internalisation and the transactions cost approach is that, following the eclectic paradigm, the firm needs an advantage (firm-specific asset) to internalise. Thus, Dunning uses the term internalisation in a different sense from authors of the transactions costs approach. In the latter case, internalisation refers not to firm-specific assets (including knowledge-based assets) but the internalisation of the market for important intermediate goods i.e. input supplies. Accordingly, in the eclectic paradigm, the firm internalises the use of its own specific assets. Whereas, with the transactions cost approach, the firm creates its own advantage though internalising transactions which can be carried out more efficiently within the firm, rather than at the sphere of the market.

As particular ownership assets become more common, i.e. diffusion of technology through trade, MNC's may simply replace FDI with exports. However, even in such a case, FDI and exports may not be perfect substitutes, particularly where the MNC can obtain further advantages from close proximity to the market. With the increasing concentration of trade within particular trade blocks (European Union, North American Free Trade Association etc.), FDI can help remove effective trade barriers (Neven & Siotis, 1993; Barrell & Pain, 1997). Moreover, Poon and Pandit (1996) identify the strategic role of foreign direct investment in forging global production links and strategic alliances. For instance, through the process of internalizing their markets multinationals create a global supply and market structure, that develop regionally integrated networks of production and distribution. As a result, they suggest that transnational corporations have had a significant influence in configuring these new trading blocks within regions. Moreover, firms can benefit from closer proximity to markets by also providing important customer support. Therefore, trade barriers have an important effect on the location of production activities, particularly FDI.

The locational advantage refers to the case where some MNC's find it desirable to locate certain parts of their production process outwith their home country. The type of factors which can influence these type of decision are trade barriers (access to markets), government policies, relative resource costs (particularly labour costs) etc. Regional policy in the UK has sought to attract FDI to particular regions (Armstrong & Taylor, 1993) and recent empirical studies of the location decision of inward investor's reveal a number of interesting results.

1.5.3 (1) - Empirical Results and Findings

In a large study of the determinants of FDI for developing countries, the EU and other developed economies (US, Japan etc.), United Nations (1996) develop and estimate an econometric model using panel data for the period 1972-1988. The model attempts to explain which factors influence particular FDI flows to different regions. The basic regression model for each region or country takes the form:

$$FDI_t = \alpha_0 + \alpha_1 GNP_{t-1} + \alpha_2 \Delta GNP_t + \alpha_3 (I/GNP)_{t-1} + \alpha_3 XR_t + \alpha_4 V(XR)_t + \{\text{other variables}\}$$

Where

FDI_t	inflow of FDI to a particular region or country in year t,
GNP_{t-1}	the level of GNP in year t-1 (which signifies the size of the market),
ΔGNP_t	the change in GDP between years t-1 and t,
$(I/GNP)_{t-1}$	the ratio of domestic investment to GNP in year t-1,
XR_t	the exchange rate, defined as a ratio of the domestic currency to the dollar, at year t, and
$V(XR)_t$	the squared deviation of the exchange rate from its mean over the period 1972-1988.

The model is estimated using ordinary least squares (OLS) regression analysis with annual (panel) data for the period 1972 to 1988. Other variables have been included in the model to capture specific factors, other than those variables mentioned above, which are relevant to the three distinct group's of economies. The 'other variable' part of the model contains specific variables that relate to factors that influence or explain the determinants of FDI in these particular locations. For instance, the regression model for the developing economies (Latin America) included variables relating to the level of external debt and the degree of openness of the economy.

Table 1.3 – Results from regression analysis of the determinants of FDI for the developed countries, the European Community and other developed countries, 1972-88 (United Nations, 1996)*

Variables	Developed Countries	European Community	Other developed Countries
Constant	-304.37 (6.29)	113.39 (5.63)	-139.41 (3.33)
GNP_{t-1}	0.022 (11.35)	0.029 (7.23)	0.017 (8.92)
ΔGNP_t	0.37 (3.19)	0.74 (4.49)	0.22 (1.45)
$(I/GNP)_{t-1}$	834.96 (4.92)	278.87 (5.26)	329.87 (2.01)
$V(XR)_t$	-414.41 (4.35)	-64.11 (2.64)	-448.04 (2.52)
R^2	.92	.87	.88
D/W	1.51	2.05	1.78

***t-statistics in parenthesis.**

Table 1.3 reports the regression results, from the above model, for the factors that determine FDI inflows to the developed economies, including the EU. The results indicate that four main factors explain the variation in FDI inflows between developed regions (economies). These are the size of the economy (GNP_{t-1}), the change in the level of GNP (ΔGNP_t), the deviation of the exchange rate ($V(XR)_t$) and the ratio of investment to GNP $(I/GNP)_{t-1}$. Note that the regression results are quite consistent across the three developed regions. In summary, the results suggest that the characteristics of developed economies are important in attracting and determining inward investment flows. The relative size of the markets and change in GDP has significant positive impacts on FDI inflows for both the developed countries and the EU. Inward investment would also appear to be compatible with domestic investment as indicated by the positive significant coefficient on the $(I/GNP)_{t-1}$ variable. Note also that exchange rate volatility has a negative (and significant) impact on inward FDI flows to these regions.

Table 1.4 – Results from regression analysis of the determinants of FDI for developing economies: Asia, Latin America and Africa, 1972-88 (United Nations, 1993).*

Variables	Asia	Latin America	Africa
Constant	-1.33 (-0.83)	-16.64 (-2.61)	-0.71 (-0.96)
GNP_{t-1}	0.022 (11.35)	0.029 (7.23)	0.014 (2.80)
ΔGNP_t	0.018 (0.66)	0.74 (4.49)	
XR_t		0.062 (0.97)	1.01 (2.49)
$V(XR)_t$	-119.19 (-3.23)		
O_{t-1}		41.68 (1.92)	
$XDBT_{t-1}$		-0.016 (-2.03)	

* **t-statistics in parenthesis.**

Table 1.4 reports regression results for three developing economy regions (Asia, Latin America and Africa), for the period 1972-1988 using the same basic regression model. Note that the regression results vary across the three regions. For Asia, the size of the market and the volatility of the exchange rate are the only significant variables. The size of the market has a strong positive influence on FDI inflows whereas the volatility of the exchange rate has a negative impact. The other two variables, which were included in the model for this region, are insignificant, though the coefficients indicate appropriate signs. In general, the results for Asia are not dissimilar to those reported for the developed regions in Table 1.3.

For the regression model of FDI inflows to Latin America, two additional variables are included. These relate (or proxy) the level of indebtedness and the openness of the economy to trade. The regression results for Latin America suggest that both the size of the market and its relative growth (Year on change in GDP) have a positive impact on FDI inflows. Both the variance in the exchange rate and the exchange rate itself play no significant role in influencing FDI inflows over this period. This is rather surprising and may indicate mispecification of the regression model. Note that the level of indebtedness had a negative impact on FDI inflows in Latin America. In general, the regression results for the determinants of inward FDI to Latin America are less convincing. The final column of results, reported in Table 1.4, is for Africa. In this case the regression results indicate that the size of the market and the exchange rate are the only statistically significant determinants of FDI into this region.

In summary their results suggest that the size of the market is an important determinant of FDI inflows in developing countries. However, this may simply reflect a scale effect, in that, larger countries will obviously have larger flows of FDI. The general regression model would appear to explain FDI inflows in developed economies substantially better than for developing economies. This may, in part, stem from the specification of the model used for these economies and regions or a lack of appropriate data. Moreover, developing economies tend to be more diverse in a number of ways and the application of such a general regression model to the different regions is perhaps inappropriate.

More recent econometric evidence of the determinants of outward FDI into Europe (based on the two largest investors, United Kingdom and Germany) provides similar evidence to support the results reported in Table 1.3. Barrell & Pain (1997) estimate a regression model in order to explain the determinants of the level of outward foreign investment, from the UK and Germany, in sector i, in location j (FDI_{ij}). Thus, the dependant variable is the stock of outward FDI in industry i, for region/location j. For the UK region, the FDI data are disaggregated into seven industrial sectors, with location j relating to UK FDI to either the US or EU. The German data also covers seven industrial sectors, however there are additional data for the locations of outward German FDI. A summary of the regression results, reported by Barrell and Pain (1997), is presented in Table 1.5.

Table 1.5 – Summary of the Determinants of FDI into Europe based on the findings of Barrell & Pain, 1997 (Page 1774-75).		
	United Kingdom	Germany
Ln $(FDI_{ij})_{t-1}$	0.5472 (8.0)	0.3799 (6.5)
Ln $(OUTPUT_{ij})_t$	0.4669 (2.1)	0.3243 (2.9)
Ln $(PATENTS_I)_t$	0.7885 (4.3)	0.6997 (5.6)
Ln $(RELCOST_j)_I$	-0.5070 (5.4)	-0.2048 (6.2)
$GEARING_{t-1}$	-0.7886 (2.0)	
$GEQP_t$		0.2800 (4.8)
Ln $(PROFITABILITY)_{t-1}$		0.4643 (2.4)
Ln $(STRIKES_j)_t$		-0.0679 (3.0)
$EXRATE_{jt}$		0.1086 (2.4)
$IMIND_{ij}$	0.0758 (2.5)	0.0539 (4.1)
$IMSER_{ij}$	0.1049 (3.0)	0.0994 (5.1)

Where:

LN $(FDI_{ij})_{t-1}$ Constant price stock of FDI in sector i in location j measured in US dollars at 1990 prices.

Ln $(Output_{ij})_t$ Value added output measured in US dollars at 1990 prices.

Ln $(Patents_i)_{t-1}$ Cumulative stock of patents

Ln $(Realcost_j)$ Unit labour costs in host location relative to investing country. (All unit costs are converted into a common currency using 1990 PPP's.)

GEARING Interest gearing in UK corporate sector

GEQP Rate of growth of German real equity prices

Ln (PROFITABILITY)	Rate of return in German business sector
Ln ($STRIKES_j$)	Number of labour disputes in host location
$EXRATE_j$	Dummy for ERM members
$IMIND_{ij}$	Dummy variable for the Single Market Participation
$IMSER_{ij}$	Dummy variable for the Single Market Participation

Barrell & Pain (1997) attempt to explain the determinants of outward FDI by the UK and Germany by estimating the above regression model. The panel data cover the period 1980 to 1992. To capture changes in the structure of the EU (completion of internal market) they include two additional dummy variables. Their results indicate that relative costs and market size continue to affect the level of foreign investment, even between developed countries. Note the statistically significant impact of relative labour costs (negative coefficient) indicating that where labour costs are higher than in the host country this has a negative impact on FDI inflows to that region. (This suggests that MNC's in the UK and Germany are reluctant to locate (or-relocate) production to a higher labour cost location.) The variable relating to knowledge-based assets (Patents), also has a significant effect on FDI outflows in both the UK and Germany, suggesting that R&D intensive sectors are more likely to invest abroad. This is consistent with the concentration of FDI in high technology or R&D intensive sectors or products, between developed economies. The existing stock of FDI in these sectors also has a positive effect in both cases. In summary their results suggest that outward flows of FDI, by UK firms, to Europe and the US are determined largely by the existing stock of FDI in that sector or region, the size of the market and the relative labour cost differential between the host country sector and the region being considered for investment.

Other studies of the determinants of inward investment suggest that inward investors enter the UK regions to take advantage of either low factor prices or access to adjacent markets (Hill & Munday, 1994). Pain and Lansbury (1997) note that UK labour market reforms have been beneficial for attracting German FDI into the UK. However, they also note that the UK has not performed as well in attracting R&D intensive investments. PACEC (1996) report that the primary reasons for inward investors locating within the UK are market led: 70% of all respondents noted that it was very important to capture new markets. Of those seeking to establish new markets, 70% were targeting the UK. Another important determinant of the UK regional distribution of FDI is the share of regional aid. Taylor (1993) finds that assisted-area status is of particular importance for explaining the location decisions of Japanese manufacturing in the UK over the period 1984 to 1991. Over the same period, however, he also found that differences in relative labour cost between regions were not significant in determining the location of Japanese FDI in the UK. Potter (1993), in his analysis of in-moving branch plants to Devon and Cornwall (76 plants), found that the availability of regional aid was the single most important factor, for two thirds of his sample, for choosing that particular location.

However, O'Sullivan (1993) in an investigation into the determinants of FDI into Ireland found that the availability of regional assistance had no significant impact on US FDI to Ireland, over the period 1980 to 1992. His results indicated that infrastructure and labour quality were more important than the availability of government subsidies. US based research on the distribution of FDI between States in the US, also suggest that infrastructure, market size and labour market characteristics of States are important determinants of inward FDI (Glickman & Woodward 1988; Woodward, 1992).

Wheeler and Moody (1992) in an empirical study of the international investment (location) decisions of US multinationals during the 1980s, develop and estimate a non-linear capital expenditure model for US multinationals. The model incorporates different measures of agglomeration economies and risk, as well as various measures of relative input costs such as labour. In their analysis they consider the main factors that determine the location patterns of FDI, in light of the growing competition to attract multinational investment to particular locations. They find all three agglomeration measures, used in their econometric model, exhibit a high degree of statistical significance and have large positive impacts on investment, with the level of infrastructure displaying the largest elasticity. Labour costs and market size are also found to be significant, although differences in corporate tax rates had no significant impact. They further split the sample of countries into developing and industrial economies in order to determine which factors are important for these different groups.

In the developing countries, infrastructure quality and labour costs were dominant, which suggests multinationals give particular weight to these variables when considering locations. This seems consistent with the view that most FDI into developing countries use that particular location as an export base, as opposed to producing for local markets. Thus, the market size of the developing country was of less importance to US multinationals. For industrial economies, the two general agglomeration variables (the existing stock of foreign investment and the level of infrastructure) are the two main factors in determining the locational choice of US multinationals. Market size and labour costs had lesser impacts. Here US FDI to developed economies would appear to be market seeking.

Overall, their findings suggest that US multinationals give almost all their decision weight to agglomeration-related factors, with infrastructure quality clearly dominant in developing countries and specialised support services more important for industrial economies. Wheeler and Moody (1992) suggest that US multinationals appear to prefer quality infrastructure ahead of tax breaks, such as the incentives currently offered by various governments to attract these investments. This is consistent with the results by O'Sullivan (1993) for US FDI into Ireland. His results find that infrastructure and the quality of labour are more important to US multinationals than the availability of fiscal incentives.

In summary this section has provided an overview of the main theoretical motivation, and related empirical work, concerning the determinants of inward investment. Dunning's eclectic paradigm attempts to provide a general rationale for explaining why inward investors choose particular courses of action. The empirical literature suggests that a range of factors can influence the location decision of mult-national companies. The results suggest that the UK is an important market for FDI as well as providing a production base to export into the EU. Outward FDI from the UK is determined largely by the size of the market and the relative factor costs of the location being considered by the investor.

1.6 The Impact of FDI on the Host Economy.

As a key component of UK regional policy, FDI is thought to have positive regeneration effects in the assisted regions throughout the UK (Armstrong & Taylor, 1993). However, the overall impact of FDI (foreign-owned manufacturing) on the host region can be influenced by a range of factors. These typically include both the characteristics of the region and the remit or level of autonomy of the multinational plant (United Nations, 1992; Young *et al*, 1994). For instance, the size, industrial structure, quality of labour available within the region, all influence the regional impact of the incoming plant. Moreover the objectives (or degree of autonomy) of the incoming plant will determine the range of economic activities the plant will consider undertaking at this particular location.

Economic theory basically provides two approaches to studying the effects of FDI on host countries. The first perspective originates from the standard theory of international trade, which focused primarily on the direct employment or export effects of FDI (MacDougal, 1960). The second approach considers FDI in a wider sense. Rather than occurring as a byproduct of international trade, FDI can have important effects on the structure of regions. The key distinction from both these approaches stems primarily from their view of a capital inflow or FDI. Modern FDI theories focus on FDI as not only representing a capital flow, but also representing entry into a national industry by a firm established in a foreign market. More importantly, these modern FDI theories note that entry by foreign firms may influence both the structure and performance of host country firms (Dunning, 1994; Caves, 1996). Thus, FDI can have substantial system-wide impacts.

The traditional view of FDI was that everyone gained. GDP would rise initially from the increases in employment, investment and capital stock, generated by the incoming foreign plant. The precise spin off to a local economy could vary, depending on the nature of the incoming plant and how integrated the production-activities of the plant are within the local economy (United Nations, 1992). Where linkages with the local economy are strong, the indirect (multiplier) effects of the plant will support a range of local activity. Moreover, indigenous firms could benefit from FDI through the transfer of technology and industry-specific knowledge or know-how. In particular, where strong purchasing and sales links exist between foreign-owned and indigenous plants, local sourcing could lead to efficiency improvements or spillovers, in indigenous plants (Blomstrom, 1990). FDI could also lead to the creation of new specialised local firms to service the local sourcing needs of the incoming foreign plant, thus indirectly improving the industrial base of the region through greater diversification. Moreover, foreign-owned plants typically export a large percentage of their output, which not only generates additional income effects at the regional and national level, but also has positive balance of trade effects. In summary, modern FDI is thought to have important impacts in the following areas: the labour market; trade and balance of payments; technology transfer and innovation; linkages and spillovers (Young *et al,* 1993).

Less favourable impacts from FDI have also been noted. For instance, FDI may simply lead to the displacement of indigenous plants or activity with no net employment gain (Gillespie *et al,* 1997). Crowding-out may arise through FDI leading to distortions in the markets for goods and services, which can cause price rises. Foreign-owned plants may source little or no inputs from local suppliers and, instead, import supplies into the region which reduces the scale of the potential employment impact and can have a detrimental effect on the balance of payments. Finally, FDI can lead to industrial dependence and the technological underdevelopment of host economy industries (Britton, 1980).

As noted previously, FDI plays an important role in regional policy for Scotland. The potential impact of incoming-plants, on a regional economy such as Scotland, has become increasingly difficult to quantify. This, in part, reflects the often distinct and different patterns of FDI and the evolving structure of multinational firms, which has led to the existence of a series of potentially wider impacts and effects (Dunning, 1994; PACEC, 1996). Traditionally, the impact of FDI centred on the direct and indirect employment effects generated by the incoming plant. Impact analysis, essentially using demand based approaches, evaluated FDI in this manner.

Employment effects are still important, particularly in a regional context, although more system-wide impacts are now being identified. In general, modern FDI is thought to have impacts in the following areas:

- Patterns of linkages.
- Efficiency and capital intensity of value-added production.
- Behaviour in the labour market.
- Research and Development activity.
- Degree of export orientation.
- Flow of profit income.
- Agglomeration economies
- Efficiency Spillovers.

I now deal with each in turn.

1.6.1 Pattern of Linkages.

The basic framework for considering linkages stems from Hirschman (1958 p. 100) who defined a backward linkage as "every non-primary economic activity which will induce attempts to supply through domestic production the inputs needed in that activity". Forward linkages are defined as "every activity that does not by its nature cater exclusively to final demands and which will induce attempts to utilise its outputs as inputs in some new activities". The specification of both backward and forward linkages is formalised in equation (1) and (2). The measurement of backward linkages is based on the proportion of total output spent on purchases from other (local) industries (equation 1 below).

$$\text{Backward Linkages (B.L.)} = \frac{(P-I)}{(O+V)} \qquad (1)$$

Where

P - Total purchases from other industries.

I - National Imports.

O - Total Output.

V - Changes in inventories.

The measurement of forward linkages is expressed in terms of the proportion of total output going to industrial users, excluding output going to final demand (equation 2 below).

$$\text{Forward Linkages (F.L.).} = \frac{(O - o - E)}{(O + V)} \qquad (2)$$

Where

O - Total output.

o - Total output going to final demand.

V - Changes in inventories.

E - Exports.

Hirschman (1958) suggests that it is important conceptually to distinguish between those inter-industry linkages that earn positive external economies and those that do not. The latter (backward linkages) induce downward shifts in cost curves through the linkage mechanism whereas the former represents non-cost reducing coupling effects between firms. Backward linkages are generally considered as being dominant in terms of the employment impact of plants or industries. Hirschman focused on linkage mechanisms within the economy. His theory of economic development centred on the proposition that industries that generate more linkage effects than others also generate greater economic growth due to their stimulus to local industry. His development theory suggests the promotion of those industries with the most in-depth linkages.

Hirschman later extended the linkage concept to include other methods by which a new firm may induce further industrial activity, and facilitate further economic development (Hirschman, 1977). He identified consumption linkages (income multipliers) arising from incomes created by new industrial activity. The analysis can be broadened further to also include learning effects that impact on skills and innovation and technical progress, as developed further by Dunning (1994) with the concept of the technological multiplier.

A principal concern of work on FDI has been the strength of local linkages, usually expressed as the degree to which foreign firms are embedded within the local or regional economy. The level of inputs that are sourced locally is often taken as a measure of how 'embedded' a plant or sector is within the region. The depth of linkages is also an important determinant of the indirect impact of the plant or sector on the regional economy. Moreover, recent research has indicated that linkages are an important vehicle or channel through which technology transfer and other non-physical inputs can flow (United Nations, 1992). The importance of FDI in a regional context has led to an increasing number of plant or industry specific studies, in which, the main focus of the analysis is the measurement of linkages. The focus on linkages for these studies essentially fall into one of two main categories:

1. The desire to quantify the actual 'physical' linkages of a plant or sector in order to measure the total impact of that sector in relation to other sectors or regions.
2. To consider the linkage mechanisms of firms or industries as a potential route for technology transfer.

FDI studies essentially cover both of these issues. The former set out to investigate the importance of a sector for a particular region and whether the plant or sector could be more integrated within the region. Here the focus is primarily based on the physical linkages of the plant within the region. i.e. sourcing patterns. These studies often consider whether there is realistic local supplier capacity within the region that would allow for import substitution. The latter consider the potential existence of spillovers or technology transfer via the 'type' or 'quality' of linkages or inputs that are sourced by foreign-owned plants from local suppliers. These studies investigate the linkage mechanisms of the incoming plants with local suppliers and consider the potential for upgrading of these suppliers via interaction with the MNC.

As noted, there has been a considerable growth in research investigating the linkage structure of individual plants or industries (O'hUallachain, 1986; Mair *et al*, 1988; Barkley & Smith, 1991; Barkley & McNammara, 1993; Phelps, 1993; Turok, 1993; Gray *et al*, 1998). The focus of these studies has tended until fairly recently to be on the scale and value of supplies and jobs created among suppliers. Turok (1993) has distinguished two distinctive alternative definitions of linkages, within this debate. These are developmental and dependency. The former is linked to collaborative partnerships between foreign firms, suppliers and distributors, encouraging geographical clustering to minimise transaction and transport costs and maximise networking benefits. In the developmental linkage case, Turok (1993) suggests that the potential exists for wider technology transfer via these linkages. In the dependency case, linkages with suppliers are hierarchical, governed by price considerations or other short-term objectives. In this scenario, Turok (1993) suggests that inward investor's ties to the locality are thus weakly embedded, in marked contrast to those in the developmental case. These type of linkages relate typically to low value-added goods, which are cheaper to source locally because of travelling costs. For instance, bulk packaging materials such as cardboard or plastics. Whether such a clear cut distinction exists is in fact dubious, since a typical inward investor could have a range of relationships with suppliers depending on the importance and perhaps technological sophistication of inputs (Young, *et al*, 1994).

Lyons (1995) in the analysis of agglomeration economies among high technology firms in Denver/Boulder separated out the linkages of sample firms into both routine and sophisticated. He further distinguished whether the products of these firms were produced for local or global markets. He suggests that different types of linkages have various potential impacts on the agglomeration potential of the region. His study found that routine input linkages (backward) accounted for 62% of all linkages, with the more sophisticated input requirements (linkages) accounting for 38%. The distinction between sophisticated and routine linkages is based on whether the inputs are required specifically for products sold in global or local markets. Products sold in global markets are more technologically advanced and require more sophisticated inputs.

Of the sophisticated inputs required, Lyons (1995) suggests that the locally produced inputs had the potential to generate the greatest innovative effect and thus add to the agglomeration impact of the region. However, his results indicate that the fixed simple linkages (routine) reflected the most common form of backward linkages and the flexible/complex linkages refer to firms within the agglomeration being able to source sophisticated inputs. Of the two sets of linkages, the latter represent a greater potential for agglomeration impacts. Nonetheless, the former represent the most common form of linkage used, with the most likely impact being realised in the form of a multiplier effects to increase local employment. This is similar to the distinction noted by Turok (1993) between developmental and dependent linkages. Finally, Lyons (1995) highlights the importance of high value added, locally produced, sophisticated linkages.

Mair *et al* (1988) note that "there has been a marked tendency for supplier firms to cluster around the particular assembly firms they supply or alternatively to locate in areas readily accessible to a number of assembly plants". They suggest that increased proximity between firms and their suppliers are encouraged by vertically disintegrated production organisations, which incorporate both specialised production runs and just in time inventory replacement systems. This is certainly the case with Nissan in Sunderland, as a number of existing Japanese suppliers to the plant located production facilities within an immediate proximity of the plant (Peck, 1990).

The issue of national level linkages is an issue that is controversial especially for countries that rely largely upon external investment. However, the degree of import dependence for particular sectors or plants can be highly misleading unless it is specified. Thus, in some cases, imports of particular inputs are essential, as it is not always possible for the host economy to supply that input more competitively. Thus increasing backward linkages may not always be possible, as non-availability of natural resources may constrain linkage development. Hence, it is important to distinguish between the total/domestic link gap, and the potential domestic linkage/current domestic linkage gap (O'Farrell & O'Loughlin, 1981). The latter represents realistic import substitution potential, that is, those imported materials and intermediates in which the host economy is able to supply.

Barkley & McNamara (1993) examined the input purchasing patterns of foreign-owned and domestic manufacturers to determine if local economic impacts vary by country of ownership. They categorised the direct effects of FDI as the increased employment opportunities, the diversification of the local industrial base, introduction of innovative management, labour and production processes, within the region. The indirect effects were focused on stimulated demand for local inputs (backward linkages). They suggest that strong backward linkages provide the impetus for a more dynamic economy and long term economic growth. Other research indicates that local (backward) linkages increase the longer the period the plant is based at a particular location (Barkley and Smith, 1991; Williams, 1997). This is consistent with the theory of FDI and the development of wider impacts, such as Dunning's technological multiplier (Dunning, 1994). Essentially, the entry of the plant may essentially be based on a series of stages. As the plant becomes established within the location, more production and related activities may be allocated to the functions of the plant. This may lead to local sourcing of inputs or in-house research and development activities. The importance of linkages stems not only from their potential impact on employment, but that they act as a potential channel or vehicle through which technology transfer or industry-specific knowledge can flow (United Nations, 1992).

The current linkage debate essentially centres on what can be regarded as a consistent measure of how tied or integrated a plant or sector is within the region. For instance, by using the Hirschman (1958) 'backward linkage' definition, foreign-owned plants will typically have lower linkages than indigenous firms within the same industry/sector. For instance, for small open regions such as Scotland or Ireland, the import-intensity of the foreign-owned manufacturing sectors is over 65 per cent. (Barry & Bradley, 1997). Many of these imports are typically sourced from inter-firm plants of the multi national corporation. Therefore, the proportion of inputs sourced locally is typically low relevant to the total output of these plants. However, the overall value of actual local purchases is significant even though it represents a low proportion of the overall total of output generated by the plant, sector or industry. O'Malley (1995) and Rodriguez-Clare (1996) in contrast, suggest that backward linkage per unit of labour is a more appropriate measure of linkage. This measure of linkage allows for the typically high intermediate and capital intensity of production, which is typically associated with foreign-owned plants. (These issues are discussed in further detail in Chapter 5 using the ownership-disaggregated Scottish Input-Output Table for 1989).

1.6.2 Efficiency and capital intensity of value-added production.

Foreign-owned firms are generally identified as being both more productive and more capital intensive than their domestic rivals (Young et al, 1993). For Scotland, net output and net capital expenditure per employee are much greater in foreign-owned, as against UK-owned plants (Scottish Office, 1997). Recall that Table 1.2 indicated that substantial structural differences exist between these sectors. For instance, although foreign-owned manufacturing plants account for around one third and one fifth, respectively, of total Scottish manufacturing output and employment, they account for nearly half of all capital expenditure (Scottish Office, 1997). Essentially, foreign-owned plants are more productive, *per se*, than indigenous plants. For instance, output and value added per employee in foreign-owned plants in Scotland is considerably greater than indigenous-owned plants. Moreover, value added per employee is often taken as a measure of labour productivity or relative efficiency.

FDI theory provides two types of explanation for the 'efficiency' or productivity differentials that exist between UK and foreign-owned manufacturing plants. The first stems from the theory of the multinational firm (transactions cost approach), where the efficiency advantage is derived from how the parent company set-up the plant and organise transactions. The second type explains the productivity advantage in terms of structural and ownership differences (Davies and Lyons, 1991). The structural effect can be attributed to foreign firms being predominately located in high productivity sectors, whereas the ownership effect is related to considerations intrinsic to the firm, such as access to new technology or products, as noted in Dunning's eclectic paradigm (Dunning, 1991). Thus, the relative capital intensity of production in foreign-owned plants may reflect either the industrial structure of the sector or the lower cost of capital available to the multinational enterprise.

The measurement of the relative productivity (efficiency) differential between foreign and indigenous manufacturers is difficult. The most commonly employed method involves comparing either gross output or gross value-added per employee.

These methods are straightforward to calculate but suffer from being based on aggregate data, which at best, provides a crude measure. For instance, in simply comparing GVA per employee for UK owned and Overseas owned firms the results suggest that considerable efficiency differences exist. For instance, applying such a method to Scotland would indicate differences of around 40 per cent, respectively. However, this method does not consider the relative factor intensities or output scale of, both sectors, and the type of industries foreign firms tend to penetrate. Thus, being based on aggregate manufacturing data, the use of GVA per employee fails to control for the industrial distribution of foreign enterprises. In particular, the possibility that foreign enterprises are disproportionately represented in the higher productivity industrial sectors without being necessarily more productive, *per se*, than indigenous companies.

Davies and Lyons (1991) calculate an aggregate productivity differential for foreign and domestic enterprises based on gross value added per employee.[5] However, they further decompose this aggregate value into the structural and ownership effects. They define R as the aggregate productivity differential, which is the ratio of aggregate labour productivity in foreign owned enterprises (FOE's) to that in domestic owned enterprises (DOE's). This is related to the levels in individual industries by equation (3):

$$R = \frac{\Sigma X_i V_i}{\Sigma Y_i W_i} \qquad (3)$$

Where;

V_i is employment by foreign owned firms in industry i as a proportion of employment by foreign owned firms in manufacturing as a whole.

W_i is employment by UK owned firms in industry i as a proportion of employment by UK owned firms in manufacturing as a whole.

X_i is the labour productivity of foreign owned firms in industry i.

Y_i is labour productivity of UK owned firms in industry i.

[5] Gross value added, per employee, is used by the government as an indicator of labour productivity in official evaluations (PA Cambridge Consultants, 1993).

X_I and Y_I relate to Gross Value Added (GVA) in the UK and foreign manufacturing sectors. All summations run from i = 1......n industries.

Davies and Lyons (1991) calculate the ownership effect (T) as follows;

$$T = \frac{\bar{X}}{\bar{Y}}, \qquad (4)$$

Where, $\bar{X}$ and $\bar{Y}$ are the arithmetic means of X_i and Y_i. From which, by applying the factor reversal test, Davies and Lyons (1991) determine the structural component of the aggregate productivity differential which is measured by S and therefore;

$$R = T * S. \qquad (5)$$

Where,

R = Aggregate productivity differential

T = Ownership effect

S = Structural effect

This decomposition was applied to UK time series data for 1971-87 and the plot showed the aggregate productivity advantage R varied over different periods but increased in absolute terms over the same period. The ownership effect T declined in absolute terms over this period while the structural effect displayed a steady almost continuos rise throughout. This is consistent with the increasing pattern of two-way FDI between high-technology sectors in developed economies. Thus, the upward trend in S suggests that it is structural factors that have been the main cause in rising aggregate productivity differentials. Therefore, this suggests the large distribution of foreign firms in high productivity industry accounts for a large part of the implied relative efficiency difference, which exists.

Table 1.6 – Results of the aggregate decomposition of Gross Value Added between indigenous and foreign-owned manufacturing sectors, as reported by Davies & Lyons, 1991, and a comparison with Scottish manufacturing data for 1989 following the same procedure.			
Year	**R –Aggregate Productivity Measure.**	**T – Ownership Effect.**	**S – Structural Effect.**
1985	1.408	1.198	1.175
1986	1.400	1.193	1.174
1987	1.486	1.235	1.203
	Scottish Estimates		
1989	1.409	1.201	1.174

Table 1.6 reports results from Davies and Lyons (1991), and my own calculations using comparable Scottish data[6], for the aggregate productivity difference (R) between foreign and UK-owned firms, further broken down into the ownership effect (T) and the structural effect (S). Davies & Lyons (1991) calculate the aggregate productivity difference at 41% in 1985, which rises to 49 per cent, respectively in 1987. Similarly, the ownership effect (T), which accounted for nearly 20% of this differential in 1985, increases to 23% in 1987.[7] The structural effect (S) follows the same upward trend and accounts for 17% in 1985 and 20% in 1987. Note that the results using the Scottish data set for 1989 are very similar to the UK 1987 figures derived by Davies and Lyons (1991). Thus, for the Scottish data, the aggregate productivity differential is nearly 41%, of which, 20% is attributed to ownership effects and the 17% to structural effects.

In summary, using aggregate measures such as GVA or output per employee may simply reflect the production processes of sectors, rather than measuring relative

[6] I replicated the same procedure followed by Davies and Lyons (1991) using Scottish ACOP manufacturing data covering 19 industrial sectors based on the 1980 Standard Industrial Classifications (SIC) with data for 1989. Of the total manufacturing employment covered, foreign-owned plants accounted for 15 per cent.

[7] The results that reported in Table 6.1 capture only the last three observations (1985-1987) of the aggregate productivity measures calculated by Davies & Lyons (1991). These data report an upward

efficiency. Davies & Lyons (1991) provide one method in which they decompose the aggregate productivity difference to reflect the factors that constitute these differences. Thus, FDI is typically concentrated in high technology sectors or industries. Moreover, given that the existing theoretical literature, relating to the determinants of FDI, points to the existence of superior technology or production processes (ownership advantages) by inward investors, this analysis provides a more appropriate measure of relative efficiency. Thus, Davies and Lyons (1991) provide one distinct approach for considering the relative productivity differences that exist between foreign and indigenous manufacturing plants.

Driffield (1996) estimates a regression model in order to explain differences in labour productivity between UK and foreign-owned manufacturing plants in 1984. The data are taken from the Workplace Industrial Relations Survey for 1984, which consisted of 472 manufacturing plants, 72 of these were foreign-owned. He finds that the most important variable in his regression model, which attempts to explain differences in labour productivity between UK and foreign-owned manufacturing plants, is the capital/labour ratio. He finds that the impact of this ratio is over three times larger, on average, for foreign firms as compared with domestic firms. Therefore, he suggests that much of the relative labour productivity differential, between foreign and UK-owned plants, are explained by differences in the internal production processes employed by these plants. Finally, the FDI literature in general focuses on the factors that influence the relative performance of both sectors rather than specifically quantifying the apparent productivity differences (Blomstrom; 1986; Wilmore, 1986; Harris, 1991b; Haddad & Harrison; 1992).

1.6.3 Behaviour in the labour market

FDI is thought to have a range of potential labour market impacts (PACEC, 1996). In Scotland, it provides an important source of employment accounting for around one fifth of Scottish manufacturing employment. The precise nature of the labour market impacts of inward investment depends, typically, on both the

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trend in the ownership effect (T) over this period. However, over the full time series (1971-87) the ownership effect falls in absolute value.

characteristics of the local labour market and the interaction with the foreign-owned manufacturing sector. For instance, foreign-owned firms typically pay higher wages than their domestic counterparts. In 1994, the average foreign-owned manufacturing wage in Scotland was £17,102 per employee, which is approximately 16 per cent higher than the equivalent average wage paid by the UK-owned manufacturing sector, £14,448 (Scottish Office Statistical Bulletin, 1997).

Moreover, Harris (1994) in his analysis into the size and causes of locational wage differentials associated with firm ownership, estimated that the mean hourly earnings of workers in the externally owned sector of industry in Northern Ireland were 34% higher than their domestic counterparts. Similarly, Driffield (1996) provides a plant level comparison of wages and productivity levels within the foreign and domestic sector of UK manufacturing. His results confirm the foreign-owned manufacturing plants are, on average, more productive and pay higher wages than indigenous firms. Before discussing the labour market impact of foreign-owned plants it is instructive to consider the determinants of wage rates in both sectors.

1.6.3.1 Foreign and UK-owned Manufacturing Wage Rates.

Dunning and Morgan (1981), find that part of the wage differential that exists between foreign and UK-owned firms is attributable to foreign-owned plants being concentrated in high wage industries. Cowling and Sugden (1987) further suggest that the wage differentials that exist between sectors relate primarily to the different work practices employed, particularly for Japanese firms. In contrast, Enderwick (1985) suggest that given the strong vertical links typically employed by MNC's, workers in such plants have increased bargaining power because a labour dispute in one plant can disrupt global production. However, very little empirical evidence exists that support these hypotheses.

Harris (1994) attempts to explain the size and causes of the locational wage differential associated with firm ownership, using data for male full-time manual individuals obtained from the 1987 Northern Ireland New Earnings survey. The survey covers 306 manufacturing plants, of these, 58 are externally owned and 248 are locally owned firms. Note that the definition of externally-owned firms in this analysis includes all companies whose headquarters are not located in Northern Ireland. UK-owned firms based in Northern Ireland are treated as externally-owned. The dependent variable is the log of hourly earnings in the sample week. He firstly estimates a bivariate Probit model in order to predict the status of the individual with regard to firm type and union coverage, with the unobserved latent variables U* representing union coverage and F* representing firm size as defined by:

$$U^* = X1\alpha + \varepsilon 1. \qquad (6)$$

Where U=1 if U* > 0 (covered by a union agreement)
U=0 if U* < 0 (not covered by union agreement)

$$F^* = X2\beta + \varepsilon 2. \qquad (7)$$

Where F=1 if F*> 0 (indicates externally owned firm)
F=0 if F*< 0 (indicates locally owned firm)

While wages in any sector (j, k) are determined by:

$$W_{jk} = X3_{\gamma jk} + \sigma\varepsilon 3_{jk}. \qquad (8)$$

Where: j = covered, not covered
k = externally, locally owned

Where:

X = a vector of regressors (explanatory variables) .
α, β and γ = parameter vectors
σ = a scale parameter.

The dependant variable (W) is the log of hourly earnings. The vector of independent (explanatory) variables, X, includes the following variables:

U dummy variable coded 1 if individual was covered by a collective agreement.

SIZE variable measuring company size.

FTSS dummy variable relating to whether the establishment in which the individual was employed had a full time shop steward.

QUAL variable relating to whether the worker had any qualifications.

AGE the age of the individual worker.

PPAY variable relating to whether the individual had received shift premium pay.

OTIME the ratio of overtime to normal weekly hours.

IPAY variable relating to whether the individual had received incentive pay.

NYRS the number of years the individual had worked in the company.

$NRYS^2$ the number of years the individual had worked in the company squared.

TAGT2-
TAGT5 dummy variables relating to the form of collective agreement, if any, covering pay at the plant.

IND dummy variables relating to particular industries.

Harris (1994) estimates the following sample means for male full-time manual workers by externally and locally owned sectors using data for the 1987 Northern Ireland New Earning Survey. He also includes industry level data, covering 21 industry groupings, for the period 1980 to 1986 to determine the characteristics of industries that are externally and locally-owned. These additional data cover the following variables.

STRIKE the average number of working days in each industry lost due to strikes.

ICOVER the percentage level of coverage by collective agreements in the industry. PRODG the average annual productivity growth.

Table 1.7 A summary of the sample means for male full-time manual workers that are employed by externally and locally owned sectors, as estimated by Harris (1994).

Externally Owned firms.				Locally Owned firms.		
Variable	Mean	Standard Deviation		Mean	Standard Deviation	t tests of means.
Log W	1.416	0.231		1.121	0.318	*6.75*
U	0.879	0.329		0.629	0.483	*3.79*
SIZE	8.690	2,617		4.838	2.559	*10.27*
FTSS	0.276	0.451		0.887	0.317	*-12.08*
QUAL	0.155	0.365		0.286	0.453	*-2.33*
AGE	44.017	12,741		38.314	12.896	*3.17*
PPAY	0.259	0.442		0.158	0.365	*1.81*
OTIME	0.157	0.221		0.182	0.352	*-0.45*
IPAY	0.276	0.451		0.258	0.438	*0.26*
NYRS	13.397	10.705		10.270	9.406	*2.21*
TAGT2	0.138	0.348		0.040	0.197	*2.86*
Data based on Industries.				Data based on Industries.		
Variable	Mean	Standard Deviation		Mean	Standard Deviation	t-tests of means
STRIKE	17.451	19.182		20.010	26.304	-0.71
ICOVER	69.670	114.165		68.840	23.689	0.33
PRODG	2.994	2.576		0.552	3.064	6.15

The first part of Table 1.7 reports sample means for workers in externally and locally-owned plants. These indicate that workers in the externally-owned sector receive a higher mean hourly wage rate than individuals employed in the locally-owned sector. The sample means also provide an indication of the characteristics of workers in both sectors. For instance, workers in the externally-owned sector are more likely to be employed in a larger plant and be covered with a single union deal. Workers in this sector also tend to be older, have more work experience, though less formal qualifications than comparable workers in the locally-owned sector. Individual workers in the externally-owned sector also receive more additional benefits in terms of productivity (PPAY) and incentive pay (IPAY). Finally, the sample means for the industry variables indicate that firms in the externally-owned sector enjoy a higher rate of productivity growth (PRODG). The other two industry variables (STRIKE and ICOVER) are insignificant. The sample means indicate that worker and industry characteristics differ across workers and plants in externally and locally-owned sectors.

Harris (1994) further estimates a bivariate Probit models for equations 1 & 2 to determine the factors which influence the probability of employees working in an industry with a single union agreement or not, or whether the firm is externally or locally owned.

Table 1.8 Summary of the estimates of the probability of employees working in an industry with a single union agreement or not, or whether the firm is externally or locally owned, as reported by Harris, 1994 (Table 2, Pg 488).

	Covered / not covered Equation (U =1 if covered)		Externally/ Locally owned Equation (F=1 if externally owned)	
Variable	α	t-value	β	t -value
Constant	-3.673	3.50	-3.924	3.28
SIZE	0.363	7.06	0.448	4.99
FTSS	0.189	0.65	-0.385	1.85
STRIKE	0.006	0.67	-0.010	1.77
QUAL	0.050	0.18	-0.320	0.93
PRODG	-0.139	1.92	0.026	0.29
PPAY	0.673	1.89	0.388	1.02
AGE	-0.004	0.05	0.015	1.72
ICOVER	0.026	2.43	-0.027	2.14

The results confirm that full-time male manual workers are not randomly sorted across sectors. The results show company size is an important determinant of workers sorting between the covered/non covered sectors and firm type. Thus, the larger the firm, the greater the probability of it being both covered with a union wage agreement and externally owned. Other variables which reduce the probability of an individual working in the externally owned sector include the presence of a full time steward (FTSS) and the number of days lost to industrial action (STRIKE). The characteristics of the individual (age, occupation and qualifications) had little influence in terms of sorting workers across sectors, which seems somewhat surprising.

Table 1.9 Summary of the OLS estimates of the parameter coefficients for male full-time manuals by externally owned and locally owned sectors, as reported by Harris, 1994 (Table 3, Page 489).

	Externally Owned Firms.		Locally Owned Firms.	
Variable	Adjusted	t-value	Adjusted	t -value
SIZE	0.133	2.32	0.064	4.33
FTSS	-0.070	0.79	-0.025	0.40
QUAL	-0.144	2.02	0.134	2.84
NYRS	0.030	2.98	0.020	3.47
$NYRS^2$	-0.757	3.32	-0.371	2.06
PPAY	0.013	0.20	0.258	5.01
OTIME	-0.097	0.69	-0.407	7.97
IPAY	0.222	3.62	0.112	2.42
STRIKE	-0.007	2.31	0.006	3.38
ICOVER	0.014	4.93	0.003	1.34
PRODG	0.010	0.33	0.035	1.91
λu ($*10^2$)	-0.292	2.70	-0.087	0.88
λf	0.587	1.85	-0.081	2.05

(Dependent variable is the natural logarithm of hourly earnings)

Table 1.9 summarises the results from the OLS estimates of the parameter coefficients for male full-time manual workers employed in externally owned and locally owned sectors (equation 4). The dependent variable is the natural logarithm of hourly earnings. Harris also includes dummy variables to control for industry effects and size. Note that the impact of company size has both a positive and significant effect on hourly wage rates for individuals in both the externally and locally-owned sector. Work experience (NYRS) also has a positive and significant impact on hourly wage rates in both sectors. However, having a qualification only has a positive effect on hourly earnings in the locally owned sector and a significant negative effect in the externally-owned sector. Productivity pay was also a significant part of the employee's wage in the locally owned sector, with incentive pay (IPAY) both positive and significant only in the externally owned sector.

With regard to union coverage, single union deals (ICOVER) led to increased wages in the externally owned sector while having no significant effect in the locally owned sector. However, the use of industrial action, as proxied by the number of days lost, had a positive (and significant) effect on the wage rate in the local sector while having a negative impact in the externally owned sector. Also, productivity growth from workers was passed on in the form of higher wages in the locally owned sector while having no significant effect on the externally owned sector. The Heckman-type selection terms for firm type (λf) and for union coverage (λu), which Harris constructed from the sample means are not significant.

In summary, these results provide empirical evidence that worker characteristics and wage determination vary across locally and externally-owned sectors in Northern Ireland. Factors which influence the wage rate paid by foreign-owned manufacturing plants are the size of the plant, whether it is covered by a single union agreement, the number of years service by the individual and the availability of incentive pay. The size of the plant is also significant in determining the wage rate in the locally-owned sector. However a different type of bargaining process is employed with local bargaining prevalent as opposed to single union deals.

Driffield (1995) provides a plant level comparison of wages and productivity levels within the foreign and domestic sector of UK manufacturing. He estimates a wage equation in order to identify the main factors that determine the manual wage rate differentials that exist between foreign and UK-owned manufacturing plants. He estimates the following regression model using data from the Workplace Industrial Relations Survey for 1984. In particular, a sub set of this data refers to all manufacturing plants.

$$Manpay = \alpha_1 + \beta_{11} Prod + \beta_{12} Union + \beta_{13} Female + \beta_{14} Inter + \beta_{15} Skill + \beta_{16} Seast + \beta_{17} Oil + \beta_{18} Metal + \beta_{19} Chem + \beta_{110} Cloth + \beta_{111} Print + \varepsilon_1.$$

The dependent variable in the model is the mean wage paid to manual workers at the plant. The explanatory variables are as follows:

Prod Relates to labour productivity, this is measured as value added per employee.

Union	Variable relates to trade union density and measures the percentage of workers covered by a trade union.
Female	The variable is the percentage of full time manual workers that are women.
Intern	Dummy variable for whether the majority of output is sold to other subsidiaries of the parent company.
Skill	Variable is the percentage of manual workers that are classed as skilled.
Seast	Dummy variable to that applies a weighting to a plant if it is located in the South East of England.
Oil	**Industry** dummy variable for Oil sector. Other industry dummy variables are included for the following industrial sectors: **metal, chem, cloth** and **print**.

Table 1.10 Comparison of wage equations for UK and foreign-owned sample, as reported by Driffield, 1995, Table 1, Pg 13.

Wage Equation Results:	UK Owned Sample		Foreign Owned Sample	
Mean of Dependent Variable	3.54		3.71	
Variable	estimate	t statistic	estimate	t statistic
Constant	2.74	(30.86)	2.78	(13.11)
Prod	$2.9.10^{-5}$	(9.45)	$1.4.10^{-5}$	(1.06)
Union	$2.6.10^{-3}$	(4.77)	$1.8.10^{-3}$	(2.07)
Female	-0.80	(6.83)	-0.88	(3.63)
Intern	0.27	(3.74)	-0.11	(1.09)
Skill	0.42	(3.92)	2.55	(0.13)
Seast	0.14	(2.51)	0.13	(1.6)

(Dependent variable is the mean wage paid to manual workers at the plant.)

Table 1.10 reports wage equations for foreign and UK-owned manufacturing sectors in the UK, 1984. Note that the mean of the dependent variable (manual pay) is higher for the foreign-owned manufacturing sector. In the UK-owned sample all explanatory variables are significant in determining the manual workers pay. In particular, the productivity variable is highly significant and positive which suggests a strong correlation exists between domestic productivity and wages. The mean of the dependent variable implies a wage rate of £3.54 per hour. In contrast, the mean of the dependant variable for the foreign sector is £3.71 per hour. In terms of explaining the foreign rate of manual pay only the union variable and the female variable are statistically significant. The coefficient value on the female variable is negative which implies that as the percentage of female workers within the plant increases, this has a downward effect on the rate of manual pay. The coefficient on the union variable is positive which suggest that the presence of a union is a major determinant of the rate of pay in the foreign sector.

Moreover, the productivity, skills, intern and seas variables are insignificant for the foreign-owned wage equation. However, the coefficient signs on both the productivity and skills variable are positive. This suggests that worker productivity is not significant in determining the rate of manual pay in the foreign-owned manufacturing sector. This is a similar to the results reported by Harris (1994). However, this could perhaps be explained in terms of the direction of causation between both variables. In that, higher foreign productivity levels may be explained by paying higher wages at the outset. In terms of the hypothesis outlined by Driffield, his results suggest that the bargaining framework for the plant determines the foreign wage rate, whereas, a combination of worker productivity and the bargaining framework determine the domestic wage rate.

In summary, foreign-owned manufacturing plants, on average, pay higher wages than UK-owned plants, with wage determination and worker characteristics across both sectors typically different. In the following section I discuss the potential impact of the different labour market practices employed by foreign-owned manufacturing plants.

1.6.3.2 Labour Market Crowding Out.

The entry of a new plant, which not only generates additional employment within the local labour market, but also pays higher wages, will have a number of potential labour impact impacts. For instance, in a tight labour market, where the supply of labour is relatively inelastic, the incoming plant through offering higher wages may simply attract employees from existing plants within the region. In doing so, the incoming plant may indirectly impair the efficiency of existing plants as well as increasing the equilibrium wage rate for the region (English Unit, 1992). For instance, this rise in the relative equilibrium wage rate will reduce the competitiveness of existing plants within the region, which may lead directly to labour market crowding-out. Even in the case where the supply of labour within the region is relatively elastic, which is often the assumption used for areas targeted by government regional policy, the incoming plant through generating additional employment, may still have detrimental labour impacts on existing plants (PACEC, 1996). The basic premise of the labour market impact of foreign-owned manufacturing plants is that the presence of a high productivity foreign sector which experiences positive growth could affect indigenous firms in other sectors, particularly if this growth is passed on to all manufacturing sector wage demands.

Barry (1996) considers the growth in wages for two sectors in Ireland, over the same period, which can be considered as both high and low productivity sectors. The high productivity sector is predominately foreign-owned and the low productivity sector consists mainly of indigenous firms. His results reveal that average earnings grew almost identically for both sectors over this period. However, Walsh (1996) disputes whether high technology employment in Ireland, which is small in proportion to other sectors, could drive wage developments in this way. Empirical evidence for Ireland suggests that wage developments in the manufacturing sector frequently drive wage increases in the larger service sector (Bradley *et al*, 1993, 1995). Driffield (1996) also finds empirical support for this hypothesis that the presence of foreign firms within an industry has led to higher domestic wages and a substitution away from the use of domestic labour. This issue is discussed further in subsequent chapters.

1.6.4 Research and Development Activity

With more R&D being undertaken outwith the donor country, foreign-owned firms are likely to account for a substantial amount of manufacturing R&D. For example, for Northern Ireland, R&D expenditure as a proportion of sales is 28% higher for externally-owned, as against locally-owned, plants (Harris and Trainer, 1995).[8] (Recall from Table 1.1 that foreign-owned manufacturing plants in Scotland typically invest more per employee than indigenous manufacturing plants). We therefore observe R&D clustering in which multi-national enterprises locate specific R&D resources in areas already heavily populated by similar type of operation. There are two main forces behind this development. The first reflects the need for more flexible production, characterised by a greater emphasis on the vertical disintegration of the division of labour and decentralised decision making. The second is due to the increasing re-emergence of the importance of agglomeration economies and the realisation of the external economies of scale in infrastructure provision (Stohr, 1986; Harrison, 1992; Lyons; 1995; Shanzi & Luger, 1996). These issues are discussed further in Section 1.6.7.

Moreover, the recent flows of FDI between developed countries, particularly the high technology sectors, would indicate the importance of R&D intensive products. Though in many cases R&D is undertaken in the home country, FDI is predominately in R&D intensive goods. For instance, in Scotland over half of all foreign-owned plants are based in the electronics sector. However, even though very little research and developmental is actually undertaken by foreign-owned plants in Scotland, the products of these plants typically embody a high degree of R&D input.

1.6.5 Degree of export orientation

Another important aspect of the development of output characterised by high levels of R&D is the likelihood that a particular location will serve a worldwide market. A subsidiary, which holds a world product mandate, will typically export a high proportion of its output. Two points are worth stressing here. Foreign-owned plants tend to be more export intensive. Moreover, exports by foreign-owned plants typically embody a higher level of technology or R&D. In contrast, domestic firms tend to rely on traditional exports based on natural-resource endowment or low labour costs (United Nations, 1992; Hill & Roberts, 1995). Recent FDI flows into continental

[8] The proportion of R&D expenditure to sales undertaken by externally-owned plants may appear rather high. However, the definition of externally-owned plants used by Harris and Trainer (1995) includes all plants from outwith Northern Ireland, including UK-owned plants.

Europe and peripheral areas of Wales and Scotland have been to secure an export base from which to service larger markets within and outwith the EU (Neven & Siotis, 1994). The export-intensity of foreign-owned firms is an important determinant of the potential level of product market displacement that may exist within a region (Dunning, 1994; Gillespie, *et al*, 1997). For instance, Monk (1991) in a survey of manufacturing firms assisted by Enterprise Board investment, estimates a local displacement effect of less than 10%, based on sales orientation and the level of local competition.

Exports are also an important determinant of regional growth. Where FDI is market-seeking then essentially FDI (production in the host country) replaces exports. With the creation of trade blocks (EU), much Japanese FDI into Europe has been viewed as a direct substitute for exports. Though, Barrell & Pain (1997) question whether exports and FDI can be such direct substitutes. Thus, the MNC may choose FDI instead of direct licensing or exports to protect their ownership advantage. Moreover, even if the company decides to switch to exporting, perhaps as their product matures and the ownership advantage declines, there is still an advantage from having backup support services based in the host country. Finally, foreign-owned activity is also thought to have positive balance of payment effects, particularly where sectors are export-intensive.

1.6.6 Flow of profit income

A traditional concern over FDI is the loss of income to the local economy through the flow of profits to a foreign owner, particularly where there is some displacement of domestically owned plants. This is likely to be less of a problem in a regional context, in that much of the profits from UK-owned plants in Scotland will already leave the region. However, the measurement of any such flows are particularly difficult as this type of information is not routinely published and very few MNC's provide regional specific accounts.

1.6.7 Agglomeration economies

With the internationalisation of production, the potential importance of agglomeration economies has re-emerged in the FDI and wider regional development literature (Oakey & Cooper, 1989; Porter, 1990; Krugman, 1991, 1995; Harrison, 1992; Young *et al*, 1994; Barry & Bradley, 1996; Garnsey, 1996). Agglomeration economies relate to the existence of positive economies that are derived primarily from the location of the plant. As such, these benefits are external to the firm and thus dependent on a number of factors that relate both to the characteristics of the location and the industrial composition of firms. However, these type of agglomeration impacts are not unique to foreign-owned plants and have been described extensively in previous literature relating to regional development, industrial districts, location theory, growth poles etc.[9] The main forms of agglomeration economies identified:

1. Availability of specialist inputs/factors of production (including labour and capital), within the region.
2. Labour market pooling.
3. Economies of scope.
4. Technological spillovers/information flows.
5. Spin-off firms.
6. Inter-firm linkages.
7. Infrastructure provision including social and cultural characteristics of region.
8. Overall level of industrial activity within the region.

Marshall (1890) was first to identify the possibility of external economies that can arise from the growth of pools of common factors of production. He suggested that the enhanced supplies of these factors and the greater specialisation of the pools would tend to drive down [long-run] factor prices and/or raise factor productivity. This basically represents the external benefit to the user firm as, in the long run, unit costs of production will be lower in the presence of such an infrastructure and specialised pools of capital and labour than if that producer had to create such factor

[9] The re-emergence of agglomeration economies, in part, stems primarily from the work of Porter (1990) and Krugman (1991, 1995).

availability. The existence of agglomeration economies, derived from the creation of specialised labour pools within a region, have been identified as the principal form of agglomeration in a number of regions (Oakey and Cooper, 1989; Scott, 1986; 1992; Lyons, 1995; Gray *et al*, 1996).

For instance, Lyons (1995) identified three separate types of labour agglomeration in his analysis of agglomeration economies in high technology firms in advanced production areas. The first is realized in the form of reduced search costs for individual firms through the availability of a large pool of skilled labour. These large labour pools also afford the firm a greater degree of flexibility in terms of labour turnover and he also suggests that the costs of job training or R&D are reduced in part by the public sector provision of universities or government research laboratories. These factors add to the pool of labour within the region for which all producers can benefit. Obviously, the level at which a firm can benefit will depend specifically on their own labour market requirements relative to the available labour pool.

Scott (1986) suggests that the social division of labour is the primary source of external economies in production systems within industrial districts. He suggests that, through the fragmentation of production processes into small specialized independent units, a complex web of interdependent industrial activities will ensue as a result of inter-establishment transactions. However these transactions will be spatially extensive which will induce these firms to converge around the one locality. This approach rooted flexibility to the division of labour in production, and linked that to agglomeration via an analysis of the transactions costs associated with inter-firm linkages. In general, the availability of specialist labour inputs within a region adds to the potential agglomeration impact.

Spin-off firms are identified as important in terms of both maintaining and expanding the level of economic activity within an agglomeration (Lyons, 1995; Storper, 1992; Scott, 1992). Lyons (1995) identifies the need for new firms to fill the market gaps generated by the evolution of new technologies which he suggests will be filled, generally, by highly skilled workers from within the agglomeration. He also suggests that the cultural characteristics of a region can influence the rate of spin-off firms, within an agglomeration. Moreover, Storper (1993) finds that the rigid structure of high-technology regions in France restricts the start up rate of new or spin-off firms. In contrast, the extended family networks, in small-craft based manufacturing sectors in Northern Italy, promote spin-off firms. Similarly he finds that the availability of venture capital in California encourages individuals in these high-tech districts to spin-off into new firms.

Oakey & Cooper (1989) suggest a circular causality exists whereby skilled labour is attracted to these areas, due to the general level of economic activity, and employed within the agglomeration. This skilled labour adds to the specialised pool of labour within the agglomeration. These individuals then spin-off into their own firms, grow in size and increase the size and power of the agglomeration which will help to further attract more highly skilled labour and firms. They suggest that a link exists between the level of labour agglomeration achieved within a region and the rate of new spin-off firms.

The existence of technological spillovers or information flows, within an agglomeration, can depend on both the existence of local or global networks and the social and cultural characteristics of the region (Amin & Thrift, 1992). Storper (1992) suggests that the distribution of industry-specific information is imperfect and the process of its exchange and the possible positive externalities which could arise are dependent on both the existence of production networks and the quality of the transactors. Gray *et al* (1996) find that where there is a larger concentration of small firms, information flows between similar firms are more likely to occur. Moreover, in general it is recognised that an area or region requires a 'critical mass' of similar firms, or specialist suppliers, skilled labour etc. to generate the type of agglomeration effects identified above. However, large dominant firms within a region can also have a significant impact on the agglomeration potential of a region.

Perroux (1950), in his theory relating to 'growth poles' identified the importance of large dominant firms or sectors within a region. Essentially, a pole can be conceptualised as a specific sector of the economy - possibly a single firm or industry, or a group of firms or industries - within which growth or change will first occur. The growth or change then spreads, via input or output flows, between various poles. A growth pole can thus be regarded as a propulsive firm or industry, characterised by the following three features:

1. It will be 'dominant' over other firms or industries, consuming a larger proportion of their output than they consume of its output.
2. It will be of a large size - the larger it is, the bigger its field of dominance, and the greater its rate of growth or change.
3. It will have strong links with, and display much interaction with, many firms or industries.

Scott (1992) suggests that large producers, particularly multinationals, can have a positive role within the activities of industrial districts. Furthermore, with the continued internationalization of production and activities, multinational enterprises can play a facilitating role in the inter-linkage of industrial districts across the globe (Scott, 1992; Poon & Pandit, 1996). Gray *at al* (1996) also illustrate the important role large dominant firms or organisations can have on the development of a region. They emphasis the important agglomeration effects generated by such 'hub' firm/organisations as opposed to the more traditional regional focus of physical linkages between 'hub' firms and other firms within the region. The case studies demonstrate the importance of agglomeration effects, particularly, the availability of factors (labour, capital etc.) and other specialised services within the region. Thus, the presence of a large dominant firm may attract labour or in-migrants to the region, which adds to the pool of labour within the region. Moreover, suppliers may cluster nearby in order to meet the production requirement of the plant. These enhance the potential agglomeration characteristics of the location, which all firms can benefit from.

However, Parr (1973) suggests it is important to distinguish between the agglomeration effect and the polarisation effect, as the former can be viewed as an outcome of the latter. He noted that "whereas the agglomeration effect is viewed at a particular point in time, the polarisation effect deals with the clustering of activity over a period of time prior to that point". Thus, polarisation involves temporal changes in spatial structure. Parr (1973) identifies three types of agglomeration force, each of which have an equivalent counterpart in terms of polarisation:

1. Economies of urbanisation or concentration. These apply to firms which, situated at a major urban centre, have constant access to communications and specialised commercial services.
2. Economics of location. These accrue to closely-related firms within the same industry: key benefits include access to relevantly-skilled labour and the opportunity for firms to cooperate in joint ventures such as purchasing, marketing and R&D, thereby spreading the costs and reducing the wastage from duplication.
3. Industrial complex economies. These apply to firms that have interindustry or input-output links, involving transportation, power-cost savings and production-cost savings from the free exchange of information. Such links may manifest themselves geographically, but this will not inevitably be the case.

Porter (1990) further contends that clusters appear at specific locales due to the need for firms to specialise and be linked both vertically and horizontally, and be concentrated geographically in mutually-reinforcing groups. These locales generate a competitive advantage for these firms as spillovers occur between interconnected firms and the cluster becomes more than the sum of its parts. These spillovers come through similar firms investing in related technology, infrastructure, information and human resources, as noted by Parr (1973) in the economics of location. However, Storper (1995) contends that the agglomeration of economic activity is the outcome of a process of transaction cost minimization, where such minimization outweighs other geographically dependent production cost differentials.

The linkages within the agglomeration and the local economy can allow multiplier effects, generated within the agglomeration, to be spread through out the region. The linkages also act as a vehicle through which technology transfer, knowledge, networking etc. can flow. Young *et al* (1994) identified local sourcing as a possible route to self-sustaining growth, increased value-added and agglomeration economies of scale. The debate surrounding the importance of linkages focuses on two aspects of the agglomeration. Lyons (1995) firstly highlights the importance of physical linkages in promoting multiplier effects. However, he suggest that the 'spatial pull' of this location will not be determined just by the volume of linkages between firms, but the quality of linkages available and whether these firms have to source high technology components (specialist inputs) from outwith the agglomeration. Thus, he stresses the importance of being able to source highly specialist inputs from suppliers within the agglomeration, with these type of linkages typically important in determining the potential agglomeration impact of the region. This is similar to the distinction made by Turok (1993) between dependent and developmental linkages.

Storper (1992) questions the role of input-output transactions in explaining fully the relationships between firms within an agglomeration. Instead, he points to the existence of agglomerations where firms have low levels of direct inter-firm transactions and instead are characterized by untraded or non-market interdependencies. This is similar to Marshall (1890) who also identified the supply of non-traded intermediate goods and technological spillovers as other significant factors within an agglomeration. In contrast Lyons (1995) suggest that the positive externalities generated within the agglomeration are related specifically to the production side of the firm. Lyons also suggests that the separation of production from other aspects of the firm can lead to considerable costs. These costs can be viewed in terms of the potential synergies that can be lost from separating production from product innovation.

In summary, agglomeration economies can generate external benefits to firms located within particular areas. In relation to FDI, these theories suggest MNC's can benefit directly from the location of production to specific areas. Moreover, the presence of large multi-national plants, within a region, may attract suppliers to cluster in that particular area, which may increase the potential agglomeration impact of the region. As noted in Section 1.6.4, MNC's are likely to locate research and development facilities in areas or regions already populated by similar operations or plants. Overall, the agglomeration potential of a region can be an important factor in attracting MNC's to that area, as indicated by Wheeler & Mody (1992) and O'Sullivan (1993) for US FDI. Similarly, the presence of a MNC or a group of specialist firms, within a region can be an important factor in attracting similar firms to locate within the area.

1.6.8 Efficiency Spillovers

Impacts of a more indirect, but potentially more significant, type take the form of efficiency spillovers from foreign-owned firms to their domestic rivals and suppliers. These "efficiency spillovers" are assumed to be the result of positive externalities from international production, which are conveyed to indigenous firms through interaction or as a direct result of competition, with foreign-owned plants within the region. The transfer of technology can occur through many different avenues.[10] New technology is embodied in imported inputs and capital goods, sold directly through licensing agreement, or transmitted to exporters who learn about new techniques from their foreign buyers. These are all components of the various mechanisms through which technology is transferred via international trade. The multinational firm is just one of these components from which the transfer of technology and management know-how can be transmitted or dispersed to indigenous firms. This type of spillover or upgrading can occur through various channels (United Nations, 1992):

- The movement of personnel between ownership sectors.
- R&D activities by foreign firms in host countries.

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[10] For instance, Malley & Moutos (1994) construct a two sector macroeconomic model of a small open-economy that is a recipient of FDI. The model is based on a developing economy where foreign firms invest in order to take advantage of lower wages. The basic model framework is a two-sector model with two goods being produced, 'old' and 'new' goods with different wage rates offered in the production of both goods. They assume that domestic producers and labour can only produce old goods (lower wage cost) were as foreign produces can produce both goods, though labour costs are higher in the production of new goods. The transfer of technology in the model takes the form of domestic labour getting acquainted with the production of (once) new goods. As soon as domestic labour is capable of producing some of the new goods an incentive is created for ROW firms to transfer production to the domestic country to take advantage of the lower wages. The model is fairly stylised and the link between foreign production and the indigenous sector depends on innovation and technology transfer.

- The licensing of know-how and technologies for by-products.
- Imitation or the diffusion of information about new technology.
- Induced technological change and productivity improvements through increased competition from foreign-owned plants.

The movement of personnel between foreign and indigenous firms is one method for the transfer of work practices between sectors. Similarly, the location of R&D activities by foreign firms in host countries and the transfer of personnel may add to the pool of specialised labour employed within the region. This increase in the stock of local knowledge can be transferred via firms through the movement of personnel. The presence of foreign firms within an industry is also believed to increase competition in host-country markets. This increased competition in domestic market can induce domestic firms to react in a number of ways that directly increase their relative performance. The increased competition may force existing firms to adopt more efficient methods or adopt some specific new technology which they were unaware of prior to the foreign firm entering the market or felt it was unprofitable to acquire (Blomstrom, 1991).

Moreover, efficiency spillovers may not be restricted to domestic firms within the particular sector or industry influenced by foreign firms. As noted in Section 1.6.3, a number of studies have analysed, in depth, the forward and backward linkages formed in the domestic economy by incoming foreign plants and the overall effects of foreign ownership within a national or regional economy. These results suggest that linkages are not only an important economic factor in terms of the employment generated (Hill and Roberts, 1995) but also a vehicle through which foreign know-how and technology or work practices can be transmitted. Accordingly the degree and depth of linkages can determine both the size and frequency of technology spillovers (United Nations, 1992). Therefore, the dispersion of these type of effects may not be restricted to domestic firms competing within a particular sector, or supplier linkages to the incoming plant, but may also include forward linkages as well intra-industry impacts.

Given the nature of these types of supply-side spillovers the components of these impacts are typically diverse and difficult to isolate and quantify. The existing 'efficiency spillover' literature test for aggregate 'spillovers' at the industry level, using cross-sectional time series data (Blomstrom; 1986; Wilmore, 1986; Harris, 1991b; Haddad & Harrison; 1992). The first of these studies (Caves, 1974) in his analysis of the impact of foreign presence on the host economy (Canada & Australia) was undertaken at a time when host and source countries alike were inclined towards restricting the activities of multi national corporations (MNC's). In contrast, both industrialised and developing countries now offer substantial financial incentives to attract multi national corporations to particular locations. Thus, the emphasis on evaluating inbound FDI over the past two decades has widened from the direct contributions of foreign affiliates to economic development (output and employment) to their wider impact, including the potential upgrading of the competitiveness of host country firms (Dunning, 1994).

The basic premise underlying the existence of 'efficiency spillovers' is that foreign plants represent, by means of international production, 'best practice' plants. These plants are typically more productive, *per se*, than indigenous firms and typically compete in world markets. Spillovers can occur via the interaction of foreign and indigenous plants but these depend typically on both the types of linkages that exist between both sectors and in the differences in relative efficiency. For instance, the perceived 'technology gap' that exists between sectors may determine any potential transfer of technology (Haddad & Harrison, 1992; Perez, 1995). The empirical analysis and more detailed discussion of the 'efficiency spillover' literature models is included in Section 2.5, in Chapter 2, relating to supply-side impacts of FDI.

1.7 Chapter Conclusions.

FDI represents the control of physical productive assets, by foreign plants, in locations outwith the host country. Global flows of FDI have increased considerably through-out the 1980's, with FDI concentrated primarily in R&D intensive or high technology products, in and between developed economies (US, EU and Japan). Parallel to the growth of FDI has been the importance of inter-firm trade within MNC's. This now accounts for around one third of World trade (Markusen, 1995) and is a byproduct of the internal structure of the multi national corporation.

The FDI literature provides a broad theoretical basis that attempts to explain why MNC's are able to undertake such activities. The basic premise is that MNC's have some specific ownership advantage, over indigenous firms, that allows them to compete directly with these firms within their own market. These advantages can relate to a number of firm specific factors (superior technology, managerial expertise, know-how etc.) or be derived from the internalisation of production via inter-firm linkages, or through the location choice of the MNC. The perceived advantages derived from the internal structure of the multi-national relate to how production and transactions are organised within the MNC as opposed to the market. Factors that typically influence the location patterns of FDI include; the market size of the country, the existing stock of inward investment, relative labour costs between both regions and the general infrastructure (primarily labour quality) of the region.

The entry of MNC's into national markets can have a number of potential impacts on the industrial structure of the region. Foreign-owned manufacturing plants are typically larger in terms of both plant employment and output, pay higher wages and are more productive, *per se*, than indigenous firms. The generation of employment, through the location of a MNC, to particular regions, encouraged UK regional policy to view the attraction of inward investment as a possible remedy to counter the industrial decline of particular UK regions. As such, FDI remains an important plank of UK regional policy in Scotland, however, policy makers are now more aware of the potential system-wide impact of FDI (PACEC, 1996).

Linkages by MNC's with local suppliers are identified in the FDI literature as an important vehicle for promoting indirect output and employment effects, as well as, providing a channel for technology transfer. The linkages of the MNC with indigenous plants are often used as a relative measure of embeddedness for the plant or sector within the region. The qualitative nature or type of linkages that exist between the MNC and indigenous plants will typically determine the potential for technology transfer via linkage interaction. However, 'spillovers' can also occur through the movement of personnel between sectors. Moreover, the presence of foreign-owned plants is thought to induce technological upgrading by indigenous plants as a result of the increased presence and direct competition of the foreign-owned manufacturing plant.

The presence of a MNC can also diversify the industrial structure of the region, as well as add to any potential agglomeration economies that may exist. The existence of positive externalities, derived from the location of production, are external to individual plants but can influence the location choice of multi national companies. The existence of agglomeration economies are important, particularly for the choice of location of research and development activities by MNC's, but also as a vehicle for generating growth within particular sectors or regions. In particular, successful agglomerations generate a high level of spin-off firms within the region. MNC's can be an important factor in encouraging firms to cluster in a particular location.

As noted, foreign-owned plants typically pay higher wages and are more productive, *per se*, than indigenous plants. Part of this 'productivity' differential can be attributed to the distribution of foreign plants in high-technology sectors. The remaining component relates to factors intrinsic to the foreign plant, including the internal production process, superior technology, know-how etc. The higher foreign-owned wage rates, reflects, in general, both the larger size of foreign-owned plants and the different wage bargaining process that they employ.

Finally, there are clearly positive spillovers from FDI in terms of the direct linkage and consumption multiplier effects, though potential negative effects can occur in the form of crowding-out in both the labour and product markets. Higher foreign-owned manufacturing wages can lead to increased wage rates in indigenous plants that adversely affect competitiveness. Moreover, the potential loss of staff can impair the efficiency of indigenous plants, though the converse is also possible. Product market displacement can also occur where the sales of foreign-owned plants displace indigenous activity. However, where MNC's export a high proportion of their output this can have positive impact on the balance of trade within particular regions.

In summary, foreign-owned manufacturing plants are distinct from indigenous plants in terms of size and structure. Their location within a region or sector can have a number of potential impacts. This chapter has provided an overview of theoretical and empirical literature relating to both the determinants of FDI and the potential regional impact. The main conclusions from this chapter are that FDI in a regional economy can not only have both positive and adverse impacts, but, more importantly FDI typically impacts on both the demand and supply-side of the regional economy. Accordingly, any analysis of FDI must account for both the potential demand and supply-side impacts.

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CHAPTER 2: Regional Impact of Foreign Direct Investment: Review and Critique of Existing Approaches.

2.1 Introduction.

Impact analysis varies widely in the degree of detail it provides. This chapter considers the alternative methods and approaches followed in the evaluation of the regional impact of FDI. Chapter 1 provided an overview of the main issues relating to FDI and the potential impacts of FDI within the regional economy. These impacts relate typically to both the demand and supply-side of the regional economy. However, regional economic models in general are demand-oriented which effectively prohibits any analysis of supply-side effects. In the first part of this chapter, I discuss the validity of these demand-side models in relation to the impact of FDI. Following on, I discuss in detail the empirical evidence relating to the existence of supply-side impacts of FDI.

As a starting point, the traditional methods of multiplier analysis and input output systems are reviewed in Sections 2.2, 2.3 and 2.4. Incorporated within the multiplier analysis is both the traditional economic base and regional multiplier approach. Following on, Section 2.5 considers the development and use of regional econometric models and their application to FDI. Section 2.6 discusses the econometric literature concerning the potential existence of 'efficiency spillovers' between indigenous and foreign-owned manufacturing plants or sectors. Section 2.7 provides a short conclusion for this chapter.

2.2 The Economic Base and Keynesian Local Income Multiplier Approach.

The economic base model divides the local economy into two sectors according to the location of the market for their goods. Economy activity within the region is split between the production of basic (or export) goods and non-basic (service) goods. The premise is that the reason for the existence and growth of a region lies in the goods and services it produces locally and sells beyond its borders, as the non-basic sector exists to serve the region itself.

Certain key assumptions are required to enable an economic base multiplier to be constructed. These assumptions are summarised as follows:

- Regional growth is dependent on the growth of the export or basic goods sector.
- An increase in the production of basic goods will bring about an increase in the production of non-basic goods.
- A stable relationship exists between basic and non-basic goods.

To derive an economic base multiplier, total regional income (or output) is divided into two components:

$$T = S + B. \qquad (1)$$

Where,

T Total regional income.

S Income earned in non-basic sector.

B Income earned in basic sector.

From equation (1), the amount of income earned in the non-basic sector can be shown to be linearly dependent upon the income earned in the region as a whole. A proportional relationship exists where by income earned in the non-basic sector is dependent on total regional income.

$$S = rT \qquad (2)$$

Where r is a positive fraction. Combining equations (1) and (2) we obtain:

$$T = \frac{1}{1-r}.B \qquad (3)$$

The term $(\frac{1}{1-r})$ or $(1-r)^{-1}$ is the economic base multiplier which is defined as the total change in regional output per unit change in basic output (exports). This is essentially an export multiplier as it arises from the production of basic goods, which are exported outwith the region. The ratio of total regional income to income earned in the basic sector (r) provides the estimate of the regional multiplier. Employment and income variants of the economic base model can also be formulated, which permits estimates of employment and income multipliers. Local economic activity or output is often proxied using employment or income data. The economic base multiplier is a very simple approach which requires only an estimate of r; the ratio of non-basic output to total output in the region.

2.2.1 Applications of this Approach to FDI.

Using this approach, the evaluation of an incoming foreign-owned plant would be limited to the total employment or income effect generated by the additional exports. Essentially, the total employment impact would be calculated by taking the level of foreign-owned employment involved in the production of basic goods for export, plus the indirect employment effects generated in the non-basic sector, which are determined by the economic base ratio between both sectors.

2.2.2 Critique of the Economic Base Model.

The economic base model is part of a wider range of demand-based models Geographers and planners initially pioneered this approach, and its use by economists has been somewhat limited. The basic model framework described above is very simple.[1] However, one positive attribute of this model is that it stresses the critical role of the region's export sector in determining income and employment levels. Many of the limitations of this approach also apply to the more sophisticated demand-based region models, which are also reviewed in this chapter. This critique considers the specific limitations of this approach with the more general limitations of demand-based approaches discussed in subsequent sections.

The choice of model used in impact analysis can very often appreciably affect the results (Conway, 1991). In regional economics, practitioners have often been limited by the availability of regional data. The economic base analysis provides a

[1] However, more sophisticated variants of this approach have been developed. For instance, McGregor *et al* (1999) develop a neo-classical export-base multiplier.

limited economic framework, which can consider only demand-side issues. The basic assumptions which the model is predicted upon leads to many inherent limitations.

For instance, the employment method of estimating regional multipliers, derived from the economic base model, is to discover the volume of employment in a region, which is engaged in the production of exports. The regional employment multiplier is simply total region-wide employment divided by export employment. However, even where all relations are linear, with constant coefficients, any change in total region-wide employment as a results of other changes in autonomous expenditure or final demand (not including exports), will impact on this export employment multiplier.

Moreover, there may exist a number of quite different export industries within the region. Different industries import large proportions of inputs and other industries rely heavily on local inputs. Therefore, changes in demand for exports will affect regions differently depending on the industrial composition of the export sectors or base. Thus, the multiplier consequences of an expansion in demand will vary between industries in the basic sector depending upon the source of their inputs and one would expect unique multiplier values for each industrial sector. To overcome this, one would have to calculate a multiplier for each industry, which is the approach followed in input-output analysis.

The economic base approach also fails to consider the possibility that a given increase in output, by the basic sector, can be achieved in a number of different ways with each one giving rise to a different multiplier effect on output. This reflects the demand-orientated approach of the model and the implicit assumption of a passive supply-side. The supply response to an increase in the demand for the output of an exporting industry can differ substantially according to the availability of spare capacity in a region. An expansion in the output of basic goods may be achieved by employing the existing labour force more intensively or by taking on workers who are currently unemployed. The consequences of whichever will affect the multiplier.

Moreover, with no supply-side incorporated within the framework, the model implicitly assumes the existence of a perfectly elastic supply of factor inputs. Without this assumption, an expansion in exports in the basic sector could result in higher wages for basic sector workers and a possible shift in labour from the non basic to basic sector, or a reallocation of labour amongst basic sectors (McGregor *et al*, 1999). A pool of unemployed labour or a perfectly elastic migration response is required to overcome this problem.

Applying this approach to FDI, one would be unable to trace the full impact of the shock throughout the regional economy. However, this approach could be used for evaluating FDI where the incoming foreign-owned plants produce solely for exports. But, as Foster & Malley (1988) suggest, the application of the economic base framework to the impact of FDI cannot cope with the necessary disaggregation of output by ownership or the behavioural differences inherent within each sector.

Finally, Conway (1991), in an empirical comparison of an economic base, input-output and an inter-industry econometric model, contrasts the output, employment and income multipliers generated by each model for the Washington state economy. The economic base multiplier is estimated following the specification shown in equation (3) with information derived from the Input-Output model. The output, employment and income multipliers, from the export-base model, are substantially larger than the comparable Input-Output multipliers, due to their aggregate structure. He also notes a potential problem with using static multiplier estimates of this type. Essentially, the impacts are not measured with respect to time and the accuracy of the estimates will depend on the time perspective of the evaluation. Thus, regional policy evaluations are typically considered within a 10-year framework (PACEC, 1993). Finally, the major strength of this approach is that it highlights the role of exports for a region.

2.3 Keynesian Local Income Multiplier Approach.

The Keynesian multiplier approach is derived from a set of identities similar to those used in the open economy version of the Keynesian income-expenditure model. The model outlined here follows the standard analysis set out by Taylor and Armstrong (1993).

$$Y = C + I + G + X - M \qquad (4)$$

Where,

Y Regional income.

C Regional consumption expenditure.

I Regional investment expenditure.

G Government expenditure in the region

X Regional exports

M Regional imports.

Investment, government expenditure and exports are all assumed to be autonomously (exogenously) determined. Therefore,

$$I = \bar{I}, \; G = \bar{G}, \; X = \bar{X} \qquad (5)$$

Consumption and import expenditure are assumed to be partly autonomous and partly dependent on disposable income:

$$C = \bar{C} + cDY \qquad (6)$$

$$M = \bar{M} + mDY \qquad (7)$$

Where DY is disposable income and is given by

$$DY = Y - tY \qquad (8)$$

Where t is the rate of income tax. By substituting the above identities into the original expenditure identity we obtain:

$$Y = K(\bar{C} + \bar{I} + \bar{G} + \bar{X} - \bar{M}) \qquad (9)$$

Where K is the regional multiplier, which is given by:

$$K = \frac{1}{1-(1-t)(c-m)} \qquad (10)$$

Where:

t Average taxes on income.

c Average propensity to consume.

m Propensity to import consumption goods and services into the region.

The standard Keynesian multiplier model, as outlined in equation (10), is derived from the standard Keynesian Income/Expenditure model. This model is predicated on a number of restrictive assumptions, similar to the export base, relating to the supply-side of the region. For instance, an expansion in demand has no price effects, implying that any changes in local output or employment are demand driven, with excess capacity and a perfectly elastic supply of factor inputs a necessary requirement. Applications in this form to regional impact analysis allow estimates to be obtained of the total employment or total income generated in a region as a result of a given change in expenditure which could be generated by various sources including FDI. The approach outlined above is consistent with an application of the model used in the FDI literature (Potter, 1995).

The income multiplier is based on the fundamental notion that one person's expenditure becomes a part of another person's income and the overall value of total income generated within the region would be greater than the initial income injection. For instance, an initial money injection into a regional economy will cause an increase in the level of income in that system by some multiple of the original injection. Income multipliers derived from the Keynesian approach, trace out the effects of an initial injection through consumption and income effects. Withdrawals of income from the region mean that expenditure in each round is less than the initial income injection, and this limits the extent of the income expansion. The key withdrawals are typically imports.

2.3.1 Extensions to the Basic Keynesian Multiplier Model.

Archibald (1967) stressed the key importance of incorporating the consequences of migration within any regional multiplier evaluation. For instance, the migration of workers or individuals from one region to another, in response to a demand stimulus will have a significant impact on both regions.[2] Labour market effects, in the form of migration flows, are accounted for in the model by incorporating transfer payments (such as unemployment benefit) and their subsequent impact on expenditure. In the longer term, one could expect a developmental impact to be working in the local area via migration impacts and capital stock effects. These would generate further economic impacts in demographically related activities such as housing, education and health. However, demographic effects are very difficult to estimate as not only are there lags but much depends on the public policy response.

Further extensions include incorporating expenditure taxes as well as income taxes and considering the interaction between regions. These modifications have been consolidated into a generalised modelling approach as illustrated in Ashcroft *et al* (1988). Further developments of this approach involve calculating several different multipliers for various categories of expenditure (Glasson *et al*, 1988).[3] Applications of this approach to regional economics, including FDI, have varied considerably (Archibald, 1967; Wilson, 1968; Lever, 1974; Ashcroft and Swales, 1982; Pullen and Proops, 1983; McDonald & Swales, 1990). [4] These are summarised in the following section.

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[2] In the instance of an unemployed person moving to another region to gain employment, since unemployment benefit is a transfer from the government to the region, the out-migration of this person would mean that the region loses the transfer payment, in terms of the income paid to the individual, which would reduce the total income within the region and the size of any potential multiplicand. The initial loss in regional income through out-migration may also lead to a fall in induced local investment related to public policy.

[3] Glasson *et al* (1988) calculates six different multiplier estimates for various categories of expenditure. The advantage of this development is that more accurate and less aggregate multiplier estimates are obtained. For instance, expenditure related to the construction of a new plant or an expansion of an existing industry would have a lower multiplier than an expansion in output within an industry, as construction workers tend to commute into regions and thus the impact on regional income and employment would be less, as much of the activity would be lost to the region through this activity.

[4] Ashcroft and Swales (1982), demonstrated the potential usefulness of this analysis for the specific purposes of estimating the impact on income and employment of relocating civil service jobs from London to the provinces. McDonald & Swales (1990), in their analysis of the local employment impact of a hypermarket incorporate the effect of lower retail prices in their multiplier model.

2.3.2 Applications of the Model to Regional Impact Analysis.

In applying this type of analysis to a specific region, industry or plant, the key parameters of the model have to be adjusted to reflect the local conditions. Since marginal tax rates can be estimated regardless of locality, and savings rates are to an extent generally uniform, the variable most likely to vary between regions is the marginal propensity to consume locally-produced goods (i.e. $c\text{-}m$). This has a crucial effect on the magnitude of the regional multiplier and several factors can influence this, not least, the size and structure of the regional economy.

Leakage of regional income through expenditure on goods and services produced outwith the region will reduce the potential magnitude of the multiplier. The size of the region has a significant influence on the import intensity of that region since smaller, less diversified economies are more dependent on trade. The marginal propensity to import is therefore likely to be high in smaller regions where imports account for a larger proportion of regional expenditure. Obviously, the greater the import contents of any exogenous investment the smaller the local multiplier.

The importance of the size of an area is related, more specifically, to the industrial base of the region. The potential regional impact of any expansion in industrial output will be greater where plants can source inputs locally (high backward linkages), and thus increase the size of the multiplier. Other regional specific sources of leakage, from expenditure or incomes, can also have a significant impact on the size of any potential multiplier. For instance, the proximity of the region to other labour markets can be an important source of leakage. Workers commuting into the region will reduce regional income in total, and the potential level of additional local income generated by the original regional demand disturbance.

Leakage can occur in both the first and subsequent rounds, although the first round effects are likely to be substantial since the first round expenditure is usually large relative to second and subsequent rounds of expenditure. Therefore, developing an accurate estimate of the first round multiplier process is paramount to obtaining correct estimates of the effects (Ashcroft and Swales, 1982; Sinclair and Sutcliffe, 1982). As noted, the main forms of leakage come through imports, taxation and savings. The marginal propensity to consume, like the import intensity of a region, can vary between regions according to average income or the distribution of income. Not surprisingly, the parameter values reported for various applications of the local Keynesian multiplier model vary considerably. Table 2.1 reports the key parameter and estimated multiplier values from a selection of regional impact studies.

Table 2.1 A comparison of key parameter values and results from a variety of impact studies using the Keynesian Income Multiplier model.

Source	Type of Impact	Average tax Income (t)	Propensity: Consume (c)	Propensity: Import (m)	Multiplier Value
Ashcroft & Swales (1982)	Civil service relocation *Cleveland*	0.28	0.87	0.6	1.14
Nairn and Swales (1987)	urban renewal *Glasgow*	0.11	0.89	0.67	1.25
Sinclair & Sutcliffe (1989)	tourism *Malaga*	0.30	0.90	0.6 0.5	1.26 1.38
MacDonald & Swales (1991)	Hypermarket	0.25	0.89	0.67	1.20
Bleaney *at al* (1992)	University *Nottingham*	0.22	0.90	0.67	1.22
Armstrong 1993	University *Lancaster*	0.27	0.88	0.74	1.11
Potter 1995	Branch Plants *Devon & Cornwall*	0.25	0.92	0.70	1.20
WERU 1996	Oil Spillage *Pembrokeshire*	0.25	0.90	0.75 0.80	1.08 1.12

The estimated multiplier values reported in Table 2.1 lie in the range 1.08 (WERU, 1996) to 1.38 (Sinclair and Sutcliffe, 1989).[5] Not surprisingly, the upper and lower bound of these multiplier estimates correspond to the lowest and highest marginal propensities to import. Sinclair and Sutcliffe (1989), report the ratio of

[5] Note that Sinclair & Sutcliffe (1989) and WERU (1996) report two estimates for the local Keynesian Income Multiplier in their studies. These simply reflect the different estimates used for the import propensity in these regions.

regional consumption which is spent on goods and services produced outwith the region (Malaga) as 0.5, similarly WERU (1996) report 0.8 for Pembrokeshire. An import propensity of around 0.8 indicates a very small open region. Larger, more industrialised areas such as Glasgow and Cleveland have import propensities between 0.6 and 0.7 (taken from results reported in Table 2.1).[6] The propensity to consume also varies by region, though to a lesser extent. These parameter value are estimated in a range between 0.87 for Cleveland (Ashcroft and Swales, 1982) and 0.92 for Devon and Cornwall (Potter, 1995). The key point table 2.1 illustrates is the size of the multiplier depends essentially on the consumption and import patterns of the region. However, most of these values are 'guess' estimates and values of local consumption are typically derived from national (rather than regional) accounts.

Finally, the Keynesian local multiplier model has been applied to various applications of regional economic activity. Its application, in this form, to FDI impact analysis has however been limited. This, in part, reflects both the focus of FDI impact studies and the limited analysis the model provides. The majority of FDI impact studies, as discussed in section 1.6.3 of chapter 1, focus primarily on one topic: the extent and economic effects of linkages typically concentrating on a specific industry or region.

2.3.3 Applications of this approach to FDI.

Potter (1995), estimates the associated direct and indirect employment and income effects of 'in-moving' branch plants in Devon and Cornwall. He derives both a linkage and income multiplier in order to trace the pattern of materials and services purchased by surveyed plants and to assess the employment generated by the spending of wages and salaries by employees of the in-moving factories. The survey-based data covers 331 externally owned plants, of which, 175 of these were identified as 'in-moving' plants. The multiplier estimates are based on a smaller more extensive detailed survey of 76 of these plants; 37 of which were foreign-owned and the remaining 39 were British owned.

[6] The Sinclair and Sutcliffe (1987) study is based on tourism expenditure within Malaga, Spain. The lower import intensity reflects the nature of tourist expenditure which is spent primarily on local services and goods.

Potter calculates separate linkage and income multipliers for the foreign-owned sector (37 plants) as well as including these plants in the estimates for the total 'in-moving' plants (76 plants). The analysis of the indirect employment effects is based on estimates of the linkage and local income multiplier. The linkage multiplier calculates the level of materials and services (backward linkages) purchased by the incoming plants from local suppliers. This is often used as an indicator of the degree or level of 'embeddedness' of incoming plants (United Nations, 1992; Turok, 1993). Local spending or backward linkages by 'incoming plants', is estimated by Potter to generate some 2,250 jobs in total (based on the survey analysis of purchases).

The employment estimates are calculated using Census of Production data whereby total local spending in each sector is translated into the equivalent employment by dividing through by the appropriate sectoral output/employment figure. For instance, if 'in-moving' manufacturing plants spend £3 million on local intermediate purchases from a particular sector, and the aggregate amount of output generated per employee in this sector is £30,000, Potter calculates that this expenditure creates 100 additional jobs in this sector.[7] Potter further estimates that the value of services purchased locally, by 'in-coming' plants, is equivalent to 50 per cent of the value of bought-in services in turnover. This is equivalent to an additional £40 million per anum in expenditure, which he calculates will generate an additional 1,600 indirect jobs. The linkage ratios derived by Potter (1995) for materials and service purchases, expressed as multipliers, are shown in Table 2.2.

Table 2.2 Estimated Linkage Multipliers for foreign-owned and 'in-moving' branch plants for Devon & Cornwall as reported by Potter (1995).

	Linkage Multiplier	Number of Plants.
Foreign-owned plants.	1.10-1.21	37
Total 'In-moving' Plants	1.13-1.22	76

Potter reports a linkage multiplier of 1.13, which relates primarily to the purchase of local manufacturing intermediate inputs. This measure excludes the impact of bought in services purchased within the region. An upper limit on the value of the regional bought services was estimated and this increased the 'linkage' multiplier estimate to 1.22. The aggregate regional multipliers for in-moving plants were therefore estimated to lie within the range of 1.13 and 1.22. The average estimated linkage multipliers for foreign-owned plants in Devon & Cornwall is lower than the average for 'in-moving' plants in total. This is consistent with FDI linkage studies of foreign-owned and indigenous plants (Phelps, 1993; Turok, 1993). However, the linkage multiplier reported by Potter (1995) relates only to the first round and is not equivalent to the Input-Output multiplier, which incorporates all intermediate expenditure in all rounds of the multiplier process.

The local income multiplier reported by Potter (1995) is derived from the increased wages and salaries generated through the direct employment created by the incoming plants. It follows the standard Keynesian income multiplier model outlined in the earlier section. Although, this is technically an income multiplier, Potter (1995) expresses the estimates in employment terms by adopting the assumption that the mean wages in surveyed plants are the same as the average wages in similar sectors. In the estimation of the local income multiplier model, average parameters values are used for the tax rate and the marginal propensity to consume for Devon and Cornwall. The marginal propensity to import consumption goods into the area is assumed to be relatively high, given both the size of the population and the narrow manufacturing base in the area. Potter estimates a Keynesian income multiplier of 1.20 for all 'in-moving' branch plants in Devon and Cornwall. Detailed results of the linkage and local income multiplier analyses are presented in Table 2.3.

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[7] However, firms within a sector typically vary in labour intensity, which such an aggregate measure cannot capture.

Table 2.3 Direct and indirect employment impacts of 'in-moving' branch plants as reported by Potter (1993).				
	Foreign-owned Plants (n = 37)		Total in-moving branch plants (n = 76)	
	Lower Range	Higher Range	Lower Range	Higher Range
Direct Employment	8,322	8,322	17,248	17,248
Linkage Multiplier: Indirect Employment Created	827	1,758	2,242	3,832
Direct plus linkage effects	9,149	10,080	19,490	21,080
Local income multiplier: Indirect Employment Created	1,830	2,016	3,898	4,216
Direct plus linkage and local income effects	10,979	12,096	23,388	25,296
Total indirect effects.	2,657	3,774	6,140	8,040

The direct employment is simply the sum of the actual plant level employment in both the foreign-owned sector and for the sample of all 'in-moving' branch plants. The direct employment plus linkage effect (backward linkage) is calculated from using both estimates of the linkage multiplier reported in Table 2.2. The direct employment plus linkage and local income effects is calculated from applying the local Keynesian multiplier estimate (K=1.20) to the direct plus linkage employment total. Finally the total indirect employment effect is simply the sum of both components of the multiplier analysis.

These indirect employment estimates, however, do not account for or consider any potential adverse employment impacts arising through displacement effects (PA Cambridge Economic Consultants, 1995). Although, Potter does note that less than 5% of the 'in-moving' plants surveyed carry out most of their sales in Devon and Cornwall and only one surveyed plant competes directly with local firms. Therefore, to account for this type of effect, these employment impacts would have to be adjusted.[8]

[8] Recall that Monk (1991), in a survey of manufacturing firms assisted by Enterprise Board investment, estimates a local displacement effect of less than 10% based on sales orientation and level of local competition.

In summary, applications of the regional multiplier approach have generally focused on applying this type of analysis to new industries or incoming plants, as a part of, a more system-wide or detailed analyses (United Nations, 1994; Potter, 1995). The use of this type of analysis is only practical at the plant or regional level, such as, assessing the employment impact of a new plant. For instance, in a similar type of application as Potter (1995), the direct and indirect employment impacts were estimated for the Nissan plant in Sunderland (United Nations, 1994). The direct employment impact of Nissan in the UK, in 1992, was estimated at approximately 4,600 direct jobs. The indirect employment or backward linkages, including on-site component suppliers, generated another 3,429 jobs, which is equivalent to a linkage or indirect employment multiplier of 1.74 (United Nations, 1994).[9] This is substantially higher than the estimates derived by Potter (1995) for 'in-moving' plants in Devon and Cornwall. However, in the case of the Nissan plant, former component suppliers of Nissan who re-located to Sunderland account for over 41% of the indirect employment generated through backward linkages. This explains why 'local content' or backward linkages are substantially higher for Nissan.

2.3.4 Critique of the Keynesian Regional Multiplier Approach.

The main criticisms of this approach stem from the basic model framework. In common with the economic base multipliers, the Keynesian multiplier approach is wholly demand-based which restricts the analysis to providing short-run static multiplier estimates of employment or income. The model framework essentially restricts the impact analysis to the consideration of demand effects, as supply-side factors are implicitly assumed to be passive in the model (these are discussed in greater detail in the following section). Applications of the regional multiplier approach do not typically account for feedback effects from other regions. Thus, increased expenditure or economic activity in Region 1 will increase the amount of imports region 1 buys, which in turn, will lead to an increase in exports in another region, which will increase regional income in their economy. This increase in

[9] The multiplier and employment estimates are based on information provided by Nissan Motoring Manufacturing (United Kingdom) Ltd and published in the World Investment Report (United Nations, 1994).

activity will in turn stimulate demand in region 1. However, these types of feedback effects are typically ignored.

Sinclair and Sutcliffe (1989) stress the importance of the time-period over which the impact is being considered. In most regional multiplier studies, the time period is assumed to be discrete rather than continuous which means there is no consideration of the time path over which the impact accrues. Finally, regional impact analysis using regional multiplier approaches provides a very aggregate picture. However, as part of a system-wide approach the use of the multiplier has a role in providing income and employment estimates, although as the sole method of analysis it is less commonly applied. A more comprehensive approach is to extend the regional multiplier analysis such that it is capable of providing a detailed disaggregation of the effects of expenditure changes, particularly intermediate linkages. This disaggregated approach is provided by Input-Output analysis.

2.4 Input-Output Modelling.

2.4.1 Introduction and Overview of the Input-Output Framework.

The basic aim of an I-O system is to produce a structural breakdown of a regional economy, for a given time period, which details the value of transactions between industries, within a system where all inputs and outputs balance. The main focus of the system is to capture the linkages that exist between various industrial sectors and regions by constructing a series of tables that quantify elements of primary inputs, final demand and the intervening flows between sectors.

Applied to a region, an I-O system affords the advantage of being able to operate at a highly disaggregate sectoral level and provides a detailed analysis of a regional economy at a particular time. The framework is essentially an accounting one, in the sense that the tables are based on the notion that the production of output requires inputs and that overall the value of the gross output of each industry is exactly equal to the value of its gross inputs. For instance, the make matrix shows the value of products made and sold by commodity and industry group. The domestic use matrix maps the input structure of each industry in terms of purchased domestic goods and services. The imports use matrix illustrates the input structure of each industry in terms of the purchase of non-domestic goods and services. In addition to the make, domestic use and import matrices, further tables may be derived. In particular, the make matrix may be applied, with some simple assumptions about the nature of the technology used in the production of non-principal products, to transform product classifications into industry classifications. This allows the principal input-output tables to be derived, namely, the Transactions or Industry by Industry Table.

The Transaction Table forms the basis of the I-O system as it captures the inter-industry linkages between industrial sectors, within the region, as well as mapping both the sources of intermediate inputs and the final market destinations of the output of each sector. Table 2.4.1 provides an overview of the basic structure of an Input-Output Transactions Table, for a region with three basic sectors (manufacturing, non-manufacturing and services) and three sources of final demand (consumer expenditure, exports and other final demand).

Table 2.4.1. – Basic Structure of an Input-Output Transactions Table

Sectors	*Purchasing Industries:* 1	2	3		*Final Demands:* CExp	Exports	OFD	**Gross Output**
Production Industries 1	X_{11}	X_{12}	X_{13}	TIS_1	$CExp_1$	Exp_1	OFD_1	X_1
2	X_{21}	X_{22}	X_{23}	TIS_2	$CExp_2$	Exp_2	OFD_2	X_2
3	X_{31}	X_{32}	X_{33}	TIS_3	$CExp_3$	Exp_3	OFD_3	X_3
	TID_1	TID_2	TID_3	$\Sigma TID_{1..3}$	-	-	-	$\Sigma X_{1..3}$
Primary Inputs:	Lab_1	Lab_2	Lab_3	-	-	-	-	ΣLab
	Imp_1	Imp_2	Imp_3	-	-	-	-	ΣImp
	OVA_1	OVA_2	OVA_3	-	-	-	-	ΣOVA
Gross Inputs	X_1	X_2	X_3	$X_{1..3}$	$\Sigma CExp$	ΣExp	ΣOFD	X_r

Where:

$X_{11...33}$	Intermediate flows between firms in Sectors 1 to 3.
$TID_{1..3}$	Total intermediate demand by firms in Sectors 1 to 3.
$\Sigma TID_{1..3}$	Total intermediate purchases/sales, within the region by by firms in Sectors 1 to 3.
$Lab_{1..3}$	Labour inputs by firms in Sector 1 to 3.

$Imp_{1..3}$	Imports of intermediate inputs by firms in Sectors 1 to 3.
$OVA_{1..3}$	Over Value Added by firms in Sectors 1 to 3.
$OFD_{1..3}$	Output sold to other final demand by firms in Sectors 1 to 3.
$CExp_{1..3}$	Output sold to consumer expenditure by firms in Sectors 1 to 3.
$Exp_{1..3}$	Output sold to Exports by firms in Sectors 1 to 3.
ΣLab	Total value of labour payments or wage income within the region.
ΣImp	Total value of Imports including imports from both intermediate and final demand.
ΣOVA	Total other value added within the region..
ΣX_1	Total output/input generated by Sector 1.
X_r	Total value of economic activity in the region.

The above Transactions Table can essentially be viewed in terms of three distinct blocks. The first block details the inter-industry linkages between sectors. The purchasing industries are detailed across the row and the producing industries down the column. So, for instance, reading down the column from sector 1, X_{11}, X_{21} and X_{31} represent intermediate purchases (backward linkages) by sector 1 from firms in sectors 1, 2 and 3. Reading across the row from sector 1 (Production Industries) indicates the sales of intermediate inputs (forward linkages), X_{11}, X_{12} and X_{31}, to firms in sectors 1, 2 and 3. Similarly, reading down the column from sector 1, TID_1 indicates the total value of intermediate demand (intermediate purchases) by firms in Sector 1.

The primary inputs part of the Table shows the additional intermediate production requirements for Sector 1, which include labour inputs (Lab_1), intermediate imports (Imp_1) and other value added (OVA_1). Primary inputs are the incomes generated from suppliers of labour and capital and the import flow of goods and services. Incomes generated include income from employment and self-employment, profits, taxes and subsidies. Total inputs are simply the sum of industrial linkages and total primary inputs. The final entry for sector 1 ($\mathbf{X_1}$) shows the total value of inputs (output) required (generated) by sector 1.

The final demand section shows the destination of output for each sector. For simplicity, the above final demand section consists of consumer expenditure, exports and other final demand, which typically includes general government final consumption, capital formation, stocks etc. Reading across the row, for sectors 1 to 3, indicates the destination of output by each sector. For instance, total intermediate sales (TIS_1) is the value of output that is sold by Sector 1 as intermediate inputs for production in other sectors, including sector 1. The key point about these forward linkages is that this output is sold not for final demand, but instead as production inputs for other sectors in the economy. The remaining sales to exports, consumer expenditure, government etc. are final market destinations. Final demand arising from households (consumer expenditure) and government typically includes output produced outwith the region (imports). Reading down the Consumer Expenditure column these household imports would be included in the I-O Table at the intersection of this column with the import row. (These are not shown in Table 2.4.1 for ease of exposition.)

The Input-Output framework provides an important set of economic accounts, particularly, at the regional level where data are typically scarce. From the basic table, a number of key structural ratios can be derived, which illustrate the different characteristics, or production process, of sectors within the regional economy. For instance, various linkage measures, import, export ratios can be calculated for the various production sectors, as well as, trade flow measures. Moreover, the internal production processes of sectors can be compared via comparisons of value added to output shares and the labour requirement per unit of output. These issues are discussed in more detail in chapter 5 with the description of the I-O data in the ownership-disaggregated Scottish Input-Output Table for 1989.

Therefore, in the first instance, an I-O Table provides an invaluable set of regional accounts. However, the purpose of constructing an I-O Table is more often for use as a tool for regional or national modelling. The I-O Table is constructed on the basis of an accounting framework, such that the following identities hold, for each sector in the Table.

$$X_1 = TIS_1 + TFD_1 \qquad (1)$$

$$X_1 = TID_1 + TPI_1 \qquad (2)$$

Where;

X_1	Total output/inputs for sector 1.
TIS_1	Total intermediate sales (forward linkages) for sector 1.
TID_1	Total intermediate demand (backward linkages) for sector 1.
TFD_1	Total final demand (government, exports and OFD) for sector 1.
TPI_1	Total primary inputs (labour income, imports and other value added) for sector 1.

These accounting identities hold for each sector in the Table, i.e. sectors 1 to 3 in the case of Table 2.4.1. Similarly, using matrix notation, these identities can be shown to hold for the region or national economy as a whole.

$$X = A.X + F \qquad (3)$$

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} * \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} F_1 \\ F_2 \\ F_3 \end{bmatrix} \qquad (4)$$

Where;

X	is a column vector of sectoral outputs.
F	is a column vector of final demand.
A	is a matrix of direct (technical) coefficients.

The matrix of technical coefficients captures the structural inter-dependence of the intermediate production sectors. These coefficients express the value of local intermediate inputs required in order to produce one unit of output in each sector. The direct coefficients for the three sector model, as illustrated in Table 2.4.1, are derived as follows.

$$a_{11} = \frac{X_{11}}{X_1}, \quad a_{12} = \frac{X_{12}}{X_2}, \quad a_{13} = \frac{X_{13}}{X_3},$$

$$a_{21} = \frac{X_{21}}{X_1} \quad a_{22} = \frac{X_{22}}{X_2}, \quad a_{23} = \frac{X_{23}}{X_3}, \qquad (5)$$

$$a_{31} = \frac{X_{31}}{X_1} \quad a_{32} = \frac{X_{32}}{X_2}, \quad a_{33} = \frac{X_{33}}{X_3},$$

Where,

X_{11} Intermediate flows between firms in Sector 1.[10]

X_1 Total value of inputs (output) for firms in Sector 1.

a_{11} Direct (technical) coefficient which captures the intermediate flows by firms within Sector 1.

From equation 4, the A matrix of direct (technical) coefficients multiplied by the column vector of outputs X, is equal to the column vector of intermediate demands (TIS) from the base Input-Output Table. In matrix notation, the system of linear demands, for each sector, can be captured within one system. The major advantage of this approach is that we can use equation 3 to calculate the gross output vector (X) for any given set of final demands (F).

$$X - AX = F \qquad (6)$$

$$(I - A)X = F \qquad (7)$$

$$X = (I - A)^{-1} F \qquad (8)$$

Where, the $(I-A)^{-1}$ matrix represents the Leontief Inverse (I is an Identity Matrix), X is a vector of total outputs and F is a vector of final demands. Equation (8) represents the basic structure of an I-O model, which is shown in full matrix notation, for a three sector model, in equation (9).

[10] These are typically expressed in the I-O literature as X_{ij}, flow from sector i to sector j, however I use the numbering X_{11} to remain consistent with the earlier identities and overview provided in Table 2.4.1.

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} 1-a_{11} & -a_{12} & -a_{13} \\ -a_{21} & 1-a_{22} & -a_{23} \\ -a_{31} & -a_{32} & 1-a_{33} \end{bmatrix}^{-1} * \begin{bmatrix} F_1 \\ F_2 \\ F_3 \end{bmatrix} \qquad (9)$$

By accepting a number of assumptions concerning the nature of local economic relationships, equation (9) forms the basis of an I-O economic model. Such regional I-O models are typically used for three main forms of analysis:

- The identification of the ultimate source of regional economic activity in terms of markets and sectors.
- The measurement of the interdependencies and interactions amongst local sectors.
- Impact analysis, including "what if ... " type simulations.

Multiplier interaction in the I-O model arises through inter-industry effects, which are captured by the Leontief inverse. Production in any one sector requires the outputs of other sectors, such as raw materials, electricity, business services, etc., as intermediate inputs. Therefore an increase in the final demand for the output of one sector will have an expansionary effect on the output of these intermediate sectors. These will correspondingly increase their intermediate demand and generate further knock-on effects. The expansion in regional activity that occurs through the sum of these derived demands for intermediate inputs is known as the indirect effect.

The development of the input-output model stems primarily from the empirically oriented applications of Leontief (1953). However, it is widely accepted that an Input-Output Model essentially imposes an extreme Keynesian perspective of the regional economy, which is predicated upon very restrictive assumptions about the supply side of the economy (Harrigan *et al*, 1988). I next discuss the assumptions necessary for I-O modelling, specifically, and demand-orientated regional models (Economic Base and Keynesian Multiplier), in general.

2.4.2 Implicit Assumptions Required for Input-Output Modelling.

Input-output analysis makes a key distinction between sales to intermediate and final markets. It takes sales to final markets as being independent of the current level of local economic activity and, as such, treats them as exogenous. On the other hand, the levels of intermediate sales are determined by the current level of local economic activity and are said to be endogenous to the model. The input-output model therefore imposes a particular causal sequence in the generation of local activity. The scale and composition of the exogenous final demands drive the endogenous intermediate demands. However, the treatment of any individual transaction as intermediate or final can be varied, depending on the scope and purpose of the analysis. Essentially the issue is whether over a particular time period or in a specific context the transaction should be seen as exogenous or endogenous to the level of local economic activity.

Moreover, the distinction between intermediate and final transactions is defined in terms of markets, not sectors. Typically, the majority of individual sectors sell to both intermediate and final demands. Moreover, within each sector firms are assumed to produce a single product. Thus, firms within an I-O sector are treated within a 'representative transactor approach', which essentially removes individual firm behaviour from the model structure, however, this assumption is common in a number of more sophisticated models, including computable general equilibrium (CGE) models.

The I-O model is completely demand driven: exogenous final demand stimulates economic activity and generates the appropriate increase in supply. The supply side is therefore entirely passive so that there are no supply-side constraints. Thus, the I-O model is based on a Keynesian vision of the economy that, as with the economic base and local income multiplier approaches, implies no role for the supply-side. The model implicitly assumes a perfectly elastic supply of factor inputs. Excess supply of factor inputs implies that there are no constraints on productive capacity and, even in the short-run, supply or output can respond simultaneously to any exogenous increase in demand. This implies that any exogenous shock to the system will have no effect on commodity or input prices. For instance, any increase in demand for labour can be satisfied wholly within the region. Thus, an expansion in employment, as a result of an exogenous change in demand, has no impact on input (existing wage rates) or commodity prices. These assumptions essentially imply that scarcity and relative prices play no role in conventional I-O models (Harrigan *et al*, 1988).

Moreover, in an I-O model, production is taken to expand linearly so that a two-fold increase in output in a given sector will result in a similar increase in input requirements. This stems from the linear system of equations, on which the model is based. For instance, the I-O model adopts industry technological coefficients that are fixed at a given time. This implies a constant linear relationship between industry inputs and final output. There is no possibility of substitution between inputs or production methods. The model therefore runs based on the existing production structure of the region, with firms interacting within the model based on the existing linear system of demands, which are captured within the Leontief Inverse of the model. Finally, there are no increasing or decreasing returns to scale within the I-O model.

2.4.3. Input-Output and the Measurement of Linkages.

Input-Output analysis provides an appropriate framework for the estimation of linkages by sector. The I-O approach examines the dependence of output on the level and pattern of exogenous demands in the economy. As noted in chapter 1, Hirschman (1958) developed various linkage measures based on the notion that the linkage structure of firms or sectors determines their potential for generating growth within the region. The Hirschman (1958) linkage measures however draw on the earlier work of Chenery and Watanabe (1958) and Rasmussen (1956) who first considered the structural interdependence of sectors within the input-output framework. The Chenery and Watanabe (1958) approach is based on the technical coefficient matrix of an input-output system (as described previously in equation 5), where

$$U_j = \sum_{i=1}^{n} a_{ij} \text{ where the (column) technical coefficients } a_{ij} = \frac{X_{ij}}{X_j}$$

and (10)

$$W_i = \sum_{j=1}^{n} c_{ij} \text{ where the (row) technical coefficients } a_{ij} = \frac{X_{ij}}{X_i}$$

Where

X_j (X_I)	is the gross output of sector j (i).
X_{ij}	is the intermediate purchases from sector i by sector j.
a_{ij}	is the column coefficient.
c_{ij}	is the row coefficient.

Thus, U_j measures the ratio of intermediate inputs to total input (output) and W_i measures the ratio of intermediate sales to total output. Essentially, high values of U and W are taken to imply strong backward (forward) linkages. These linkage measures are analogous to those proposed by Hirschman (1958).

However, the Hirschman (1958) and Chenery and Watanabe (1958) linkage measures essentially capture only the first round effects. The backward linkage measure indicates the sourcing or indirect requirements, for a sector, following a unit change in output. However, they do not capture the subsequent indirect effects of the changes in output required by sectors in order to supply inputs to the purchasing sector. Thus, a more appropriate measure of these linkages, which capture all indirect effects, can be expressed within the I-O model in the form of both backward and forward linkage output multipliers. These multipliers are derived from the Leontief inverse of the static input-output model. Rasmussen (1956) first established these measures which he defined as statistical summary methods of structural interdependence, i.e. multipliers

$$R_j = \sum_{i=1}^{n} r_{ij} \text{ and } R_i = \sum_{j=1}^{n} r_{ij} \qquad (11)$$

Where

r_{ij} is defined as the total (direct and indirect) impact on the output of sector i which arises through a unit of exogenous demand for the output of sector j. The r_{ij} relate to elements of the open Leontief Inverse.

As noted these multipliers are calculated from the Leontief inverse of the model. The variable R_j is equivalent to the standard backward linkage output multiplier, with R_i equivalent to the forward linkage output multiplier. The output multiplier for a particular industry is defined as the total output generated from a unit change in final demand for the output of a particular sector. Given that these sectoral multipliers are derived from the Leontief inverse, which is based primarily on the direct technical coefficients, these multipliers provide an extended measure of the basic Hirschman (1958) and Chenery and Watanabe (1958) linkage measure, as they incorporate all rounds of subsequent expenditure. However, these measure include only direct and indirect effects, although the additional induced household effects can be easily incorporated within the Leontief Inverse of an I-O model. Hewings (1982) has demonstrated the role and importance of household expenditure particularly in regional economies.

Rasmussen (1956) devised an 'index of the power of dispersion' (backward linkages) and an 'index of the sensitivity of dispersion' (forward linkages) from the open Leontief inverse (r_{ij}). From the open Leontief inverse, where r_{ij} is a typical element, the sum of the row and column elements can be as R, and R_I (equation 11). Rasmussen further calculated the averages of these impacts $\frac{R_j}{n}$ and $\frac{R_i}{n}$, where n is the number of interindustrial sectors, in order to compare inter industry linkages between sectors. (For instance $\frac{R_j}{n}$ captures the average of each element in column j). Thus, the values of $\frac{R_j}{n}$ can be interpreted as estimates of both the direct and indirect increases in output which could be supplied by any randomly selected industry if final demand for industry j's output increased by one unit (O hUallachain, 1984).

Rasmussen normalised these indices so that comparisons could be made across I-O Tables, so that the average $\bar{R}$ is defined as,

$$\bar{R} = \sum_{j=1}^{n} \sum_{i=1}^{n} \frac{r_{ij}}{n^2} \qquad (12)$$

He then defined the power of dispersion index (U_j) and the sensitivity of dispersion index (U_i) as,

$$U_j = \frac{R_j / n}{\bar{R}} \quad \text{and} \quad U_i = \frac{R_i / n}{\bar{R}} \qquad (13)$$

Thus, the backward linkage index (U_j) is defined as the column mean divided by the average column mean. A value of $U_j > 1$ denotes a strong dependence for that industry on the rest of the national economic system. Thus values of U_j greater than one are interpreted as strong backward linkages. A value of $U_i > 1$ implies that industry i's output must expand more than the average value to meet a unit increase in the final demand in all *j* industries. This indicates above average dependence on the output of other sectors, which indicates strong forward linkages. However, one problem with such measures is that these results can be influenced by extreme measures (Hazari, 1970). In particular, where purchases or sales by a sector are concentrated in one other sector. Hazari (1970) proposed the generation of a coefficient of variation (V) for each sector, which is calculated by dividing the column mean, in each sector, by the column standard deviation. A small value for the coefficient of variation (V) in a sector indicates a relatively even spread of linkages across sectors.

However, Harrigan and McGilvray (1988) criticise these multiplier linkage measures on the basis that they are constructed essentially within a model that is closed to trade. They suggest that alternative linkage measures and ranking of sectors would be obtained from a I-O model based on the regional or intranational flows matrix, as opposed to the inverse of the technology matrix. In general, criticisms of these linkage multipliers stem from their reliance on the Leontief input-output system that ignores the possible effects that changes in relative prices may have on linkage strength, i.e. substitution of inputs. (These issues are discussed in more detail in the following section). However, these linkage measures, particularly the backward linkage output multiplier, are generally accepted within the literature, as the standard approach for undertaking impact analysis (Alexander & Whyte, 1995).

However, Cella (1984) developed the idea of 'total linkages' using a technique known as hypothetical extraction. This approach exploits a simple but powerful idea. By removing or suppressing a sector's transactions and linkages with other sectors within the economy, its linkage strength (or total contribution) in terms of supported output can be attained. Cella's (1984) approach is based on the standard input-output model.

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} 1-a_{11} & -a_{12} & -a_{13} \\ -a_{21} & 1-a_{22} & -a_{23} \\ -a_{31} & -a_{32} & 1-a_{33} \end{bmatrix}^{-1} * \begin{bmatrix} F_1 \\ F_2 \\ F_3 \end{bmatrix} \qquad (14)$$

Where

$X_{1\ to\ 3.}$ Vector of total outputs for sectors 1 to 3.

$a_{11...33}$ Matrix of direct (technology) coefficients for sectors 1 to 3.

$F_{1\ to\ 3.}$ Vector of final demands for sectors 1 to 3.

Cella (1984) proposed that to consider the linkage impact of a sector's intermediate purchases and sales of intermediate inputs (backward and forward linkages), these elements should be set to zero within the Transactions Table. For instance, for sector 1 the intermediate linkages (direct coefficients) a_{21}, a_{31}, a_{12}, a_{13}, from equation (12) are set to zero, so that, we can solve the model with these intermediate linkages suppressed and thus compare the difference in supported outputs with the previous case.

$$\begin{bmatrix} \hat{X}_1 \\ \hat{X}_2 \\ \hat{X}_3 \end{bmatrix} = \begin{bmatrix} 1-a_{11} & 0 & 0 \\ 0 & 1-a_{22} & -a_{23} \\ 0 & -a_{32} & 1-a_{33} \end{bmatrix}^{-1} * \begin{bmatrix} F_1 \\ F_2 \\ F_3 \end{bmatrix} \qquad (15)$$

Where $\hat{X}_1$, $\hat{X}_2$ and $\hat{X}_3$ are the output for each sector following the suppression of the backward and forward linkages of sector 1. Note that purchases or sales by sector 1 from other firms within the same sector (a_{11}) are not suppressed. Cella (1984) refers to these as 'closed loop' linkages, although in principal these could also be suppressed. The new outputs for sectors 1 to 3, which are generated by solving equation (13), must be less than the original outputs for these sectors given that these linkages (direct coefficients) have been set to zero. This implies that,

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} > \begin{bmatrix} \hat{X}_1 \\ \hat{X}_2 \\ \hat{X}_3 \end{bmatrix} \qquad (16)$$

from which Cella's measure of the total linkage (backward and forward) for the sector are calculated as the differences in sectoral output's following the suppression of sector 1's backward and forward linkages (excluding closed loop in this example),

$$TL_1 = \begin{bmatrix} X_1 - \hat{X}_1 \\ X_2 - \hat{X}_2 \\ X_3 - \hat{X}_3 \end{bmatrix} \qquad (17)$$

From the differences in supported outputs, associated total output linkage multipliers can be derived. Lahr and Miller (1997) provide a comprehensive review of this approach, which includes a number of different measures relating to various linkages. Thus, natural extensions to this approach include suppressing all intermediate linkages including closed loop, suppressing final demands or extracting individual components of these intermediate linkages. However, it is difficult to provide an economic rational or motivation for all of the extractions illustrated by Lahr and Miller (1997). The basic premise underlying the hypothetical extraction approach is that the local intermediate requirements of all sectors in the model (critical supply dependencies), following the suppression of all or part of the intermediate linkages of a sector, can be fulfilled through import substitution.

However, motivating this type of total linkage measurement is not so difficult in the case of foreign direct investment, particularly at the plant or sectoral level. Thus, given the highly mobile nature of FDI plants and the organisational structure of the multi-national corporation (MNC), it is not unrealistic to assume that the MNC can switch production across plants in different locations or close plants entirely. Thus, Bradley *et al* (1995) find evidence of this type of behaviour for foreign-owned manufacturing in Ireland (this is discussed further in chapter 6). Moreover, given the typically lower levels of linkages associated with foreign-owned plants, these plants are less dependent on the region for intermediate inputs. Therefore, by suppressing all linkages, or hypothetically removing a foreign-owned sector, we can calculate the total contribution of this sector in terms of supported output and employment. (In chapter 5, I provide an application of this approach using the ownership-disaggregated Scottish Input-Output Model).

Moreover, analytical solutions can be derived for the suppression of these linkages and decomposed to illustrate the components of both backward and forward linkages, closed loop linkages, total suppression etc. As noted, Lahr and Miller (1997) provide a comprehensive review of this approach including analytical solutions. Gillespie, McGregor and Yin (1998) provide a regional application of this approach to the measurement of the total linkage (supported output and employment) of the Oil and Gas sector in Scotland using the Scottish Input-Output Model for 1994.[11]

The analytical expression for the total linkage (TL_1) of a sector (for a two by

[11] They extend the linkage measures discussed in Lahr and Miller (1998). For instance, given the representation of the Oil and Gas sector in the Scottish I-O model, total suppression of this sector includes not only all intermediate purchases, sales and final demand by the sector, but an additional adjustment has to be made to final demands in all other sectors to account for sales by these sectors to the 'continental shelf' (Off-shore oil platforms), which are included with RUK exports from Scotland.

two case) is based on the solution for the original output vector for an I-O model. This exposition is taken from the analysis provided in Gillespie, McGregor and Yin, 1998:

$$\begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} H & HA_{12}L_{22} \\ L_{22}A_{21}H & L_{22}(I + A_{21}HA_{12}L_{22}) \end{bmatrix} \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} \qquad (18)$$

Where $H = (I - A_{11} - A_{12}L_{22}A_{21})^{-1}$ and $L_{22} = (I - A_{22})^{-1}$.

For the suppression of the total linkages of a sector we extract all sales to both intermediate and final demand. In a two sector case this corresponds to the suppression of all intermediate linkages, $A_{11} = A_{12} = A_{21} = 0$ and final demand for sector 1, $F_1 = 0$. Gillespie, McGregor and Yin (1998) derive the expression for the total linkage of sector 1 as:

$$TL_1 = (-H - L_{22}A_{21}H)F_1 - HA_{12}L_{22}(I + L_{22}A_{21})F_2 \qquad (19)$$

Where $H = (I - A_{11} - A_{12}L_{22}A_{21})^{-1}$ and $L_{22} = (I - A_{22})^{-1}$.

In summary, the Input-Output model provides a comprehensive framework for considering the various impacts of linkages within a regional or national economy. The Hirschman (1958) and Chenery and Watanabe (1958) linkage measures are essentially 'first generation' linkage measures. By using the I-O Model these measures can be extended to include the direct and indirect impacts (Rasmussen, 1958). Moreover, measures of total linkages can be derived by 'hypothetically extracting' the total linkages of the sector (Cella, 1984), which are typically described as 'second generation' measures of linkages (Harrigan and McGilvray, 1998).

2.4.4 Applications of I-O Analysis to the Impact of Foreign Direct Investment (FDI).

O'hUallachain (1984) provides an analysis of Input-Output Linkages and Foreign Direct Investment in Ireland using an Input-Output Model for Ireland for 1969. He calculates weighted indices of Rasmussen's (1956) 'index of the power of dispersion' (backward linkages) and the 'index of sensitivity of analysis' (forward linkages) for the 92 sectors contained in the model. He then ranks sectors according to whether they have high or low values of both backward and forward linkages. For sectors with strong backward linkages, he finds that 35 of the 92 sectors in the model have U_j values greater than unity. These sectors consist primarily of food processing or agriculture related sectors. He finds that foreign firms are predominant in those sectors that are weakly dependent on national inputs, low values of U_j. However, the inclusion of the household sector in the Leontief model (induced effects) increase the number of sectors judged to have strong backward linkages to 49 sectors. However, the biggest change in the ranking of sectors, by including household effects, was in the public sector organisations, particularly police.

In general, he found that sectors where foreign plants are located typically had lower backward linkages, even after including the induced multiplier effects. Sectors with higher backward linkages were typically traditional sectors. However the model provides only an analysis of the aggregate linkage structure of each sector as foreign and indigenous plants are not identified separately, within sectors. Moreover, the structure of the Irish economy and its general approach to FDI has changed considerably since 1969.

Alexander and Whyte (1995) illustrate how the Scottish Input-Output Model for 1989 can be used to assess various regional economic disturbances. They highlight the use of I-O multipliers and illustrate one application for incoming foreign-owned manufacturing plants (FDI). They essentially estimate the total (direct, indirect and induced) employment impact of incoming FDI plants by using the relevant type II employment multiplier. The sectoral I-O multipliers used by Alexander and Whyte (1995), although highly disaggregated (123 sectors in total); again relate to the aggregate structure of the sector i.e. there is no distinction between ownership categories within individual sectors. Therefore, the multiplier relates to the aggregate characteristics of all firms within the sector.

Hill and Roberts (1995) construct and use an I-O table for the Welsh economy to explicitly consider the importance of linkages between indigenous and foreign-owned manufacturing sectors within Wales. They construct an I-O table that provides a part disaggregation of Welsh manufacturing by ownership. They survey 25 per cent of manufacturing inward investors (FDI) in Wales, 1993. They incorporate these survey data into the I-O Table to distinguish manufacturing sectors separately between the surveyed FDI plants and the remaining manufacturing sector plants, which also includes indigenous and (non-surveyed) foreign-owned plants. (The construction of the Welsh I-O Table, by Hill and Roberts (1995) is discussed further in chapter 4.)

They consider the regional policy relevance of attracting a new incoming foreign-owned plant, as opposed to a policy of import-substitution whereby the level of spending on local inputs (linkages) are increased by the existing foreign manufacturing sector by 1%. Hill & Roberts (1995) use the I-O multipliers from the constructed Welsh I-O Model to estimate the potential impact of a new incoming plant, within Wales, generating output worth £10 million per year. In the first instance, the direct effect simply represents the increased output, worth £10 million per year, from production at the new plant. With the linkage or indirect effects, illustrated by the Type II output multiplier for that sector, the total system-wide increase in output, generated by the incoming plant within Wales, increases to £13.45m per year. Hill & Roberts (1995) calculate that this would generate a further £1.3 million in direct local wages and, including all indirect effects, this would rise to over £1.7million, in accordance with a Type II income multiplier of 1.713. The employment impacts, associated with generating output of £10m per year in this manufacturing division, are equivalent to 81 full time direct jobs within the plant. With the indirect multiplier effects of the additional income and output generated by the incoming plant, total employment increases to 140. These results are summarised in Table 2.4.2.

Table 2.4.2 - Direct and Indirect effects associated with an incoming plant generating output worth £10million per year, as reported by Hill & Roberts, 1995.		
	Direct Impact	**Direct + Indirect Impact**
Output £m	10.0	13.45
Income £m	1.31	2.24
Employment (full-time Equivalent)	81.5	140.3

These estimates are then compared with the impact of increasing the level of direct linkages within the Welsh economy by 1%. In effect, they illustrate the impact of an import-substitution policy aimed at reducing the level of inputs imported into Wales. In essence they increase local sourcing (spending within Wales) by 1% and reduce the level of import spending by an equivalent amount.

This is calculated by increasing the current flows or expenditures between industrial sectors. In effect, intermediate demand is stimulated in each sector by an equivalent amount equal to 1% of final demand. For instance, if current inward investors spend £250 million on manufacturing division II firms, through backward linkages, then the increased intermediate demand, by 1%, would result in an additional £250,000 thousand being spent in this sector. The increased final demand or sales stimulates all sectors directly, which in turn, increases sectoral final demands further through the associated increase in each sectors own particular linkages and input requirements. Estimates of the total impact on output, income and employment by Hill & Roberts, 1995 are reported in Table 2.4.3.

Table 2.4.3 The total output, income and employment impact - generated by a 1% increase in final demand in Wales (calculated by Hill & Roberts 1995).			
Sector	**Output (£000's)**	**Income (£000's)**	**Employment (FTE's)**
Total	16,727.2	4,307.5	274.3

Their results suggest that the impact of increasing local linkages are potentially greater, particularly in generating employment, than the associated impact of attracting a new FDI plant, generating output worth £10million a year to the local economy. The analysis demonstrates the importance of linkages within a regional economy. However, the generality of such results is questionable as an important factor is the present stock of FDI as against the proposed level of new FDI.

Moreover, foreign-owned plants typically source high 'value-added' (technologically sophisticated) intermediate inputs from within the multi-national organisation. These inputs cannot typically be sourced within the local economy. The main inputs sourced by foreign investors in Wales are Energy and Water and low-value-added inputs, which are costly to transport (plastics, packaging etc.), based on the I-O transactions table constructed by Hill & Roberts (1995). Therefore several important points concerning the analysis by Hill and Roberts (1995) are worth noting. Firstly, such a systematic shift in sourcing (1% across the entire sample of inward investors) is unlikely to occur. Secondly, Hill and Roberts (1995) are not comparing equivalent output shocks in the sense that the direct (first round) impacts are different.

Fuentes *et al* (1993) use an I-O framework to obtain an estimate of the indirect employment effects attributable to linkages between foreign and indigenous plants in the *maquiladoras* area in North Mexico. They find that the level of backward linkages and the level of indirect employment generated by foreign-owned plants are particularly low. The model considers the indirect employment impacts of *maquila* firms, using a four-sector I-O model, based on plant-survey data. The *maquiladoras* relate to an area in Northern Mexico, adjacent with the US border, which the Mexican government designated to attract US multinationals. Incoming plants within this location are permitted to import inputs into Mexico without paying duty and only pay a tariff on exports. In essence, these border locations were designed to attract incoming foreign-owned manufacturing plants to use the location as a production base for exports, by utilising the availability of relatively low labour costs.

The I-O model comprised four sectors: *maquila*, non-*maquila* manufacturing, commercial activities and services. Spending by the foreign-owned plants in these specific regions (*maquiladoras*), in Northern Mexico, was divided into wages and salaries spent by employees, plant expenditures on services related to production and distribution, and plant purchases of materials inputs. The I-O results also incorporate the indirect employment and income effects of jobs indirectly created by these foreign-owned plants. Note that labour costs accounted for 61% of the total expenditure of *maquila* plants, with a further 33% spent on services and the remaining 6% on intermediate inputs.

US firms based within this region supported over 500,000 jobs in total: 84% by wages and salary expenditures (household consumption), 15% by purchases of services and only 1% by purchases of intermediate inputs. The direct employment generated by *maquila* plants was 430,000, in 1989. This employment supported further (indirect) 78,313 service sector jobs and 6,118 manufacturing sector jobs. This implies a type II employment multiplier of 1.20. (Recall that Potter (1995) obtained a similar multiplier value for in-moving branch plants in Devon and Cornwall.) The most notable factor of these results is the size of the indirect employment effect generated by foreign-owned plants, given the level of backward linkages or input supplies. Obviously, the foreign-owned plants within these locations are importing the bulk of their supplies. The area essentially consists of a number of labour intensive assembly plants where ready-made components are assembled. The US companies are attracted to this region by lower relative labour costs. The major economic impact of these plants, within this area, originates through the consumption expenditure of workers employed within the plants, which accounts for the bulk of the knock-effects (supported outputs). Beyers (1974) similarly demonstrated that for the State of Washington the multiplier effects from the payment of wages and salaries by firms to consumers is more important than interindustry linkage effects.

2.4.5. Critique of Regional I-O Models.

As noted, the input-output approach to regional modelling is based on a number of restrictive assumptions. In modelling terms, the I-O system provides only a very restrictive general equilibrium framework (Harrigan and McGregor, 1988). The strengths of this approach are that it provides a very detailed account of a regional economy for a given time period. However, as a tool for regional modelling, the system models quantities independently of prices and embodies the traditional demand orientated view of a regional economy. This renders the model incapable of considering supply-side impacts or issues. However, recent research has indicated that a range of flex-price neo-classical models converge on the I-O solution in the long run (McGregor *et al*, 1996). Thus, in the case of an exogenous demand disturbance, the long run results for these models approximate I-O with no price effects, substitution of production technology and equi-proportionate change in output, value added and employment.

The internal consistency of the I-O model, which relates to the fact that all the effects on a given change in final demand can be traced throughout the model, is quickly eroded where inter-industry linkages or production technology change over time. Input-Output tables are produced for a specific time period and are typically parameterised with data for one year. If production techniques are changing through time, or if the pattern of linkages is sensitive to changes in the relative price of inputs, the model may lose a great deal of its accuracy and consistency. CGE models are also typically parameterised in a similar manner. However, within the I-O model, the assumption of Leontief technology essentially determines the structure of the model. Whereas, with a CGE model, these data provide base year estimates for the structure of the region. However, in comparison with the I-O model, this structure can change via input substitution (labour, capital and intermediates) through incorporating relative price effects into cost minimising production functions. (These issues are discussed in more detail in chapters 3 and 6).

In addition, technological coefficients may vary systematically even within the same industry, due to firm structure, size, ownership or simply that some firms may be more efficient than others in their use of inputs. (Thus, it is apparent that there are significant structural differences between indigenous and foreign-owned plants within the same sector.) Furthermore, the I-O Model (and multipliers) are typically assumed to apply in the short-run (Richardson, 1985). Even allowing for input coefficients not to change a great deal over time, uncertainty in the short run can cause problems. Thus, the problem of predicting the scale of any secondary expansion in the short run is complicated by the existence of various lags in expenditure, production etc, which implies that instantaneous adjustment may not be possible. Therefore, it is questionable whether the multiplier can be described as applying in the short run. In reality, where there are significant lags in the adjustment of output etc. then the multiplier would overestimate the short-run impact. In the longer run, the significance of these lags in adjustment would diminish. However, the input coefficients could no longer be assumed to have remained unchanged. (The importance of capacity constraints is discussed further in chapter 3).

One final drawback with regional I-O, or any extensive accounting framework, is the high cost of collecting data and constructing regional I-O Tables. However, this has led to the development of a substantial literature on the use and development of partial and non-survey techniques for estimating these tables (Hewings and Jenson, 1980; Round, 1983; Richardson, 1985). Recent research has indicated that the quality and accuracy of the database does have an impact on the model results. Coomes *et al* (1991) and Israilevich *et al* (1995) have demonstrated the choice of input-output tables does matter when these are incorporated in modelling systems. These issues are discussed further in Chapter 4, with the construction of the ownership-disaggregated Scottish Input-Output Table for 1989.

In conclusion, the I-O framework provides both an accounting and modelling framework. Its strengths are that it sets out in detail the economic linkages that exist between the various sectors of a region for a given time period. The implicit assumptions of I-O typically mean that the I-O model is usually applied in the short run, in an imperfectly competitive, excess capacity, setting (Richardson, 1985). The main criticism of this modelling approach is the complete neglect of supply-side issues. Extensions to the I-O framework have incorporated endogenous population and endogenous prices, as well as, a number of other extensions which attempt to capture the supply-side.[12] These extensions however are limited by the existing structure of the model, in the sense that they have to be converted to an output measure for use within the I-O structure system.

[12] There has been work undertaken in developing supply-side I-O models, as well as, endogenous price models and models which incorporate labour market and demographic type effects (Richardson, 1985; Batey & Madden, 1981; 1983). However these are not standard and most regional practitioners use the more basic I-O model outlined in this section.

2.5 Econometric Applications to FDI.

Introduction.

Econometric analysis provides an important method of research for foreign direct investment (FDI). (Recall that much of this literature was discussed in the general review of FDI impacts in Chapter 1.) Recent econometric applications to FDI have typically focused on identifying whether 'efficiency spillovers' arise from the presence or interaction of foreign and indigenous plants within a region. Essentially, these studies focus on identifying cross-sectional impacts of FDI on indigenous productivity. However, before discussing this literature I provide a brief overview of regional econometric models and consider a recent econometric application to the impact of FDI in Scotland.

2.5.1 Overview of Regional Econometric Models.

A regional econometric model is a set of equations describing the economic structure of a regional economy. The parameters of the equations are estimated econometrically, largely by regression analysis, as distinct from an I-O model in which parameters are based on single-point observations. The early regional models where typically dominated by ideas originating in national econometric modelling and also by the export base framework. For instance, Klein (1969) recommended the strategy of linking a regional model to a national econometric model and suggested regional models should adopt the standard Keynesian income-expenditure framework, which was prevalent in national models at that time. (This is the approach on which the Keynesian multiplier model is based).[1] However, it should be noted that, owing to

[1] Klein (1969) advocated two approaches which he referred to as the top-down and bottom-up approach. The regional top-down approach relies on exogenous variables which are generated by a national model. These regional models are driven by the national model which imposes a particular direction of causation i.e. the national variables can induce change in the region but not vice versa. In contrast, the bottom-up approach starts with a regional model which accounts for the interdependent nature of relationships between regions and the nation and aggregates the regional models up to form the national model. This method has theoretically more appeal However data restrictions at a regional level make it technically more difficult. The top-down approach has the advantages of consistency, and better data.

the absence of reliable trade data, the majority of regional econometric models are not expenditure based but rather income or output based.[2]

Estimation of regional econometric models is characterised typically by a lack of both monthly and quarterly data which often necessitates the use of annual time series data. With very few data series of sufficient length, and relatively few observations, the complexity of dynamic specification and the range of diagnostics testing available for regional modellers is often limited. In general, the dearth of regional data, particularly interregional trade, capital stock and relative prices, restricts the potential analysis and specification of regional models. Moreover, the spatial nature of a regional economy makes it difficult to account for or quantify various transfers which occur across regional boundaries.

However, an important issue for regional econometric modellers is their view of the determination of output within the regional economy. This has led to economic research on the determination of regional output being segmented into two distinct approaches. Either a Keynesian view of the operation of markets is adopted which leads to a demand orientated short run model or a long run supply side (neo-classical) model is developed. . In general, very few econometric models attempt to incorporate anything approaching a complete "supply-side", which requires a full specification of demand and supply schedules for product and factor markets. The simulation of a regional economy within a macroeconomic model which does not or cannot incorporate supply side variables specific to that region, however, may fall short of allowing the full impacts of a change in demand within a region to be analysed (Harrigan & McGregor, 1988). Therefore, for analysing the macroeconomic impact of FDI, at a regional level, there is a case for a modelling approach that has an active supply side. (Bradley *et al*, 1993; 1995 provides an example of this type of framework with an econometric model of Ireland which has a fully specified supply-side.)

[2] See Glickman (1971, 1977) for an application and review of this approach.

2.5.2 Applications of Regional Econometric Models to FDI.

Applications of regional econometric models to analyse the impact of FDI are rare. However, Foster & Malley (1988a) develop a macroeconomic model of the Scottish economy which is based on the general Keynesian income expenditure framework:

GDP(t) = C(t) + I(t) + G(t) + (X(t) - M(t))	[1]
C(t)[L^n] = f(Y(t) [L^n], R(t) [L^n])	[2]
I(t) = IH(t) + IF(t)	[3]
IH(t) [L^n] = f(Y(t) [L^n], R(t) [L^n])	[4]
IF(t) = IF(t)*	[5]
G(t) = CG(t) + IG(t)	[6]
CG(t) = F(Y(t) [L^n]	[7]
IG(t) = IG(t)*	[8]
X(t) [L^n] = f(W(t) [L^n], ER(t) [L^n]	[9]
W(t) = W(t)*	[10]
ER(t) = ER(t)*	[11]
M(t) [L^n] = f(Y(t) [L^n]. ER(t) [L^n]	[12]
R(t) = R(t)*	[13]

* Indicates this variable is exogenously determined outwith the region.

Where:

GDP	Scottish Gross Domestic Product.
Y	Scottish Regional Income.
C	Scottish Total Private Consumption
I	Scottish Total Private Investment
IH	Scottish Home investment
IF	Foreign Direct Investment in Scotland.
G	Total Government Spending in Scotland
CG	Government Consumption Spending
IG	Government Investment Spending.
X	Scottish Total Exports
W	World Expenditure (excluding UK)

M	Scottish Total Imports
R	UK Long-term Interest Rate.
ER	UK Multilateral Exchange Rate.

(t)	Is the time subscript and denotes the current period.
[L^n]	L is the lag operator and n is the order of the lag polynomial.
Ln	Is the natural logarithm.

Foster & Malley (1988a) estimate a reduced form equation, which contains all exogenous variables in the structural model, to estimate the impact of FDI flows on Scottish GDP. This model was estimated by Foster & Malley (1988a) to allow the impact of FDI flows on GDP to be assessed and to consider direct comparisons between the relative impact of FDI and government fixed investment (GFI).

GDP (t)[L^n] = f(IF(t)[L^n], IG(t)[L^n], W(t)[L^n], R(t)[L^n], ER(t)[L^n])

The dependent variable is the log of GDP at time period t. The explanatory variables include foreign direct investment (IF) in Scotland, government investment savings (IG), world expenditure (Wt), UK long term interest rates (Rt) and the UK exchange rate (ERt). Foster and Malley (1988a) estimate the above specification for Scottish GDP for the period 1961 to 1984 using annual data.

Table 2.5.1 Regression results for the determinants of Scottish GDP for the period, 1961-1984, as estimated by Foster and Malley, 1988a.[3]

Ln GDP	Constant	*Ln*IF	*Ln*IG	*Ln*W	*Ln*ER	R
Coefficients	6.66	0.057	-0.131	0.391	-0.40	0.005
St Errors	0.57	0.03	0.045	0.037	0.056	0.003

Table 2.5.1 reports the regression results for Scottish GDP for the period 1961 to 1984. The bulk of explanatory power in the equation is attributable to world expenditure (W) and the UK exchange rate (ER). The effects of FDI (IF) are positive, although it contributes a relatively small amount in terms of explaining the dependent

variable, and is significant at the 10% level (applying standard t -tests). This constitutes a positive effect on GDP. The estimated coefficient implies that a 1 per cent rise in IF (stock of foreign investment) induces a 0.0571% rise in GDP. However, this estimated coefficient was rendered to be unreliable due to the magnitude of FDI compared with GDP. Moreover, autocorrelation tests confirmed that the equation was misspecified. In a priori sense, Foster & Malley (1988a) suggest that these results are what one would expect from such a regression as FDI flows from such a small component of GDP (less than 1% over the sample period).

To overcome this problem, Foster & Malley (1988a) specified a narrower reduced form equation in which the dependant variable was total manufacturing output (TMO). As TMO constitutes around one quarter of Scottish GDP it was expected to be more responsive to the inclusion of FDI. Foster and Malley (1988a) estimated the following model for total manufacturing output, using annual data for the period 1962 to 1984.

TMO (t)[L^n] = f(IF(t)[L^n], IG(t)[L^n], W(t)[L^n], R(t)[L^n], ER(t)[L^n])

The explanatory variables again relate to foreign direct investment (IF), government investment savings (IS), world expenditure (W), exchange rate (ER) and UK long term interest rates (R_t).

Table 2.5.2 Regression results for the determinants of total Scottish manufacturing output, for the period, 1962-84, as estimated by Foster and Malley, 1988a.

Ln TMO	Constant	*Ln*IF (-1)	*Ln*IG (-1)	*Ln*W	*Ln*ER	R
Coefficients	0.182	0.0066	0.097	0.593	-0.321	-0.022
St Errors	0.782	0.039	0.062	0.055	0.730	0.0049

Table 2.5.2 reports the regression results for the determinants of total manufacturing output. These results are relatively similar to that reported in Table 2.5.1, with world expenditure (W) and the UK exchange rate (ER) the main

[3] The results reported in Table 2.5.1 represent the 'best estimation' results obtained by Foster & Malley

determinants of total Scottish manufacturing output. The FDI coefficient (IF) is again significant at the 10% level and has a coefficient elasticity value of 0.0661. Foster & Malley (1988a) suggest that this constitutes a large impact with a £1 increase in sample average foreign investment (I^F) associated with a £2.08 rise in sample average TMO.

In summary, Foster & Malley (1988a) suggest that international factors such as world demand (W) and the UK exchange rate (ER) are extremely important in the determination of Scottish GDP over the period. (This is not surprising given the high export-intensity levels of Scottish manufacturing output.) Their results also show that FDI forms a significant part of total manufacturing output (TMO) considering the small size of FDI flows. However, the paper is restrictive in only analysing FDI flows. The authors suggest that a more appropriate measure of the behaviour and effect of FDI would have been to use total output in the foreign owned manufacturing sector. Moreover, they suggest that the Keynesian explanation of manufacturing output may be inappropriate. Instead, they believe it would have been better to analyse the responsiveness of manufacturing output to total aggregate demand and how the foreign owned and indigenous sectors differ in this regard. This variable would then include both the impact of current disinvestment and the benefits of past FDI.

This theme is developed in Foster & Malley (1988b), where they investigate the responsiveness of Scottish manufacturing output to aggregate Income/Expenditure measures over the period 1962-84. They disaggregate Scottish manufacturing output into its domestic and foreign owned components so that they can determine any differences in the responsiveness of these ownership sectors to changes in aggregate income levels. The component of output they are concerned with is Scottish manufacturing output (SM).

They specify aggregate Scottish expenditure (AE) as a function of aggregate income at 3 levels: Scottish (SY), rest of UK (RUY) and World (WY). They also divide total manufacturing output in Scotland (SM) into both its Scottish (SMD) and foreign-owned components (SMF). Foster & Malley (1988b) are interested in "testing

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(1988a).

for the existence of any systematic tendency for the SM/AE relationship to move over time, implying a parametric shift which is evolutionary in character". They estimate the same equation using data for total Scottish, foreign-owned and indigenous-owned manufacturing output, in order to test for any relationship between the different components of Scottish manufacturing and different components of aggregate income. They estimate the following models.

$$Ln\mathrm{SM} = Ln a_1 + c_2 Ln\mathrm{SY} + c_3 Ln\mathrm{RUY} + c_4 Ln\mathrm{WY} + b_1\mathrm{T}. \quad (1)$$

$$Ln\mathrm{SMF} = Ln a_2 + c_5 Ln\mathrm{SY} + c_6 Ln\mathrm{RUY} + c_7 Ln\mathrm{WY} + b_2\mathrm{T}. \quad (2)$$

$$Ln\mathrm{SMD} = Ln a_3 + c_8 Ln\mathrm{SY} + C_9 Ln\,\mathrm{RUY} + c_{10} Ln\mathrm{WY} + b_3\mathrm{T}. \quad (3)$$

Where

SM	Scottish manufacturing output (Index of Industrial Production for Scottish Manufacturing).
SMF	Scottish foreign-owned manufacturing output
SMD	Scottish indigenous manufacturing output
SY	Scottish Income (GDP)
RUY	Rest of UK Income (UK GDP)
WY	World Income (World GDP)
T	Time trend.
Ln	Is the natural logarithm.
(t)	Is the time subscript and denotes the current period.

The structure of these equations was adjusted using the General to Specific criterion. (Note that the RUK income variable is dropped from the regression and Scottish income (SY) lagged one period, is included as an explanatory variable.) The explanatory variables are Scottish income, Scottish income lagged one period and world income lagged one period.

Table 2.5.3 Regression results for the analysis of Scottish manufacturing output disaggregated by ownership, for the period, 1962-94, as reported by Foster and Malley, 1988b.					
Ln SMO	*Constant*	*LnSY*	*LnSY* (-1)	*Ln*WY(-1)	*T*
Coefficients	-10.63	1.01	-0.73	1.56	-0.51
St Errors	1.24	0.26	0.27	0.23	0.007
Ln SMF	*Constant*	*LnSY*	*LnSY* (-1)	*Ln*WY(-1)	*T*
Coefficients	-32.18	1.33	0.98	3.91	-0.11
St Errors	2.71	0.56	0.58	0.50	0.015
Ln SMD	*Constant*	*LnSY*	*LnSY* (-1)	*Ln*WY(-1)	*T*
Coefficients	-7.15	0.96	-0.76	1.25	-0.044
St Errors	1.23	0.26	0.26	0.23	0.007

The results reported in 2.5.3 vary considerably between the foreign and domestically-owned manufacturing sectors. Firstly, from the aggregate results reported in Table 2.5.3 Foster and Malley (1988b) suggest that the responsiveness of Scottish Manufacturing (SM) output to domestic income (*Ln* SY) indicate that Scottish manufacturing is in a mature phase of economic development. Moreover, they suggest that the negative time trend for total Scottish manufacturing output, reveals that a 'systematic erosion of the overall relationship has taken place'. They suggest that the negative and significant coefficient on the lag of Scottish income indicate that the short-run increase in output that arises from changes in Scottish income (SY) is partially reversed. This result is consistent with switching behaviour from domestically produced available output to imported goods.

However, changes in domestic income have a larger impact on foreign-owned manufacturing output. Furthermore, the regression results for the indigenous and foreign-owned components of Scottish manufacturing output indicate that over the period, 1962-84, world income had a significantly larger positive impact on foreign-owned manufacturing output than indigenous output. The coefficient for world income in the foreign-owned equation is over three times the equivalent coefficient for the indigenous manufacturing sector (equation 3). Foster & Malley (1988b) suggests that these results imply two things. Firstly, the domestic sector is just holding its share of world income, whereas the foreign sector has recorded a rapid rate of output expansion. Secondly, that the foreign sector has a greater share of its output sold in world markets than the indigenous sector. Overall, they suggest that the Scottish economy has benefited from the growth of the foreign-owned manufacturing sector. However, they suggest that the negative time trend, which is larger in the foreign-owned sector, indicate that the foreign-owned sector is affected by the decline in indigenous manufacturing.

However, it is difficult to generalise from such results. The fact that foreign-owned manufacturing output is more responsive to changes in World Income (expenditure), over this period, is not surprising given the nature of multi national corporations. What is perhaps more surprising is that foreign-owned output is more responsive to changes in domestic income. Foster & Malley (1988b) highlight the differences in the determination of foreign and indigenous manufacturing output between sectors. However, the paper is restrictive in a number of ways. Firstly, the results are for very highly aggregated for manufacturing. Differences across manufacturing sub-sectors are not picked up, even though the bulk of FDI inflows to Scotland have been concentrated primarily in Electronics. Thus, although the regression analysis is based on data for a number of years, it does not provide the level of sectoral detail provided by I-O. Secondly, the explanation of Scottish GDP is determined extensively by demand-side variables that are exogenously determined. Thus, the model of Scottish GDP imposes a particular causation, similar to I-O, in the determination of Scottish GDP.

In evaluating the effectiveness of regional econometric models, one would have to consider the approach and methodology adopted. Where these approaches are predominately demand-based they face the same limitations as other Keynesian models, such as I-O or regional base. However, where such models incorporate a fully specified supply-side, their scope for analysis is much improved (Bradley *et al*, 1993; 1995). However, econometric analysis is important for estimating both the level of significance and the magnitude of impacts or relationships that exist between variables within a regional economy. Such information is important for informing the pattern or existence of behavioural relationships between different variables. (This information is typically used for parameterising behavioural relationships within computable general equilibrium (CGE) models.)

In summary, very few applications of regional econometric models consider wholly the impact of FDI. Instead, much econometric work relating specifically to FDI has considered the existence of supply-side impacts from FDI, in both developed and developing economies (Caves, 1974; Globerman, 1979; Blomstrom, 1983, 1986; Haddad & Harrison, 1993; Barrell & Pain, 1997). In the following section I discuss this literature.

2.5.3 Supply-side Impacts of FDI

As noted in chapter 1, there is a growing literature which has identified the potential existence of supply-side impacts arising through FDI (PACEC, 1996). One such issue is the existence of 'efficiency spillovers' from FDI. There are, however, inherent difficulties in trying to estimate such spillovers. Spillovers or efficiency improvements can be derived in a number of ways. For instance, through direct linkages with foreign-owned plants, via direct competition, movement of personnel, international trade etc. Caves (1974), in one of the first empirical studies of this nature, identified two possible avenues for efficiency spillovers: technical efficiency and technology transfer. The premise underlying the technical efficiency spillover is that the foreign firm may induce a higher level of technical or 'X' - efficiency in indigenous firms that compete with it, supply it or purchase from it. This increase in technical efficiency would be induced through the added competitive force of the foreign firm or through demonstrative effects of its products and processes. Both Gorecki (1976a) and Blomstrom and Persson (1983) suggest that the most important source of spillover efficiency are found to be in the competitive pressure induced by foreign firms.

The early 'efficiency spillover' models (Caves, 1974; Globerman, 1979) set out to identify whether the presence of foreign-owned plants within a sector had a positive impact on the aggregate labour productivity of domestic firms within the same sector. The dependent variable (value added per employee) was typically regressed on a number of explanatory variables, including FDI, labour quality variables, average weekly hours worked per employee, plant economies of scale, capital/labour ratio etc. Various proxies for FDI were used with a positive and significant coefficient for the FDI variable indicating a positive spillover from the presence of FDI on indigenous labour productivity. Both the Caves (1974) and Globerman (1979) studies deal with the technical efficiency of host country firms, as proxied by a measure of value added per employee (labour productivity). They both find limited empirical support for their 'spillover hypothesis'. However, in both studies, there are some fundamental problems connected both with the lack of data and, more importantly, the specification of the econometric models they estimate. These issues are discussed in more detail in the subsequent section.

Blomstrom and Persson (1983) followed the Caves (1974) and Globerman (1979) studies except that they test for the existence of 'efficiency spillovers', arising from the presence of foreign-owned manufacturing plants in one sector, in other sectors of the economy. Therefore, their analysis is aimed at identifying the existence of intra-industry spillovers, from FDI. The dependent variable in their analysis is value added per employee (labour productivity). This is regressed on a number of explanatory variables including capital intensity, labour quality, level of industry concentration, scale economies within the industry and the average effective working day. The FDI spillover hypothesis is captured by a variable that measures the degree of foreign participation in different industries.

The data are taken from the Mexican 1970 Census of Manufacturing, which consist of a sample of 215 manufacturing industries, divided between domestically owned private and foreign-owned plants. The data that are disaggregated by ownership include the following variables: number of plants, employment, wages, assets, gross production (output), value added, and gross investment. Blomstrom and Persson (1983) also uses the following data that are not disaggregated by ownership: size distribution of plants (measured in gross production), average man hours per year and the division between blue collar and white collar workers. They estimate the following model to explain labour productivity in Mexican manufacturing.

$$Yd = f(KLd, H, SCALEd, AD, (LQ_1, LQ_2), FS) \qquad (1)$$

Where

Yd dependent variable is the ratio of value added to total employment in domestically owned private plants.

Kld is a measure of capital intensity in domestically owned private plants (ratio of total assets to employment).

LQ_1 is a labour quality variable measuring the ratio of white collar to blue collar workers for the whole industry (including foreign plants).

LQ_2 is the error term 'e' in the regression ($LQ_1 = \alpha + \beta$ FS+ ε) and is a measure of labour quality in Mexican plants.

H is a Herfindahl index measuring concentration.

AD represents average effective working day for the whole industry.

FS represents the share of employees in an industry employed in foreign plants.

Table 2.5.5 Regression results for intra-industry spillovers from FDI, as reported by Blomstrom and Persson, 1983.

Equation	Constant	KLd	H	SCALE d	LQ1	LQ2	FS	R^2
1	0.0546 (0.017)	0.532 (0.04)	0.009 (0.03)	0.0280 (0.058)	0.081 (0.03)	-	0.056 (0.03)	0.55
2	0.0710 (0.016)	0.532 (0.04)	0.009 (0.03)	0.0280 (0.058)	-	0.081 (0.03)	0.087 (0.02)	0.55
3	0.0745 (0.010)	0.532 (0.04)	-	0.0319 (0.056)	-	0.079 (0.03)	0.088 (0.02)	0.55
4	0.0771 (0.009)	0.542 (0.04)	-	-	-	0.079 (0.03)	0.085 (0.02)	0.55
5	0.0722 (0.016)	0.558 (0.04)	0.0002 (0.033)	0.0255 (0.059)	-	-	0.082 (0.02)	0.54

From the results presented in Table 2.5.5, note that the capital intensity variable is significant and positive which suggests that intra-industry differences in labour productivity can be explained, in part, by differences in capital intensity. Neither the concentration index nor the scale factor variables have a significant effect on labour productivity although both coefficient signs are positive. The FS variable, which represents the proportion of foreign-owned employment within that industry, is both positive and significant at the 0.01 per cent level in equations 2-4. The labour quality (LQ1) variable was excluded, by Blomstron & Persson (1983), after the first regression because of the high level of collinearity between the LQ1 and the FS variable. The AD variable, which represented average working hours, was also dropped from the regression and no results are reported. The LQ2 labour quality variable, which is a measure of labour quality in Mexican plants, was also positive and significant.

Blomstrom and Persson (1983) suggests that these results indicate that a positive correlation exists between the number of foreign firms (as proxied by the number of employees in foreign-owned plants within an industry) and domestic labour productivity. In comparison with the results from the studies of Caves (1974) and Globerman (1979), they suggest much stronger support for the 'efficiency spillover' hypothesis are found, as their study included more variables and observations, which increased statistical reliability. However, direct comparisons of these studies may not be valid as the earlier work by Caves (1974) and Globerman (1979) is based on developed economies.

Kokko (1994) repeats the analysis of Blomstrom and Persson (1983), except he incorporates additional explanatory variables into his regression model in order to consider whether the initial technology gap which exists between foreign and indigenous firms within an industrial sector is a factor in determining whether 'efficiency spillovers' occur. His data cover 230 manufacturing sectors in Mexico, 1971, and are disaggregated into three ownership categories: domestic private, foreign and state owned. He estimates the following regression model in order to explain the determinants of labour productivity across manufacturing sectors in Mexico, 1971.

$$VA/Ld = f\,(K/Ld, LQ, HERF, FOR). \qquad (1)$$

Where

VA/Ld — dependent variable is the ratio of value added to total employment in locally-owned plants (average labour productivity).

K/Ld — is the firm's capital/labour ratio and is measured as the ratio of total assets to total employment in locally-owned plants.

LQ is a proxy for labour quality.

HERF is the Herfindahl index, and measures the level of concentration in each industry.

FOR is the ratio of foreign-owned employment to total employment in each industry, and measures the degree of foreign presence

If 'efficiency spillovers' occur as a result of the presence or interaction of foreign and indigenous manufacturing plants in Mexico, the coefficient on the foreign ownership variable (FOR) should have a positive and significant impact on the domestic labour productivity.

Table 2.5.6 – Regression results for efficiency spillovers from FDI, as reported by Kokko, 1994.

Equation	Constant.	K/Ld	HERF	LQ	FOR	Adj R^2	F	N
1.1 All Industries	0.265 (2.47) **	0.464 (11.77) **	-0.003 (0.04)	0.161 (2.58) **	0.112 (3.49) ***	0.53	61.84	216
1.2 Foreign Industries	0.256 (1.99) **	0.443 (8.47)* **	0.030 (0.30)	0.130 (1.88) *	0.141 (2.38) **	0.43	29.62	156

(*t statistics in parenthesis*)

Table 2.5.6 reports OLS regression results for the presence of 'efficiency spillovers' in Mexican manufacturing for 1971. Note that Kokko (1994) obtains similar results to those reported by Blomstrom and Persson (1983). He finds that the level of capital intensity within the industry, labour quality and foreign presence all have positive and significant impacts on labour productivity, as defined by value added per employee. From these results he suggests that foreign presence has a positive impact on local productivity. He further re-aggregated the Mexican manufacturing data, which covered 230 manufacturing sectors, into six further categories based on the specific industrial characteristics of plants across the manufacturing sectors. These categories are as follows.

Low Pat	Sectors with a low patent to output ratio (proxy measure for the level of research and development).
High Pat	Sectors with a high patent to output ratio (sectors which are more R&D intensive).
Low K/Lf	Sectors with a low average capital expenditure per plant ratio.
High K/Lf	Sectors with a high average capital expenditure per plant ratio.
Small PGAP	Sectors with a high average value added per employee.
Large PGAP	Sectors with a low average value added per employee.

Kokko (1994) re-estimates the initial regression model, discussed above, for each of the above six categories. He further undertakes an additional set of three regressions, where he includes an additional explanatory variable to capture the characteristics of foreign-owned manufacturing plants. These variables are constructed from the foreign-ownership category. Recall that the initial data cover 230 manufacturing sectors and are disaggregated into three ownership categories: domestic private, foreign and state owned.

FOR PAT	Foreign-owned sectors with a high patent to output ratio.
FOR K/Lf	Foreign-owned sectors with a high average capital expenditure per plant.
FOR/PGAP	Ratio of foreign-owned value added to value added in indigenous manufacturing.

Table 2.5.7 – Determinants of indigenous labour productivity (value added per employee) by industry type, as reported by Kokko (1994).

	Low PAT 2.1	High PAT 2.2	Low K/Lf 2.3	High K/Lf 2.4	Small PGAP 2.5	Large PGAP 2.6	2.7	2.8	2.9
Const	0.140 (0.74)	0.218 (1.01)	0.390 (2.65) ***	0.253 (1.09)	0.106 (0.72)	0.433 (3.38) ***	0.254 (1.97) *	0.265 (1.99) **	0.262 (2.12) **
K/Ld	0.433 (5.99) ***	0.449 (5.36) ***	0.425 (7.24) ***	0.426 (3.54) ***	0.375 (5.41) ***	0.441 (9.99) ***	0.447 (8.44) ***	0.438 (7.94) ***	0.426 (8.46) ***
HERF	-0.059 (0.15)	0.155 (0.98)	-0.136 (1.20)	0.254 (1.26)	0.261 (2.05) **	-0.343 (3.67) ***	0.023 (0.22)	0.030 (0.29)	0.024 (0.25)
LQ	0.318 (2.62) **	0.065 (0.70)	0.113 (1.41)	0.054 (0.66)	0.075 (1.13)	0.342 (4.38) ***	0.130 (1.88) *	0.126 (1.77) *	0.119 (1.78) *
FOR	0.168 (2.41) **	0.114 (0.85)	0.208 (3.34) ***	0.014 (0.11)	0.182 (2.47) **	0.127 (2.32) **	0.151 (2.42) **	0.128 (1.72) *	0.274 (4.09) ***
FOR* PAT	-	-	-	-	-	-	-0.006 (0.51)	-	-
FOR* K/Lf	-	-	-	-	-	-	--	0.014 (0.28)	-
FOR* PGAP	-	-	-	-	-	-	-	-	-0.104 (3.75) ***
Adj. R2	0.41	0.40	0.46	0.22	0.43	0.74	0.42	0.42	0.47
F	17.85	10.55	30.40	4.46	27.36	37.12	23.64	23.57	28.56
N	97	59	107	49	105	51	156	156	156

*, ** and *** denote significance at the 10, 5 and 1 per cent levels of significance.

The dependent variable is the ratio of value added per employee for each of the industry categories. Note, firstly that the capital/labour ratio has a positive and significant effect on labour productivity across all industry types. Note also that the coefficient on the foreign-ownership variable varies with the different industry characteristics. The results suggest that the likelihood of 'efficiency spillovers', in terms of indigenous labour productivity, is influenced by the industrial characteristics of the different manufacturing sectors. For instance, the results that are reported in Table 2.5.7 find that there is evidence of positive spillovers from FDI. These are however in industries with low patents (technology levels), low capital expenditure per plant and both where large and small productivity gaps exist as measured by sectors with low and high levels of value added per employee. (Though sectors with both low patents (technology) and capital expenditure per plant could be more likely to suffer from displacement or crowding-out which might be getting picked up as an 'efficiency spillover', because of the use of aggregate data. This issue is further discussed at the end of this section.)

The additional three explanatory variables, included by Kokko 1994, which relate to the characteristics of the foreign-owned manufacturing sector are insignificant in two of the three regressions. The FOR*PGAP variable indicates that where the productivity gap between foreign and indigenous manufacturing plants is large, this has a negative and significant impact on indigenous labour productivity, which is an important result. The other explanatory variables (FOR*PAT, FOR*K/Lf) are both insignificant.

In summary the results, reported by Kokko (1994), find evidence of foreign impacts on indigenous labour productivity. The analysis extends the earlier work of this type by considering industry characteristics and the extent to which differences in productivity, as captured by value added per employee, are important in determining efficiency spillovers. However, Kokko (1994) follows the earlier work of Caves (1974), Globerman (1979), Blomstrom and Persson (1983) by using average productivity of domestic firms (value added per employee) as the dependent variable in his regression models. However, the analysis of the impact of foreign presence (FDI), within or across industries, on the average productivity of domestic firms can be very misleading, especially when foreign presence is included as an explanatory variable. The problems stem from the two different processes or outcomes, which can arise from foreign presence (Perez, 1995).

For instance, the possible crowding out of less efficient domestic firms can, independent of other factors, lead to the detection of a positive correlation between foreign presence and the productivity growth of domestic firms. Thus, if we assume that the technological gap is such that domestic firms do not have the ability to catch up with the foreign competitors, then the most inefficient domestic firms will be driven out of the market. Therefore, even though the aggregate market share of all domestic firms will decline, the average productivity of the remaining domestic firms will increase, even though their own level of domestic efficiency may have remained unchanged. In a similar vain, foreign competition or presence may entail losers and winners amongst domestic entrepreneurs which aggregate data, such as used in these models so far discussed, cannot capture. Moreover, these aggregate studies of spillovers are static in the sense that the results are based on observations for only one year.

However, alternative measures of indigenous productivity were employed by Blomstrom (1986 & 1989), in further empirical work relating to the investigation of 'efficiency spillovers' from FDI, in Mexican manufacturing plants. He defined an efficiency index, for each industry, which was defined as the difference in efficiency between the best practice technique or firm and the industry average. The efficiency frontier is obtained by choosing the size class within each four-digit industry showing the highest value added per employee, which is denoted by $\bar{Y}_i$. The average value added per employee (Y_i^+) was then calculated as the ratio of total value added in each industry to the total number of employees, denoted Y. The efficiency index, e, for each industry i, is then defined as:

$$e_i = \frac{\bar{Y}i}{Yi^+}$$

Where

$\bar{Y}_i$ is the highest value added per employee within sector i.

Y_i^+ is the average value added per employee for sector i.

The closer the efficiency index is to unity, the more equal is the aggregate average labour productivity of the sector with that of the best practise plant within that sector. Thus, the efficiency frontier represents the most productive firm as proxied by value added per employee and this is used as a measure against the average value added for each industry. He then uses the deviations from the frontier as the dependent variable in the 'efficiency spillover' regressions. The model is cross sectional and relates the deviations from the frontier to various explanatory variables. The explanatory variables used in the model are the rate of technical progress, the Herfindahl index, market growth and the foreign share variable. The data source used was the Mexican Census of Manufacturing 1970 & 1975, supplemented by unpublished data broken down by ownership in different industries.

However, Blomstrom (1986) found no correlation between the relative changes in labour productivity in the best practice plants within each industry and changes in foreign participation during this period. He did however conclude that industries dominated by foreign firms tend to be more efficient than others in the sense that the average firm is closer to the frontier.

Haddad & Harrison (1993) follow the same methodology as Blomstrom (1989) and examine the impact of foreign investment on manufacturing firms in Morocco. The panel nature of their data allowed them to extend the previous contributions of Caves (1974), Globerman (1979), Blomstrom and Persson (1983), Blomstrom (1986 & 1989) to compare explicitly the behaviour of foreign and domestic firms by sector. Their hypothesis centred around the belief that if the knowledge or new technology embodied in foreign firms is transmitted to domestic firms, one would expect to see evidence in the form of higher productivity levels and growth rates for domestically owned firms in sectors with a large foreign presence. The possible transfer of these types of technologies across sectors would occur through the linkage mechanism.

They firstly examine the influence of foreign presence on the dispersion of productivity levels across sectors, which is similar to the approach set out by Blomstrom (1986 & 1989). The productivity levels are calculated for each firm and compared to the level achieved by the most efficient firm in each sector j. Given *n* manufacturing firms, there will be *n* estimated productivity measures within each sector j, given by $\hat{a}_{1j},.....\hat{a}_{nj}$. From which, they define relative efficiency for a firm i as given by Z_{ij}, where

$$\hat{a} = \max(\hat{a}_{ij}),$$

$$Z_{ij} = \hat{a}_{ij} - \hat{a}_j, \ i = 1,2,......n \text{ for each sector j.}$$

Thus with a high value of Z_{ij} (in absolute terms) indicating that firm i is very inefficient relative to the most efficient firm in sector j. However, these productivity levels are only comparable across firms within the same sector. Therefore, to compare the influence of FDI on productivity levels across sectors, Haddad & Harrison (1993) compare the deviation of firm level productivity from each sector's best-practice firm or frontier. However, they firstly have to normalise the residual productivity terms calculated above. This was done as follows:

Given *n* firms, there will be *n* estimated intercepts within each sector j, given by $\hat{a}_1,......,\hat{a}n$. From which Haddad & Harrison (1993) define;

$$\hat{a}_j = \max(\hat{a}_{ij}),$$

$$\hat{U}_{ij} = (\hat{a}_{ij} - \hat{a}_j)/\hat{a}_j, \qquad i = 1,2,....n.$$

They then estimate the following regression model:

$$U_{ij} = f(\text{DFI Firm}_{ij}, \text{DFI Sector}_j, \text{Size}_{ij})$$

Where

Uij's	are the dependant variable and are defined as the deviation of firm level productivity from the sector's best practice frontier.
DFI Firm	The variable represents the degree of foreign participation or investment in domestic firms. Therefore, this variable relates to indigenous firms that are involved in joint ventures with foreign-owned

manufacturing plants. (The share of foreign assets in each firm's total assets is used to proxy this.)

DFI Sector — This variable represents the share of the industry sector which is made up of foreign assets. Again this variable is measured by the share of the foreign firms assets in a particular industrial sector.

$Size_{ij}$ — This variable represents the average size of firms across the different sectors.

Haddad & Harrison (1993) estimate the above model using firm-level industrial survey data. The data cover the period 1985 to 1989 and include all manufacturing enterprises with 10 or more employees or a minimum turnover of $11,000 US dollars. In estimating the model, they further disaggregate the sample between all firms, including foreign and indigenous firms, which covers Moroccan manufacturing firms only. They estimate the model using data for all manufacturing firms and also with data for only the indigenous firms to test directly the 'efficiency spillover' hypothesis and compare the effects on domestic efficiency.

Table 2.5.8 Regression result for 'efficency spillovers', as reported by Haddad and Harrison, 1993.

	Al Firms		Non DFI Firms	
Intercept	-0.0441	(0.004)	-0.444	(0.004)
DFI (firm)	0.030	(0.008)	-	
DFI (Sector)	0.170	(0.019)	0.174	(0.022)
Size of Firm	0.0002	(0.00001)	0.002	(0.0001)

Standard errors in parenthesis.

Table 2.5.8 shows that all explanatory variables have a positive and statistically significant impact on the dependent variable, (U_{ij}), which represents the deviation of firm level productivity from the sector's best practice frontier. Recall that the DFI (firm) variable captures the degree of foreign participation or investment in domestic firms. The positive and significant coefficient suggests that foreign participation in these firms had a positive effect on relative domestic efficiency, which brings these firms closer to the best practice frontier for the sector. The DFI (Sector) variable, which represents the share of the industry sector that is accounted for by foreign assets (investment), also demonstrates a positive and significant coefficient. This implies that firms in a sector which is dominated or has a higher percentage of foreign firms will have a smaller deviation from the best practice firm within that sector. The positive and significant size variable simply suggests that larger firms are more likely to achieve higher levels of productivity. Therefore, these results show that foreign presence at both a firm and sector level can lead to a quicker dispersion of technology as firms increase their relative efficiency and move towards the best practice firms.

The second hypothesis analysed in this paper concentrated on the impact of foreign investment on productivity growth. A production function approach was adopted with value added Y a function of two inputs, capital and labour:

$$Y_{ij} = A_{ij} F(L_{ijt}, K_{ijt}) \qquad (1)$$

The level of productivity is given by A_{ij}, which is assumed to vary across firms within each sector j and across time t. Haddad & Harrison (1993) totally differentiate equation (1) and express this in log form. They further assume that the marginal product for each factor equals its cost. From which they attain:

$$d \log Y_{ijt} = d A_{ijt}/A_{ijt} + a1 \; d \log L_{ijt} + ak \; d \log k_{ijt}, \qquad (2)$$

where Y is value added, dA/A is productivity growth, and L and K are labour and capital inputs. They test the hypothesis that productivity growth is affected by the share of foreign investment at both the firm and sectoral level. This is done by assuming that productivity growth can be decomposed into the following components:

$$d\, Ai_{jt}/Ai_{jt} = a\, DFI\_Firmi_{jt} + b\, DFI\_Sector_{jt} + c\, C_j + d\, D_t. \qquad (3)$$

where C_j and D_t are sector and time dummy variables. Productivity growth is assumed to vary both across sectors and with time. Furthermore, it is also assumed to be a function of the level of foreign investment at both the firm and sectoral level. Haddad

& Harrison (1993) combine the above two equations and estimate the following regression model:

$$dLog\ Y_{ij} = aDFI\_Firm_{ij} + bDFI\_Sector_{jt} + cC_j + dD_t + atdlogL_{ij} + akdlogK_{ij}.$$

The dependent variable is the log of the rate of change of value added Y and the model attempts to explain the extent to which the presence of FDI increases the rate of productivity growth, after allowing for other factors. The variable DFI_Sector is a measure of the share of foreign assets in a particular sector and the coefficient measures the 'spillover effect'. Similarly, the variable DFI-Firm captures this effect at the firm level. The variables C_j and D_t are sector and time level dummy variables. The other two independent variables represent the rate of change of both capital and labour and are expressed in log format. As the model is trying to explain productivity growth, Haddad & Harrison (1993) suggest that if foreign presence at the firms and sectoral level productivity growth then it is expected that both the firm and sector level FDI coefficient values should be positive and significant.

Table 2.5.9 Regression results of 'efficiency spillover' analysis as reported by Haddad & Harrison (1993).

	All Firms			Non DFI Firms		
	(1)	(2)	(3)	(4)	(5)	(6)
d (log L)	0.773 (0.009)	0.772 (0.009)	0.770 (0.009)	0.772 (0.010)	0.770 (0.010)	0.770 (0.010)
d (log K)	0.088 (0.011)	0.090 (0.011)	0.088 (0.011)	0.105 (0.013)	0.108 (0.013)	0.106 (0.013)
DFI (firm)	-0.018 (0.023)	-0.019 (0.023)	-0.020 (0.023)	-	-	-
DFI (Sector)	-0.037 (0.052)	-0.029 (0.052)	-0.039 (0.061)	-0.009 (0.063)	0.001 (0.063)	-0.011 (0.073)
Time Dummies	No	Yes	Yes	No	Yes	Yes
Industry Dummies	No	No	Yes	No	No	Yes
N (Sample)	11,772	11,772	11,772	9,629	9,629	9,629

Standard errors in parenthesis.

The results that are reported in Table 2.5.9 indicate that both foreign investment variables, at the firm and sector level, are negative and insignificant in determining output growth. Thus, the main explanation for the rate of change of value added, in the model, is explained by the rate of change of both capital and labour variables. However, the coefficient values on the capital (K) and labour (L) variables indicate decreasing returns to scale. Note that columns (1) to (3) estimate the model with the full sample which includes all firms. Whereas columns (4) to (6) report results from estimating the model with only the domestic firms who have no foreign involvement. By estimating the model with this restricted sample, Haddad & Harrison (1993) were testing exclusively for positive spillovers from sector-level foreign investment. However, the above results show there is no statistical evidence of spillovers in terms of productivity growth.

Two possible explanations were given for these results. One possibility was that the lack of positive spillovers from productivity growth could be attributed to distortions in the trade policy regime. This was tested for by splitting the sample into both low and high protection sectors. Haddad and Harrison (1993) used three different measures of protection in this analysis but the results remained insignificant and generally negative. Therefore, both the foreign sector variables were negative and insignificant regardless of the hypothesised level of protection. The other possible concern regarding the results was the short time period used in the estimations as the data covered only a four year time period (1985 to 1989).

In summary, the results presented by Haddad and Harrison (1992) differ markedly from previous studies, which found limited empirical evidence of positive spillovers from FDI. Haddad & Harrison (1993) replicated both the approaches developed by Caves (1974) and Globerman (1979) using data for Moroccan manufacturing. They estimated these models with annual firm data aggregated at a three digit level to replicate these studies. Following the Globerman (1979) methodology, they find the relationship between foreign investment and domestic firm labour productivity in Morocco is statistically significant, but negative. Applying the Caves (1974) approach, Haddad and Harrison (1993) find no significant impact between the presence of FDI and domestic labour productivity (value added per worker).

In relation to the other empirical studies discussed, there seems to be some ambivalence concerning these results. In particular, the results obtained by Caves (1974), Globerman (1979) and Blomstrom (1983) demonstrate a positive significant spillover effect on domestic productivity proxied in each study by value added per worker. However, Blomstrom (1986) found no correlation between the relative changes in labour productivity in the best practice plants within each industry and changes in foreign participation during this period.

Therefore, one can conclude from the papers reviewed in this section that positive efficiency spillovers can exist from foreign direct investment but their presence and significance may relate to country specific factors. Thus, a case study analysis may be required to identify why foreign investment generates positive spillovers in some countries but not others. A comparison of the magnitude of the spillover effects obtained by these studies cannot be satisfactorily done. For instance, even within the studies where model specification is similar, such as Caves (1974), Globerman (1979) and Blomstrom (1983), differences in data availability, definitions of variables used and sample size render direct comparisons to be of a limited use. Therefore, comparisons of the magnitude of effects are not possible.

Moreover, in comparing the results from studies between developing and industrialised countries, the level of development within that particular country may have a direct bearing on those results. Thus, Morocco could be viewed as being in the early stages of industrialisation and thus not directly comparable to the results obtained for Canada and Australia (Caves, 1974; Globerman, 1979). Furthermore, the productivity gap could be so large in a country of this type that the domestic firms cannot bridge the gap and thus are not yet at a level where efficiency spillovers are translated into increased domestic efficiency. Similarly, if the technology gap between domestic and foreign firms is too small, foreign investment may transmit few benefits to domestic firms.

A more fundamental criticism of these approaches is the use of value added per employee to proxy labour productivity. However, more recent work was able to overcome these limitations. Barrell and Pain (1997) consider the impact of foreign-owned manufacturing in the UK and West Germany on the productivity of indigenous manufacturing. In particular, they consider the degree to which technology transfers and other spillovers, from foreign-owned firms, affect the pace of technical change and hence economic growth. In their analysis, technical progress is assumed to be labour augmenting and they obtain estimates of the elasticity of substitution (α) and the technical progress coefficient (λ) from the labour demand equations derived from the first-order conditions of a constant elasticity of substitution (CES) production function, as described in equation (4).

$$Q = \gamma[s(\mathrm{K})^{-p} + (1 - s)\,(Le^{\lambda t})^{-p}]^{-v/p} \qquad (4)$$

Where

Q Sectoral output.

γ & s	Production function scale parameters
K	Capital inputs
Le	Labour inputs

The elasticity of substitution (α) is given by $\frac{1}{1-p}$

From the first order conditions of the CES function,

$$\frac{\delta Q}{\delta L} = v(\gamma)^{-p/v} (1-s)\, Q^{(1+p/v)} (Le^{\lambda t})^{-(1+p)} e^{\lambda t} \qquad (5)$$

they impose the condition of long-run constant returns to scale ($v = 1$) and obtain the following log-linear labour demand equation.

$$Ln (L) = Ln (Q) - \alpha Ln (W/P) - (1 - \alpha) \lambda t = [\alpha Ln \{(1-s)/\beta\} - (1 - \sigma) Ln (\gamma)] \qquad (6)$$

Where

Ln	log-linear
L	employee hours.
W	denotes labour costs per person hour
P	price of value added
β	denotes the mark up

They further assume that technical progress in any given sector is dependent on the aggregate level of foreign-owned assets within that sector, together with an exogenous element proxied by a linear time trend.

$$\lambda t = \lambda_{TIME} TIME + \lambda_{FDI} \ln (FDI)_{t-4}. \qquad (7)$$

Where

λt	Technical progress
TIME	Exogenous linear time trend
$Ln (FDI)_{t-4}$	Stock of FDI within that sector, lagged four periods.

Barrell and Pain (1997) estimate the following regression model using quarterly time series data for the period 1972 to 1985 for West Germany and the UK. The dependent variable in the regression model is the log of the rate of change in labour productivity, as proxied by employee hours in sector i.

Table 2.5.10 – Summary of the regression results for labour productivity (technical progress) in Germany and the UK, as reported by Barrell and Pain (1997, p.1780).

Dependant Variable $\Delta \text{Ln}(L_i)_t$	West Germany (All Sectors)		UK (Manufacturing)	
Constant	0.88171	(2.6)	-0.14417	(0.9)
$\text{Ln}(L_i/Q_i)_{t-1}$	-0.35607	(6.1)	-0.15389	(4.4)
$\text{Ln}(W_i/P_i)_{t-1}$	-0.13854	(4.8)	-0.06371	(2.4)
TIME	-0.00090	(4.5)	-0.00068	(2.7)
$\text{Ln}(FDI_i)_{t-4}$	-0.05912	(4.8)	-0.02406	(2.5)
$\Delta \text{Ln}(L_i)_{t-1}$	-	-	0.16434	(2.7)
$\Delta \text{Ln}(Q_i)_t$	0.38290	(5.8)	0.33395	(5.8)
$\Delta \text{Ln}(W_i/P_i)_t$	-0.38061	(3.5)	-0.21281	(2.4)
α	0.3891	(5.5)	0.4140	(2.3)
λ_{TIME}	0.0041	(21.0)	0.0075	(9.0)
λ_{FDI}	0.2718	(7.3)	0.2668	(4.9)

(t statistics in parenthesis)

Where

L_i	employee hours in sector i
Q_i	output in sector i at constant prices.
W_i/P_i	real compensation per employee hours in sector i
Pi	price of value added in sector i
FDI_I	real stock of inward direct investment in sector i

Barrel & Pain (1997) find that there is clear evidence of increased technical progress arising from FDI in both the UK and West Germany. Note, firstly that the lagged FDI variable $(FDI_i)_{t-4}$, has a significant negative impact on the dependent variable (the log of the rate of change of employee hours in sector i), in both the UK and Germany. This implies that an increase in the stock of inward investment (FDI), in sector i, will have a positive impact on labour productivity, as the number of employee hours required by firms within sector i is reduced. Barrell & Pain (1997) also find that the elasticity of substitution values for West Germany and the UK are significantly different from one. For West Germany the elasticity of substitution is 0.38 and for the UK, 0.41.

Moreover, for Germany, Barrell and Pain (1997) estimate that a 1 per cent rise in the stock of FDI (inward investment) raises technical progress (λFDI) by an estimated 0.27%. Similarly, in the UK case, a 1 per cent rise in the stock of inward investment leads to an increase in UK manufacturing technical progress of 0.26%. Moreover, Barrell and Pain (1997) use the estimated technical progress coefficient λ_{FDI} (0.2668) to estimate the impact of a given level of inward FDI into UK manufacturing, on the growth of output, over the period 1984 to 1994. Over this period, they suggest that inward investment raised manufacturing output by 12.5% or 1.2% per annum. (This is calculated by multiplying the average labour share value for manufacturing between 1986 and 1995 by the estimated value for the technical progress coefficient (λ_{FDI}).)

In summary, Barrell and Pain (1997) identify the existence of positive spillovers from inward investment in UK manufacturing. The authors acknowledge that the appropriate specification for endogenising technical progress, equation (3), is worthy of further investigation and that in an aggregate sectoral equation, apparent efficiency impacts may simply pick up compositional effects. However, their results, which are subject to a series of diagnostic tests, appear relatively robust. Moreover they provide estimates of the existence of efficiency spillovers, which are both more conclusive and statistically more robust than previous empirical studies, which focused primarily on developing economies (Kokko, 1994; Haddad & Harrison, 1995).

2.6 Chapter Conclusions.

This chapter has reviewed the different methods and approaches that have been used in the evaluation of the regional impact of FDI. The previous chapter provided an overview of the various demand and supply-side impacts that are typically associated with FDI. The traditional regional approaches of economic base, Keynesian multiplier and input-output vary significantly in terms of their application to FDI. Of these approaches, input-output is the most sophisticated and provides a more detailed analysis of the system-wide impact of FDI. The strengths of the input-out approach are that it provides a very detailed breakdown of the inter-dependencies that exist within a regional economy, which allow any exogenous change in final demand to be traced throughout the system. However, the input-output approach is based on a number of restrictive assumptions, which renders the model incapable of considering supply-side impacts, such as labour market or efficiency spillovers impacts. Moreover, given the distinct structural differences that exist between indigenous and foreign-owned manufacturing plants, these ought to be incorporated within the input-output framework when considering FDI impacts.

The application of regional econometric models to FDI impact typically provides a more aggregate analysis of the potential impact. Moreover, problems of development and specification of these regional models has typically restricted their use in identifying supply-side impacts. However, the approach has been used extensively to test for the existence of supply-side impacts relating to FDI. The most recent of these, Barrell & Pain (1997), found statistical evidence of positive spillovers, in terms of labour productivity in UK manufacturing, as a result of FDI. These results are important and provide an estimate of the potential spillovers that can be derived in terms of labour augmenting technical progress from inward investment, particularly given the inconclusive nature of the earlier work in this area.

In the following chapter, I consider the system-wide impact of FDI using a Computable General Equilibrium (CGE) model for Scotland (AMOS). This framework is capable of considering both demand and supply-side issues and can overcome many of the existing limitations of the approaches discussed in this chapter.

2.7 Chapter 2 Bibliography.

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CHAPTER 3 – The System-wide Impact of Foreign Direct Investment: A Computable General Equilibrium (CGE) Analysis.

3.1 Introduction

In this Chapter, I consider the system-wide impact of FDI using a computable general equilibrium model (CGE) for Scotland. The analysis considers the impact of FDI on both demand and supply-side variables. In particular, highlighting the potential impact of product market, labour market and efficiency spillover effects. (Recall that Chapters 1 and 2 discussed many of these FDI impacts.) The existing AMOS model framework provides a system-wide perspective for evaluating the regional impact of FDI. The analysis outlined in this chapter is, however, complementary to the existing regional impact literature rather than encompassing, due to the apparent structural differences that typically exist between indigenous and foreign-owned manufacturing plants, that are not captured within the existing model framework.

The remainder of this Chapter is structured as follows: Section 3.2 provides an introduction and overview of CGE modelling, in general, and the AMOS CGE model specifically. Section 3.3 considers the impact of an exogenous FDI investment shock and accompanying export stimulus. In section 3.4, I consider the labour market effects of FDI and section 3.5 illustrates the potential impact of efficiency spillovers. Section 3.6 provides an analysis of the combined effects of FDI and section 3.7 provides a short conclusion.

3.2. AMOS: A REGIONAL CGE MODEL FOR SCOTLAND.

3.2.1 – Introduction and Overview of Regional CGE Modelling.

In this section, I provide an overview of the general structure of a CGE model, before going on to discuss the AMOS CGE model, in detail. A CGE model provides a quantitative system-wide framework, which aims to capture the equilibrium nature of an economy or region. The approach is similar to I-O except that it encapsulates both demand

and supply-side variables in a manner, which is consistent with economic theory. In the previous chapter, I outlined the traditional method of regional economic multiplier analysis, regional I-O and regional econometric modelling. Many of these approaches, particularly economic base and input-output analysis, are in fact general equilibrium in nature. For instance, recall that the I-O model implicitly assumes the existence of perfectly elastic supply of all factor inputs and fixed prices, with all predicted changes in the economy driven by changes in exogenous (final) demands. This, in fact, represents a rather simplified general equilibrium view of an economy, where only demand matters and the supply-side is entirely passive.

In contrast, the CGE approach, which is generally based on neo-classical theory, advocates less than perfectly elastic supply of factor inputs, with relative prices endogenously determined within the model through the interaction of demand and supply schedules. However, given certain assumptions about the nature of the economy, a CGE model can replicate I-O results i.e. by assuming an entirely passive supply-side. Moreover, in certain circumstances the total response, in a regional economy, to an exogenous change in final demand is the same across both fixed price I-O and CGE models. Therefore, I-O can be viewed as a limiting case of a CGE model (McGregor *et al*, 1996).

However, in general, a CGE model can overcome many of the apparent limitations of the fixed price regional I-O models as well as incorporating many of the positive features, which characterised these types of analysis. The theoretical framework which underpins CGE is typically based on the Walrasian general equilibrium structure, which was formalised in the Arrow-Debreu Model (Arrow & Hahn, 1971). CGE modelling, in general, attempts to provide a framework that encapsulates the system-wide characteristics of the economy. Given the nature of such models, assumptions concerning the working of markets have to be explicitly modelled.

CGE models typically have a strong theoretical base with the model calibrated with real data. Model simulations are typically based on a benchmark data-set, which is calibrated to replicate the equilibrium conditions the model aims to represent. By replicating the general equilibrium structure of an economy, counterfactual policy analysis can be undertaken and compared with the base simulation. In order to facilitate such use, however, CGE models have to explicitly model an extensive range of demand and supply-side variables.

3.2.2 Overview of a Regional CGE.

In general, the theoretical base for CGE's is derived from neo-classical theory. However CGE models can in fact model disequilibrium processes.[1] For this overview, I consider the benchmark case, or assumptions, which characterise to some extent most CGEs: perfectly competitive factor and product markets and utility maximising behaviour for households. These basic assumptions have important implications for the nature of the economy. For instance, with the assumptions of perfect competition, this implies that firms maximise profits, which in turn, dictates that they choose the combination of labour and capital (production technology) that is cost minimising. Moreover, the assumption of perfectly competitive factor markets implies that factor prices are determined by the interaction of supply and demand, with demand for individual factors responsive to changes in relative prices. Utility maximising behaviour by households implies that households maximise their utility, through consumption, by responding to price differences across goods and services. Note the central role of relative prices in all of these assumptions. Price adjustments serve to equate demand and supply schedules in goods/services and factor markets with equilibrium characterised by a set of prices and levels of production in each industry such that market demand equal supply for all commodities. The general structure of such a framework is outlined in Figure 3.1.

[1] Recent advances in CGE modelling have incorporated imperfectly competitive markets, increasing returns technology and various labour market configurations.

Figure 3.1 – General Structure of a Regional CGE Model.

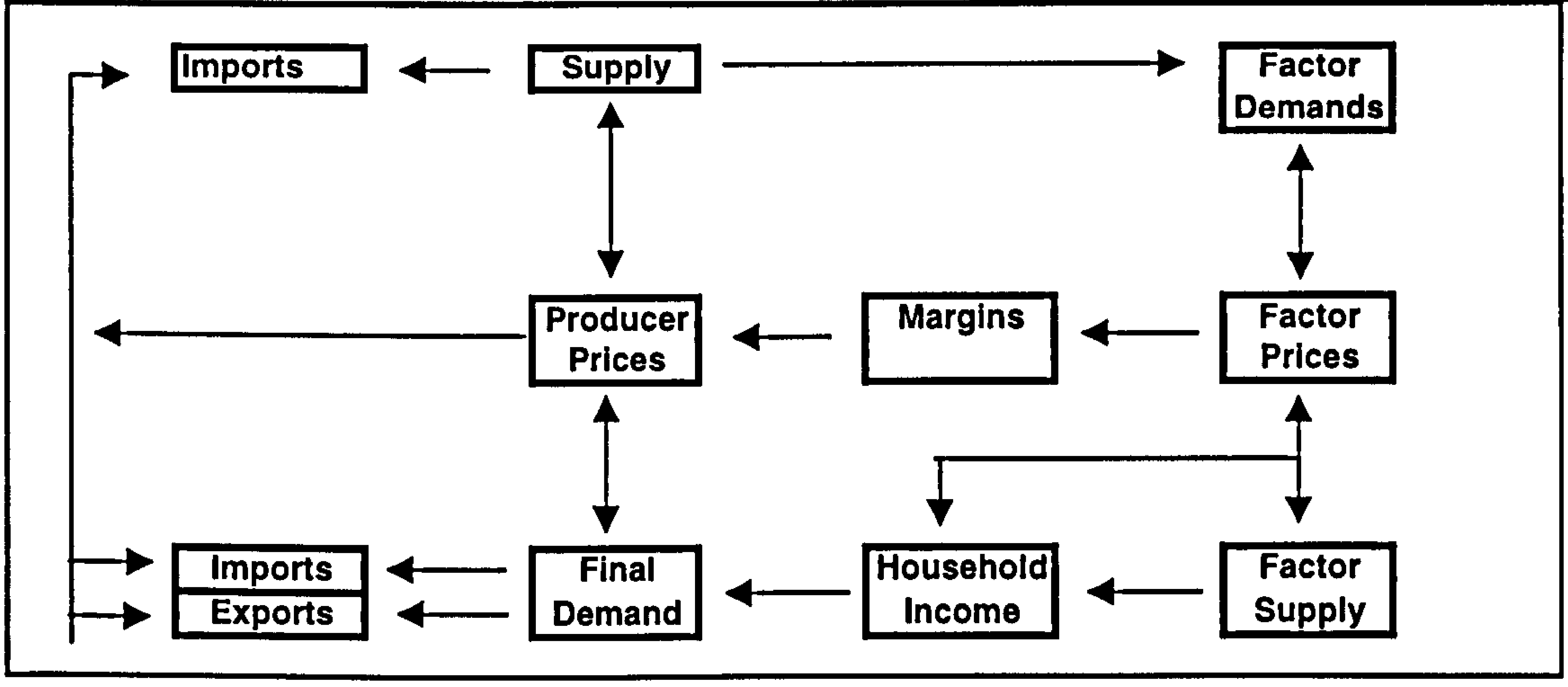


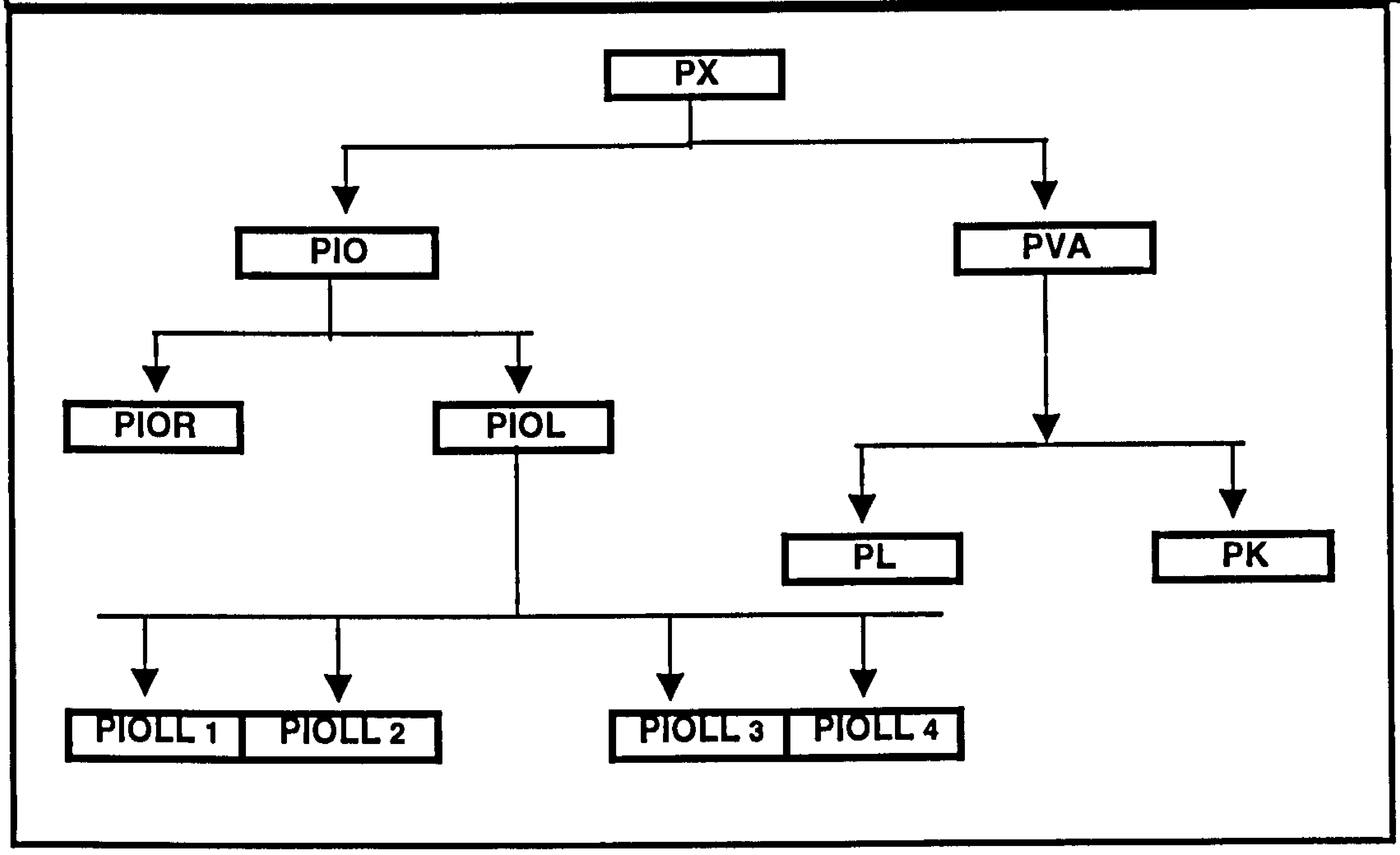
Figure 3.1 provides a schematic overview of the general structure of a regional CGE model (Partridge and Rickman, 1998, pp 208). From the supply block in Figure 3.1, production creates demand for value added factors (labour & capital) and intermediate inputs. Intermediate inputs for production consist of both locally produced and imported goods and services. Demand for intermediate inputs (both locally produced and imported) is determined by relative prices as firms set out to minimise production costs. Similarly, the interaction of value added factor demands with factor supply, determines factor prices. These, and additional margins for transport etc., generate the producer price of the locally produced goods and services. These goods/services are then sold to final demand (markets), which has been stimulated via production through the returns paid to both owners and suppliers of factors (capital and labour) required in the production of the locally produced goods/services. These changes in income and relative producer prices influence the demands for imports and exports (locally produced goods), with equilibrium arising in all markets at the price where demand and supply are equated.

Although Figure 3.1 provides a very simple overview of the structure of a regional CGE, it illustrates the high degree of endogeneity that exists between sectors within an economy. Note the interaction of the various segments of the economy and the crucial role of price in equilibrating markets. For instance, in the I-O case, the production of goods and services (Supply block) would also lead to an increase in demand for value added factors and intermediate inputs. However, the supply of these would not be determined by the interaction of demand and supply, i.e. relative prices, but by the existing structure of production employed within that sector. Accordingly, prices have no role in I-O and resources are assumed to be perfectly available at the existing price (Harrigan & McGregor, 1988).

Moreover, I-O analysis is characterised by the assumption of Leontief technology, which implies that factor demands are linearly dependent on output. In contrast, the specification of production in CGE models are determined by both output and relative factor prices. Production in most CGE models are determined either through Cobb Douglas (CD) or Constant Elasticity of Substitution (CES) production functions. (Partridge and Rickman (1998) provide a comprehensive review of the various characteristics of different regional CGE models.) The key difference between the structure of production in a CGE and I-O model is that value added production in a CGE is responsive to factor costs and imports of intermediate goods are price sensitive. In contrast, Leontief technology is based on the assumption of fixed technology coefficients, whereas substitution in technology and factor inputs is a key element of production in CGE's. To incorporate these characteristics within the production structure of the CGE, multi-level CES production functions are typically employed.[2]

[2] These have the advantage over the single CES function of allowing different elasticities between sets of factors inputs (Harrigan *et al*, 1991).

Figure 3.2 – General Structure of regional production with a regional CGE model.



Where:

PX	Price of Total Output
PVA	Price of total Value Added.
PIO	Price of total Intermediate Composite.
PL	Price of labour
PK	Price of Capital
PIOR	Price of imported intermediate composite
PIOL	Price of locally produced intermediate composite
$PIOL_1$	Price of intermediate composite in sector 1
$PIOL_2$	Price of intermediate composite in sector 2
$PIOL_3$	Price of intermediate composite in sector 3
$PIOL_4$	Price of intermediate composite in sector 4.

From Figure 3.2, gross output, value added and all intermediate composite commodity prices are determined through the minimisation of the cost of production at each level of the CES function. For instance, gross output prices (PX) are determined by the combination of value added (PVA) and intermediate inputs (PIO), which is the top level of Figure 3.2. Value added itself consists of two elements: capital and labour. However, the production of the intermediate composite is rather more complex. Intermediate composites can be supplied via imports (PIOR) or through locally based suppliers (PIOL). The final level of the CES production function captures the different sources of local composite inputs across four different sectors. Figure 3.2 provides a general overview of the general structure of CES multi-level production functions. However, the choice of different inputs at each level of the production function can be varied to capture the different structure of various regions. The key point about using this approach is that it embodies substitution in production which means technology can change, within firms, in response to changes in relative prices. Therefore, changes in relative factor inputs rather than the existing structure of production, as in the I-O context determine regional production in CGE models.

Moreover, in CGEs, changes in final demands are endogenously determined through relative price and competitiveness effects. For instance, export demands are typically determined through a relative price link (Armington, 1969). Further, total regional (household) income drives demand for both imported and locally produced consumption goods. Consumers, as utility maximisers, switch between relative commodities (substitutes) depending on relative prices. Again relative prices are key to determining the consumer demands of individuals. The treatment of consumer utility, in CGE's, is generally analogous to production with multi-level (CES) consumption structures, which allow different elasticities of substitution to be incorporated for different sets of goods. Typically, the consumption choice for each good, or basket of goods, is between imports and locally produced goods. Recall that in the I-O case, with households endogenous, consumption is linearly dependent on output i.e. there is no substitution between local and imported consumption goods with consumption expenditure dictated by the existing structure of consumption demands.

A key component of regional income is payments to factor inputs, particularly labour. In CGE models, factor markets are often assumed to be perfectly competitive with factor prices determined by the interaction of factor demand and supply. In such a case, individual workers and firms are assumed to have no influence in factor markets and thus take the wage-clearing price. Therefore, wage and capital rental rates are endogenous to the system. However, this is one area where CGEs generally offer various configurations, particularly, in the determination of regional wage rates. Moreover, many CGEs make population flows endogenous, with migration determined by changes in relative factor prices between two or more regions.

Figure 3.1 outlined the general structure of regional CGEs. However CGEs can vary in terms of the assumptions and options available. Typically, CGE analysis can offer a host of configurations relating to the regional economy. However, a key feature of CGEs, in general, is the important role of endogenous prices for equilibrating markets. An important determinant of the level of sectoral disaggregation incorporated within the model is the availability of regional data. Thus, CGE models provide a quantitative framework, which encapsulates the equilibrium characteristics of an economy. However, CGE models are typically data intensive with model calibration requiring a range of different parameter values for the different functional relationships explicitly captured within the model. As a result, many of the parameters used in CGE models reflect "best guess" estimates due to the lack of appropriate regional data or econometric estimation of key functional forms. This is a fundamental criticism of the CGE approach, in general, though sensitivity analysis can be undertaken to confirm the robustness of model results. These issues are discussed further in the following section.

3.2.3 CGE Data Requirements and Calibration.

Data requirements for a CGE are typically extensive with a social accounting matrix (SAM) an essential component. Within the CGE model, the use of a SAM provides considerable scope for handling specific regional features. For instance, the SAM can be extended to include further disaggregation of household income and employment by skill groups. The general structure of a SAM is similar to an I-O Table except the SAM incorporates more accounts within its framework (King, 1981). For instance, a SAM incorporates institutional accounts such as those for households, corporations and government. Moreover, the interaction between these accounts and the production sectors are captured within the SAM. In contrast, the Input-Output table captures only the relationships within the production accounts. The basic accounts captured in the SAM are the production accounts; consumption account; capital accumulation account and the external trade account.

The information in a SAM is presented in a similar manner to an I-O Table with the data in matrix form and the rows and columns representing the income and expenditure accounts. The basic framework of a SAM is presented in Table 3.2.1, following Yin (1991).

Table 3.2.1 – Overview of the basic structure of a Social Accounting Matrix.

	Production.	Consumption.	Accumulation.	Trade	**Total**
Production	ID	C	CF	E	T1.
Consumption	V	-	-	Tri	T2.
Accumulation	-	S	-	B	T3.
Trade	M	Tro	-	-	T4.
Total	T1.	T2.	T3.	T4.	-

Where;

ID Total intermediate demand

C Consumption

V Factor incomes of institutions i.e. receipts of labour incomes, profits and surpluses.

Tri Inward transfers from the outside world.

Tro Outward transfers from households in payment of imported consumption goods.

M Intermediate imports.

CF Capital formation.

E Exports

S Domestic savings

B Foreign borrowing

As with the I-O framework, every entry appears in both a row and column and what is an incoming into one account must be an outgoing from another account. Moreover, the SAM is constructed in a manner that reconciles the various accounts within a coherent framework. The framework of a SAM ensures that certain balancing requirement must be met. Specifically, these are as follows:

1. The value of total demands (both intermediate and final) for each commodity (industry) equals the value of its total supply.

2. The value of total products by each activity (or industry) equals the total costs of its production.
3. On the demand side, each sector must satisfy its budget constraint.
4. From a system point of view, the accounts must be intersectorally articulated, all inputs, outputs and flows must balance in the base year.
5. The depicted economy as a whole is in zero external sector balance. As a result, the corresponding row totals (total incomings) and column totals (total outgoings) should be equal.

Essentially, the SAM provides an extensive set of accounts for a region for one particular year. These data are used to paramaterise the model for that given year. However, in order to generate a consistent benchmark data-set, which is compatible with the equilibrium conditions the model aims to present, these data must be adjusted. That is, parameters are specified such that the model reproduces the benchmark data; thus, the base model is calibrated on the individual data set. Parameter values for the selected functional forms are crucial in determining the overall results generated by CGE models. These parameter values are typically econometrically estimated. However, given the extensive configurations offered by the CGE framework, many of the parameter values reflect 'best guess' estimates. This stems primarily from both the diversity of CGE models and the extensive time series data that are required to econometrically estimate these parameters. This is a justified weakness of CGE analysis. Nevertheless there are strong practical grounds for such an approach and sensitivity analysis can be used to confirm the robust nature of these results. Sensitivity analysis allows a further more detailed investigation of both the adjustment paths and results implied by a CGE model. (This is discussed further with an application of this approach to the AMOS CGE model in the subsequent section.)

The parameters of the CGE model are of two main kinds: those that are derived from the base year data set and those that are extraneous to it. The parameters that are extraneous to the base-year data set are generally the price elasticities of substitution in consumption and the parameters of the production functions.

As noted previously, an important attribute of the CGE framework is the role of prices. However, even though the CGE framework models regional prices, it requires no actual price data. This stems from microeconomic theory, which yields price equations (unit cost functions) which are 'dual' to the production or demand functions that are expressed in terms of quantities only (Harrigan & McGregor, 1988). Accordingly, the price equations share the parameters of their associated production or demand functions, as prices are all scaled to unity and the parameters of the model are derived from observations of quantities only. This is analogous to the convention in I-O models, in which quantities are indexed to their base year value (Bulmer-Thomas, 1982).

In summary, a CGE provides an extensive system-wide modelling framework. The model attempts to replicate the equilibrium conditions of a region. The model is typically parameterised on data for a single year. Such a framework can offer a wide range of configurations for a regional economy. Central to this modelling approach is the role of prices with the model incorporating a fully-specified supply-side. In the next section I provide an overview of the AMOS CGE model.

3.2.4 – AMOS CGE Model

AMOS is a CGE modelling framework parameterised on data from Scotland (AMOS is an acronym for a macro-micro model of Scotland). An outline of the model is presented in this section with a full listing provided in Harrigan *et al* (1991b) (although the social accounting matrix data base of the model has since been updated). AMOS has four domestic transactor groups: households, the non-household personal sector, corporations and government. In AMOS, Scotland is treated as a self-governing economy, in the sense that there is only one consolidated government sector. Central government activity is partitioned to Scotland and combined with local government activity.

The model consists of three commodities and activities: manufactures, non-manufacturing traded and sheltered. Manufacturing comprises sectors 12-89, non-manufacturing traded sectors 1-10, 91-97, 99-102 and 109-111 and sheltered sectors 11, 90 and 98, 103-108 and 112-114 in the 1989 Scottish Input-Output Tables (Industry Department for Scotland, 1994). There are four major components of final demand: consumption, investment, government expenditure and exports. Of these, real government expenditure is exogenous. Consumption is a linear homogeneous function of real disposable income. Exports (and imports) are determined via an Armington link (Armington, 1969) and are therefore relative-price sensitive. Investment is a little more complex as I discuss below, although the initial inward investment is treated as exogenous throughout.

Throughout this chapter commodity markets are taken to be competitive. The AMOS model does not explicitly model financial flows. Instead it is assumed that Scotland is a price-taker in competitive UK financial markets. Table 3.1 provides a condensed version of the AMOS model, which follows the exposition reported in Gillespie *et al*, 1998.

Table 3.1 – A Condensed Version of AMOS 1989.

Equations	Short-run
(1) Price Determination	$p_i = p_i(W_n, W_k)$
(2) Wage setting	$W_n = W\ (N/L, cpi, t_n)$
(3) Labour force	$L = \bar{L}$
(4) Consumer price index	$cpi = \sum_i \theta_i\ p_i + \sum_i \theta_i^{RUK}\ \bar{p}_i^{RUK} + \sum_i \theta_i^{ROW}\ \bar{P}_i^{ROW}$
(5) Capital supply	$K_i^S = \bar{K}_i^S$
(6) Capital price index	$kpi = \sum_i \gamma_i\ p_i + \sum_i \gamma_i^{RUK}\ \bar{p}_i^{RUK} + \sum_i \gamma_i^{ROW}\ \bar{P}_i^{ROW}$
(7) Labour demand	$N_i^d = N_i^d(Q_i, W_n, W_k)$
(8) Capital demand	$K_i^d = K_i^d(Q_i, W_n, W_k)$
(9) Labour market clearing	$N^S = \sum_i N_i^d = N$
(10) Capital market clearing	$K_i^S = K_i^d$
(11) Household income	$Y = \Psi_t N W_n(1-t_n) + \Psi_k \sum_i K_i W_{ki}(1-t_k) + \bar{T}$
(12) Commodity demand	$Q_i = C_i + I_i + G_i + X_i$
(13) Consumption Demand	$C_i = C_i(p_i, \bar{p}_i^{RUK}, \bar{p}_i^{ROW}, Y, cpi)$

(14) Investment Demand	$I_j^d = P_j(K_j^d - K_j)$ $I_i = I_i(p_i, \bar{p}_i^{RUK}, \bar{p}_i^{ROW}, \sum_i b_{ij} I_j^d)$
(15) Government Demand	$G_i = \bar{G}_i$
(16) Export Demand	$X_i = X_i(p_i, \bar{p}_i^{RUK}, \bar{p}_i^{ROW}, \bar{D}^{RUK}, \bar{D}^{ROW})$
Equation	**Short Run**
Multi-period model	**Stock up-dating equations**
(17) Labour force	$L_t = L_{t-1} + nmg_{t-1}$
(18) Migration	$\frac{nmg}{L} = nmg$ (W/cpi, W^{RUK}/cpi^{RUK}, u, u^{RUK}
(19) Capital Stock	$K_{it} = (1 - d_i) K_{it-1} + I^d_{i,t-1}$

NOTATION

Activity-Commodities

i, j are activity/commodity subscripts

Transactors

RUK = Rest of the UK, ROW = Rest of World

Functions

p (.)	CES cost function
K^S(.), W(.)	Factor supply or wage-setting equations
K^d(.), N^d(.)	CES factor demand functions
C(.), I(.), X(.)	Armington consumption, investment and export demand functions, homogenous of degree zero in prices and one in quantities

Variables

C	consumption
D	exogenous export demand
G	government demand for local goods

I	investment demand for local goods
$\mathbf{I^d}$	investment demand by activity
$\mathbf{K^d, K^S, K}$	capital demand, capital supply and capital employment
L	labour force
$\mathbf{N^d, N^S, N}$	labour demand, labour supply and labour employment
p	price of commodity/activity output
Q	commodity/activity output
T	nominal transfers from outwith the region
$\mathbf{W_n, W_k}$	price of labour to the firm, capital rental
X	exports
Y	household nominal income
b	elements of capital matrix
cpi, kpi	consumer and capital price indices
d	physical depreciation
$\mathbf{t_n, t_k}$	average direct tax on labour and capital income
u	unemployment rate
Ψ	share of factor income retained in region
θ	consumption weights
γ	capital weights
P	capital stock adjustment parameter

The AMOS framework allows a high degree of flexibility in the choice of key parameter values and model closures. For instance, no matter how it is configured, the Model imposes cost minimisation in production with multi-level production functions, generally of a CES form but with Leontief and Cobb-Douglas being available as special cases. For all simulations in this chapter I adopt a CES functional form similar to that outlined in the earlier part of this chapter.

For all the simulations in this chapter I impose a single Scottish labour market characterised by perfect sectoral mobility. As noted, the AMOS framework allows a high degree of flexibility in the choice of labour market closure. Accordingly, I consider two alternative hypotheses about the determination of regional wages. The standard default case I adopt is the labour market closure under which the regional nominal wage is fixed. This is the assumption that characterises most conventional analyses of regional economic behaviour, of both a theoretical (e.g. Harris (1989) and Holden and Swales (1995)) and empirical (e.g. Harris (1991a) and Roper and O'Shea (1991)) nature. In a macroeconomic context this is most often motivated by appeal to the nominal-wage-taking behaviour implied for a small open region that is part of a spatially integrated wage-bargaining system. This provides an important benchmark case. However, as recent research suggests that regional wages are sensitive to changes in workers power, I incorporate the regional bargained real wage function (BRW). In this relationship, the regional real consumption wage is directly related to workers bargaining power, and therefore inversely to the regional unemployment rate. In the AMOS model, the BRW function is taken from the regional econometric work reported by Layard, Nickell and Jackman (LNJ, 1991):

$$w_{s,t} = \alpha - 0.068u_s + 0.40w_{s,t-1}$$

where: w_s and u_s are the natural logarithms of the Scottish real consumption wage and the unemployment rate respectively. Empirical support for this "wage curve" specification is now widespread, even in a regional context (Blanchflower and Oswald (1994)).[3]

In each period of the multi-period simulations I report here, both the total capital stock and its sectoral composition are fixed, and commodity markets clear continuously. The exogenous inward investment stimulus in the manufacturing sector occurs in the first period. Each sector's capital stock is then updated between periods via a simple capital stock adjustment procedure, according to which investment equals depreciation plus some fraction of the gap between the desired level of the capital stock and its actual level. This process of capital accumulation is compatible with a simple theory of optimal firm behaviour given the assumption of quadratic adjustment costs. Desired capital stocks are

[3] However, note the work by Cameron and Muelbauer (1999) suggest contrary results.

determined on cost-minimisation criteria and actual stocks reflect last period's stocks adjusted for depreciation. In long-run equilibrium, desired and actual capital stocks become equal. Accordingly, in the long-run simulations capital stocks are endogenous, and determined on cost-minimisation criteria, with investment equal to depreciation at the optimal capital stock.

This treatment is wholly consistent with sectoral investment being determined by the relationship between the capital rental rate and the user cost of capital. The capital rental rate is the rental that would have to be paid in a competitive market for the (sector specific) physical capital: the user cost is the total cost to the firm of employing a unit of capital. Given that the interest, capital depreciation and tax rates are taken to be exogenous, the capital price index is the only endogenous component of the user cost. If the rental rate exceeds the user cost, desired capital stock is greater than the actual capital stock and there is therefore an incentive to increase capital stock. The resultant capital accumulation puts downward pressure on rental rates and so tends to restore equilibrium. In the long-run, the capital rental rate equals the user cost in each sector, and the risk-adjusted rate of return is equalised between sectors.

Furthermore, the flexibility of the labour market options available within a CGE model such as AMOS allow the explicit nature of a particular regional labour market to be included in the model. This labour market is also linked to other regions through a migration relationship which allows the direct effects of migration to be transmitted through the labour market into the model. Thus, nearly all labour market conditions can be mimicked by some of the specifications included in AMOS.

For the simulations in this Chapter I use two alternative characterisations of labour mobility. The first case assumes that labour is geographically immobile, an assumption often implicit in past UK regional policy analyses. Alternatively, I use the Layard Nickel & Jackman (LNJ, 1991) net migration function where net migration is positively related to the real wage differential and negatively to the unemployment rate differential in accordance with the estimated model reported in LNJ (1991, chapter. 6). This model is based on that in Harris and Todaro (1970), and is commonly employed in studies of US migration (eg Greenwood *et al* (1991) and Treyz *et al* (1993)). The net migration equation used in the AMOS is as follows:

$$m = \beta - 0.08(u_s - u_r) + 0.06(w_s - w_r)$$

where: m is the net in-migration rate (as a proportion of the indigenous population); w_r and u_r are the natural logarithms of the real consumption wage and unemployment rates, respectively, in the rest-of-the-UK. In the initial period we assume zero net migration. In the multiperiod simulations reported below the net migration flows in any period are used to update population stocks at the beginning of the next period, in a manner analogous to the updating of the capital stocks. Ultimately, net migration flows re-establish a zero-net-migration equilibrium.

For the key parameters in the model, all sectors use a CES technology with "best guess" elasticities of substitution of 0.3 (Harris, 1989) and Armington trade substitution elasticities of 2.0 (Gibson, 1990). The capital stock adjustment parameter (λ) is taken to be 0.5 in each sector.[4] Throughout, I typically discuss results by interpreting the conceptual "periods" of the model as "years". This is in common with other work (McGregor *et al*, 1996; Gillespie *et al*, 1998) and I believe this to be reasonable, in that all of the data employed in the calibration (and, where applicable, estimation) of the model are annual. However, since the model is not (and cannot be) entirely econometrically estimated on annual data, this interpretation is suggestive, rather than definitive.

Moreover, as noted previously, since most CGE models cannot be fully parameterised econometrically, the simulation results are subject to a degree of uncertainty and might be extremely sensitive to changes in key parameters values. However, one method used to confirm how robust model results are is to subject the model to systematic sensitivity analysis. Harrison and Vinod (1992) develop an approach aimed at generating an unbiased and asymptotically consistent estimator of the population mean of the solution values for aggregate employment levels (see also Harrison *et al*, 1991, 1993). This procedure can be used, for instance, for a more detailed investigation of the adjustment paths of alternative formulations.

[4] This default value of the adjustment parameters is based on investment equations estimated for the Scottish manufacturing sector. This is, in fact, the only sector in AMOS for which a time series of investment data exists. For other sectors information is available only for the years in which a Scottish I-O table has been constructed.

Gillespie, McGregor, Swales & Yin (1998) use this approach to investigate alternative adjustment paths of alternative formulations of the AMOS model. In particular, they concentrate on three broad groups of elasticities in AMOS. These are: the speed of adjustment parameters, that indicate how fast actual capital stocks adjust to their desired levels (the values of these parameters are selected from the range 0.2 to 0.8); the CES production substitution elasticities (selected from the range 0.1 to 0.5); and the intermediate demand and final demand elasticities (0 to 4). They assume that each elasticity has a uniform distribution and that all the uniform distributions are symmetric about their means (which are the default point estimates in AMOS).[5]

Gillespie *et al* (1998) divide the distribution into 3 equal intervals and take the mean of each interval for perturbation. There are 39 elasticities selected, with no cross-sectoral parameter constraints imposed, in contrast to the default specification. The set of all possible parameter perturbations is therefore 3^{39}. The model programme follows randomized factorial design and selects a subset (1000) of the possible configurations with each simulation run for 50 periods. The results of their sensitivity analysis reveal that the total-employment estimates from the model are robust. The mean values for the 1000 simulations are very close to their original results and the ± one-standard deviation range is relatively narrow.

Finally, note that a number of distinctive features of inward investment cannot be captured within the "representative transactor" approach to modelling the manufacturing sector, which essentially assumes that all manufacturing plants are identical. For instance, it is well known that, in practice, foreign-owned plants exhibit differential capital intensities, local linkages and wage levels. A full treatment of these differences would necessitate disaggregation of the manufacturing sector by ownership. This would incorporate these differences into the base year model. However, more importantly, this approach also implicitly assumes uniform behavioural characteristics across all manufacturing plants.

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[5] Following this approach implies that you need only consider those alternative values for a given parameter that are equiprobable (Harrison and Vinod, 1992). The assumption of uniform distributions makes the selection of these alternative values straightforward.

From Chapter 1, we know that FDI manufacturing plants are typically part of a wider international production process. This could have several implications for how the plant would respond to changes in local economic conditions. (These issues are discussed further in Chapter 6 where I alter the behavioural assumptions of the foreign-owned manufacturing sector.) However, the main purpose of this chapter is to illustrate both the range of potential impacts associated with FDI and the importance of supply-side impacts from FDI. I now proceed in the following section with the FDI simulations.

3.3 The System-wide Impact of Foreign Direct Investment (FDI) In Scotland.

3.3.1 Introduction

In the AMOS simulations in this chapter, the simulated inward investment (or incoming manufacturing plant) is equivalent to a 20% increase in manufacturing investment in Scotland. This corresponds to FDI, which increases total Scottish manufacturing capacity by 3.0% and produces around 15,810 direct jobs.[6] This is in fact a very large injection in terms of employment and is used for pedagogic effect. This is the standard default shock I use to represent a typical manufacturing inward investment. The 20% increase in manufacturing investment provides a reasonable magnitude for an FDI shock and could also represent the combined stock of inward investment over a period of time (1 year) into a small region such as Scotland.

3.3.2. Exogenous manufacturing Investment Shock.

In this first set of simulations, I report the results from a 20% single period increase in manufacturing investment. This corresponds to foreign direct investment which increases total Scottish manufacturing capacity by 3.0% and produces 15,810 direct jobs. The simulations involve an exogenous investment shock in period one and the model is then run forward with investment endogenous in subsequent periods. In this section I assume that the regional labour market is characterised by national bargaining. This assumption is often implicitly employed in FDI impact evaluations (Alexander & Whyte, 1995; Hill and Roberts, 1995) and can be motivated as reflecting UK-wide bargaining in

[6] (In Gillespie et al, 1998, the number of RSA assisted jobs in Scotland, in 1989, after adjustments for additionality and deadweight was 9,872).

Table 3.3.1 - 20% increase in Manufacturing Investment with National Bargaining					
	Period 1	Period 2	Period 10	Period 25	Period 50
GDP (income measure)	0.32	0.46	0.14	0.01	0.00
Consumption	0.37	0.22	0.08	0.01	0.00
Investment	5.48	0.02	0.01	0.00	0.00
Nominal before-tax wage	0.00	0.00	0.00	0.00	0.00
Real B-Tx consumption wage	-0.12	-0.03	0.02	0.01	0.00
Total employment (000's):	0.40	0.39	0.12	0.01	0.00
Manufacturing:	0.09	1.08	0.21	0.01	0.00
Non-Manu traded:	0.23	0.27	0.13	0.02	0.00
Sheltered:	0.75	0.09	0.04	0.01	0.00
Unemployment rate (%)	-3.03	-2.99	-0.89	-0.09	0.00
Labour participation rate (%)	0.09	0.09	0.03	0.00	0.00
Total population (000's)	0.00	0.00	0.00	0.00	0.00
Net in-migration (000's)	--	--	--	--	--
Price of value added:					
Manufacturing	0.07	-1.46	-0.28	-0.01	0.00
Non-Manu traded	0.25	0.30	-0.05	-0.02	0.00
Sheltered	0.41	0.05	-0.01	0.00	0.00
Capital rental rates:					
Manufacturing	0.30	-6.08	-1.16	-0.06	0.00
Non-Manu traded	0.75	0.91	-0.14	-0.05	-0.01
Sheltered	2.51	0.31	-0.06	-0.02	0.00
Consumer price index	0.12	0.03	-0.02	-0.01	0.00
Value-added:					
Manufacturing	0.07	1.53	0.30	0.02	0.00
Non-Manu Traded	0.15	0.18	0.15	0.02	0.00
Sheltered	0.63	0.08	0.05	0.01	0.00
Commodity Output:					
Manufacturing	0.08	1.28	0.25	0.01	0.00
Non-Manu Traded	0.17	0.21	0.14	0.02	0.00
Sheltered	0.64	0.08	0.05	0.01	0.00
Capital stocks:					
Manufacturing	0.00	3.00	0.56	0.03	0.00
Non-Manu Traded	0.00	0.00	0.17	0.03	0.00
Sheltered	0.00	0.00	0.06	0.01	0.00
Exports to RUK:					
Manufacturing	-0.06	1.32	0.25	0.01	0.00
Non-Manu Traded	-0.36	-0.44	0.07	0.02	0.00
Sheltered	-0.74	-0.09	0.02	0.01	0.00
Nominal income:					
Households disposable	0.49	0.25	0.06	0.01	0.00
Firms disposable	0.92	-0.06	-0.06	-0.01	0.00
Firms disposable	0.92	-0.06	-0.06	-0.01	0.00

Figure 3.3.1: Total and sectoral employment change relative to the base year values, generated by a 20% increase in manufacturing investment.

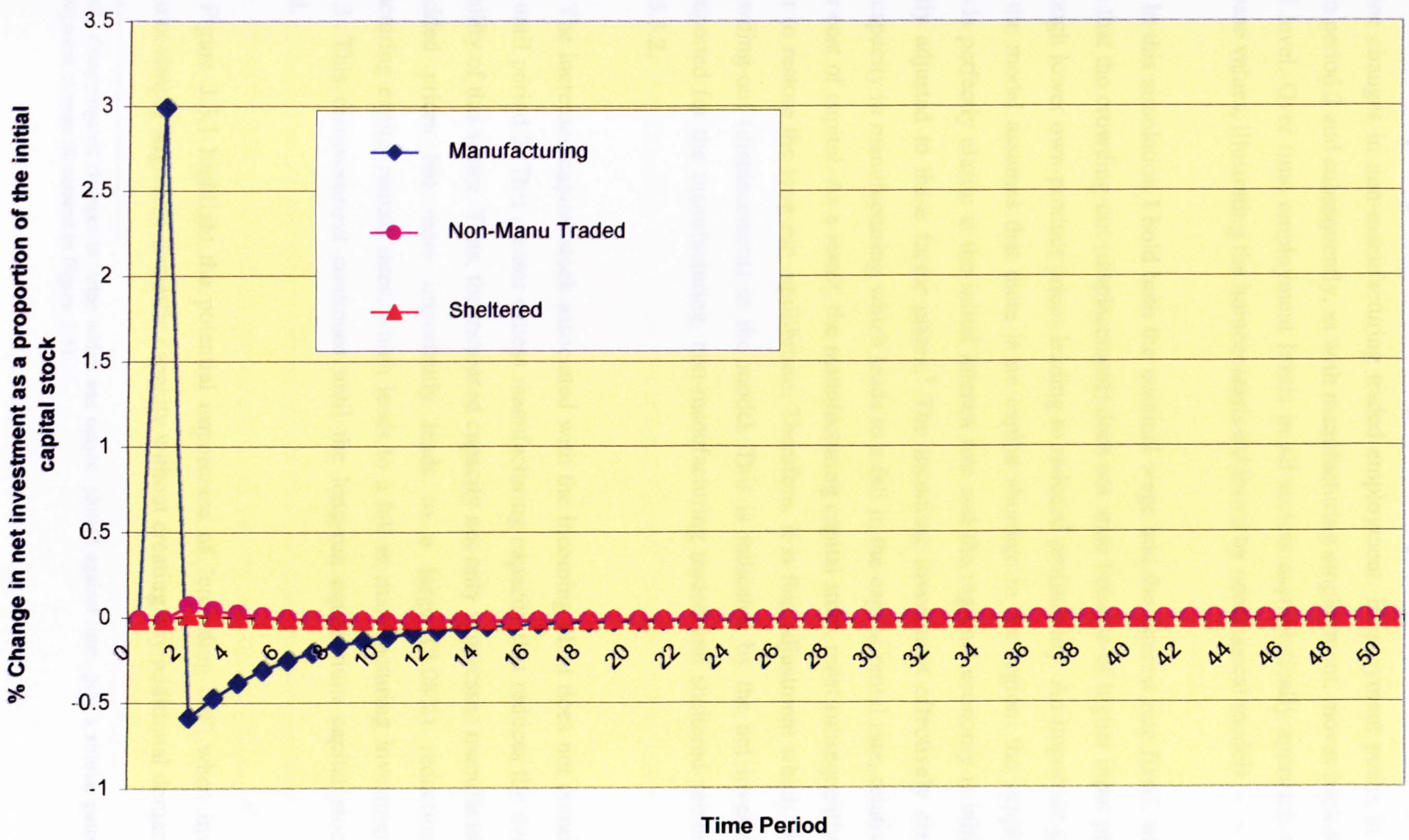
which small open regions, such as Scotland, become nominal-wage takers. The economic effects of the investment shock are driven both by the initial demand impact and the resultant supply-side effects of the increased manufacturing capacity.

Table 3.3.1 reports the changes in key economic variables for the initial (period 1) impact effect and for the subsequent periods 2, 10 & 40. Figure 3.3.1 plots the total and sectoral employment change, relative to the base year values, generated by a 20 per cent increase in manufacturing investment, with national bargaining.

Period 1 is the construction period in which the initial investment is undertaken. The 20% increase in manufacturing investment generates period 1 increases of 0.32% in regional GDP and 0.40% in employment. The initial increase in employment is greater than the increase in GDP because capital stocks are fixed in this period. The period 1 expansion in activity is concentrated in construction, which is part of the sheltered sector, where value added and employment increase by 0.63% and 0.75% respectively. Accordingly, the initial employment gains are predominately located in the sheltered sector. The period 1 (impact) results represent the short-run effects of a demand shock and are similar to those from a Keynesian multiplier or I-O analysis (Harrigan *et al*, 1991; McGregor and Swales, 1993; McGregor *et al*, 1996), apart from the crucial difference that increases in commodity demand have an impact on product prices, real wages and competitiveness.

In period 2, the additional capacity comes on stream so that the manufacturing capital stock is augmented by 3%, whilst the capital stock in the other sectors remains unchanged. The main stimulus is now focused on the manufacturing sector where the increased capacity leads to a reduction in manufacturing value added prices (-1.46%) which stimulates exports, import substitution and substitution towards manufactured goods in other demand categories. However, an exogenous increase in capital stock, with no other demand or supply-side changes, will have purely transitory effects. In so far as the FDI does increase employment initially, there is subsequently 100% displacement.

Figure 3.3.2: Sectorally disaggregated net investment flows as a percentage of the initial capital stock, generated by a 20% increase in manufacturing investment.



From Figure 3.3.1, note that the employment effect in the sheltered sector is essentially a one period spike.[7] Manufacturing sector employment peaks in period 2 and then shows a subsequent gradual decline. Higher consumption and intermediate demand determine changes in non-manufacturing traded employment. Employment peaks in this sector in period 2 and subsequently, as with manufacturing employment, moves back to its original level. Over time employment levels in all sectors asymptotically approach their initial base values, illustrating the homoeostasis exhibited by neoclassical models.

In this simulation I hold both the nominal wage and the interest rate fixed, which implies that the crowding-out (displacement) does not arise because of higher input prices but through lower own-product prices leading to reduced profitability. An important point is that the model assumes that there is no capital shortage in the region: the supply of finance is perfectly elastic at the initial interest rate and the regional economy is initially optimally adjusted to these factor prices.[8] The incoming investment effectively creates excess capacity in manufacturing which leads to a fall in the capital rental rate, relative to the user cost of capital. As a result, the manufacturing capital stock must subsequently fall in order to restore the long-run equilibrium. Therefore, it is this adjustment which drives the crowding-out (displacement) in the model. This is indicated by the net investment flows reported for the manufacturing, non-manufacturing traded and sheltered sectors in Figure 3.3.2.

The increased capital stock associated with the incoming plant does not come on-stream until period 2. This creates excess manufacturing capacity that reduces the overall profitability of this sector. Thus, the increased capacity not only suppresses manufacturing value-added prices but more importantly leads to a large (6.08%) reduction in manufacturing capital rentals rates, which leads to a fall in manufacturing investment in period 3. This disinvestment continues until the long-run equilibrium capital stock is restored.

Figure 3.3.1 highlight the potential importance of "crowding out" when inward investment simply augments domestic capacity without creating any additional demand or

[7] Sectorally disaggregated changes in value added and output, plotted against time, give a similar pattern to the employment change illustrated in Figure 3.31.

supply stimulus. In this simulation, in the long run the regional economy returns to its original equilibrium, with foreign-owned production simply replacing domestic activity. This displacement occurs through product market competition where the incoming plant reduces, on a one-for-one basis, the sales and market share of indigenous plants. In effect, the incoming plant invests in the region to service existing markets, which implies an increase in competition for indigenous producers, a fall in profitability within that sector, and the eventual displacement of indigenous production to accommodate the new entrant.

There are two important points that this section of the chapter highlights. Firstly, the region-wide impact of FDI is typically more than just a manufacturing capital investment, as increased manufacturing capacity in its own right will have no permanent system-wide impact. This begs the question as to whether in such circumstances an inward investment of the nature demonstrated in this simulation would occur, given that it depresses the rate of profit, within the manufacturing sector, to below the user cost of capital until long-run equilibrium is restored. Typically FDI is also associated with an export demand stimulus, especially as foreign-owned plants export a high proportion of their output. Finally, the exogenous investment shock simulation provides a benchmark case that serves mainly to highlight the important characteristics that are typically associated with incoming manufacturing plants. i.e., exports. Although there is some evidence of market seeking FDI, this evidence occurs at the UK and European level.

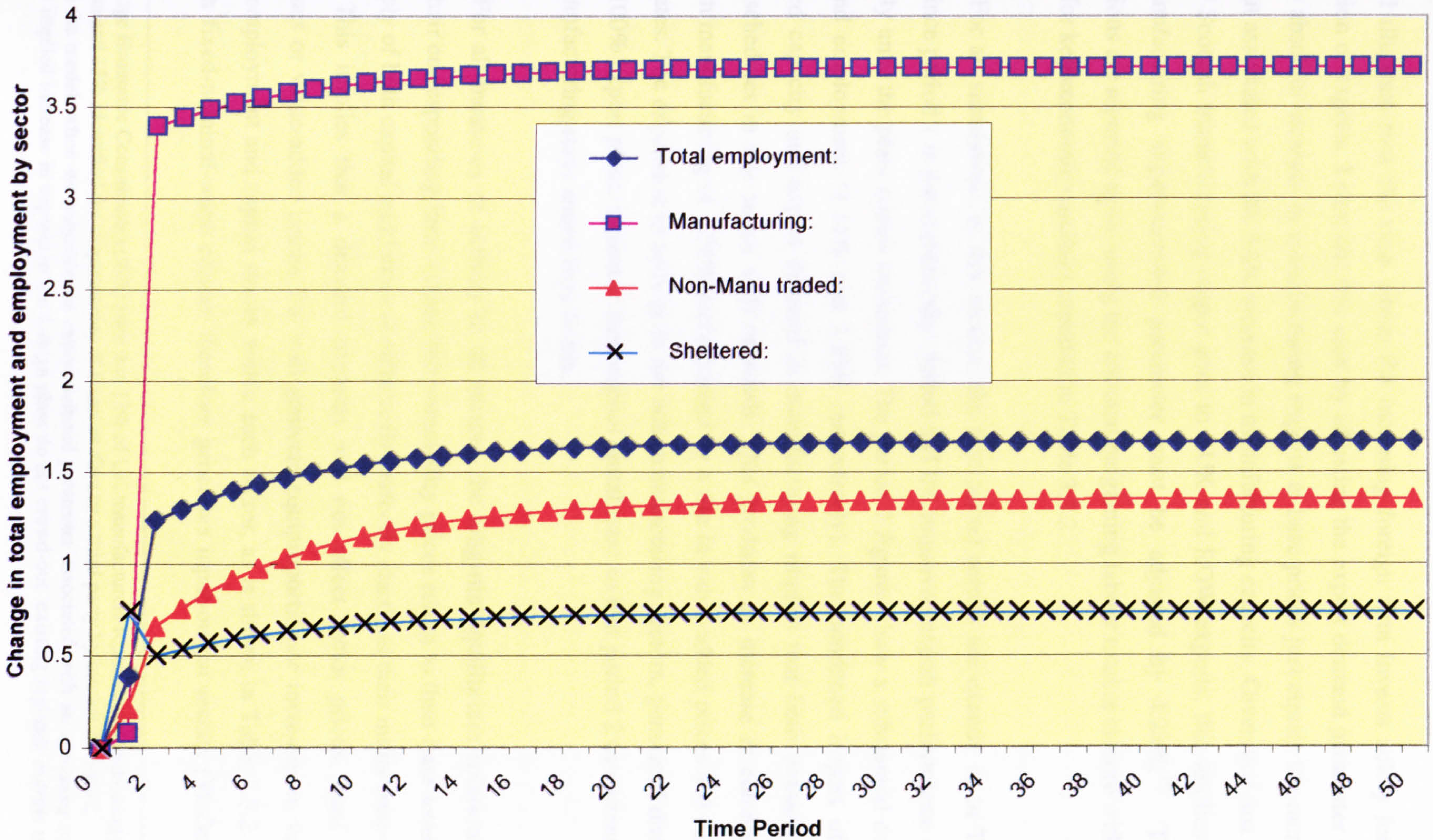
3.3.3 – Varying the Export Stimulus.

Although there is some reporting of product market displacement in the FDI literature[9], inward investment is typically associated with increased exports which will offset some, or all, of any displacement. Inward investment is typically undertaken to internalise country-specific advantages in production, often location derived, or to use a particular location as a base from which to export into new markets. For instance, Hill & Roberts (1995) report that 97% of the output produced by foreign plants in Wales is exported out of the region. I therefore incorporate the impact of the increased exports, which are typically associated with FDI.

[8] This differs from the CGE work of Buffie (1993) where, in a developing-economy context, capital scarcity plays a key role in the analysis of the impact of FDI.

Table 3.3.2 - 20% increase in Manufacturing Investment and 4.28% Export Shock with National Bargaining					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.32	1.11	1.51	1.66	1.67
Consumption	0.37	1.08	1.34	1.44	1.45
Investment	5.48	1.81	1.76	1.76	1.76
Nominal before-tax wage	0.00	0.00	0.00	0.00	0.00
Real B-Tx consumption wage	-0.12	-0.22	-0.06	-0.01	0.00
Total employment (000's):	0.40	1.25	1.55	1.67	1.68
Manufacturing:	0.09	3.41	3.64	3.72	3.73
Non-Manu traded:	0.23	0.67	1.16	1.35	1.36
Sheltered:	0.75	0.51	0.68	0.74	0.75
Unemployment rate (%)	-3.03	-9.49	-11.83	-12.66	-12.75
Labour participation rate (%)	0.09	0.28	0.35	0.38	0.38
Total population (000's)	0.00	0.00	0.00	0.00	0.00
Net in-migration (000's)	--	--	--	--	--
Price of value added:					
Manufacturing	0.07	0.31	0.08	0.01	0.00
Non-Manu traded	0.25	0.73	0.22	0.02	0.00
Sheltered	0.41	0.27	0.05	0.00	0.00
Capital rental rates:					
Manufacturing	0.30	1.32	0.35	0.03	0.00
Non-Manu traded	0.75	2.25	0.66	0.06	0.00
Sheltered	2.51	1.69	0.31	0.02	0.00
Consumer price index	0.12	0.22	0.06	0.01	0.00
Value-added:					
Manufacturing	0.07	3.31	3.62	3.72	3.73
Non-Manu Traded	0.15	0.45	1.10	1.34	1.36
Sheltered	0.63	0.42	0.67	0.74	0.75
Commodity Output:					
Manufacturing	0.08	3.36	3.63	3.72	3.73
Non-Manu Traded	0.17	0.51	1.11	1.34	1.36
Sheltered	0.64	0.43	0.67	0.74	0.75
Capital stocks:					
Manufacturing	0.00	3.00	3.53	3.71	3.73
Non-Manu Traded	0.00	0.00	0.96	1.33	1.36
Sheltered	0.00	0.00	0.59	0.73	0.75
Exports to RUK:					
Manufacturing	-0.06	3.99	4.20	4.27	4.28
Non-Manu Traded	-0.36	-1.06	-0.32	-0.03	0.00
Sheltered	-0.74	-0.50	-0.09	-0.01	0.00
Nominal income:					
Households disposable	0.49	1.30	1.40	1.44	1.45
Firms disposable	0.92	2.23	1.86	1.75	1.74
Firms disposable	0.92	2.23	1.86	1.75	1.74

Figure 3.3.3: Percentage changes in total employment and employment by sector, relative to the base tear values, generated by a 100% export plant.



3.3.4 The 100% Export FDI Plant.

I illustrate first the case where the incoming foreign firm invests solely for the production of exports. I simulate this case by adjusting the export demand parameter such that the absolute increase in manufacturing exports at base prices just equals the increase in output associated with the 3.0% increase in manufacturing capacity. Given that just over 70% of Scottish manufacturing output goes to RUK and ROW exports, this implies that the manufacturing export-demand parameter must be adjusted by 4.28%.[10] These simulations are reported again using the national bargaining labour market closure with the results for key economic variables reported in Table 3.3.2.

For all simulations in this section, the first period results are exactly as in Table 3.3.1, since period 1 is the construction period and the improved export performance does not apply until the plant comes on-stream. The period 2 figures show a substantial rise in GDP and employment (1.11% and 1.25% respectively). The combined impact of the increased capacity and export demand in manufacturing implies that both demand and supply schedules in this sector shift outwards. This produces an increase in commodity output in manufacturing of 3.36% accompanied by a rise in value-added prices and capital rental rates. The expansion in activity in the non-manufacturing sectors, generated directly by the 100% export plant, increases their capital rental rates so that period 2 investment in non-manufacturing stays above base levels.

For all measures of activity in all sectors, the long-run equilibrium solutions lie above their corresponding base values, but commodity prices return to their base levels as the supply of both capital and labour is effectively perfectly elastic at their initial base-year prices. This implies that a demand stimulus will not affect factor prices, least cost techniques or value-added prices, but will generate equiproportionate increases in value-added, employment and capital stocks within each sector, as is shown in Table 3.3.2. The long-run fixed-nominal-wage closure therefore generates input-output results (McGregor

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[9] Cambridge Economic Consultants (1995) state that 13% of UK manufacturers reported rationalisation of production and 15% identified the displacement of a known firm or a third party by inward investors.
[10] Within the model, when we augment the export-demand parameter associated with an incoming foreign plant, the implied increase in exports to the foreign plant do not crowd-out existing regional exports in that sector.

et al, 1996). Thus, the rise in manufacturing exports is ultimately the full 4.28%, with no change in non-manufacturing exports. This generates an increase in activity in manufacturing, non-manufacturing traded and sheltered sectors of 3.73%, 1.36% and 0.75% respectively.

Figure 3.3.3 highlights the change in total employment and employment by sector from the initial base-year values. Employment in all sectors is stimulated by the export performance of the incoming plant. In the short run, employment in the sheltered sector overshoots its long-run value due to the scale of the one-period investment shock in this sector, attributable to the construction of the plant. Manufacturing output rises after period 2 due to increased intermediate demand and consumption effects similar to those operating in the sheltered sector. The adjustment towards the long-run equilibrium values occurs quickly since by period 2 total employment is 74% of its long-run value, although the non-manufacturing traded sector adjusts more gradually.

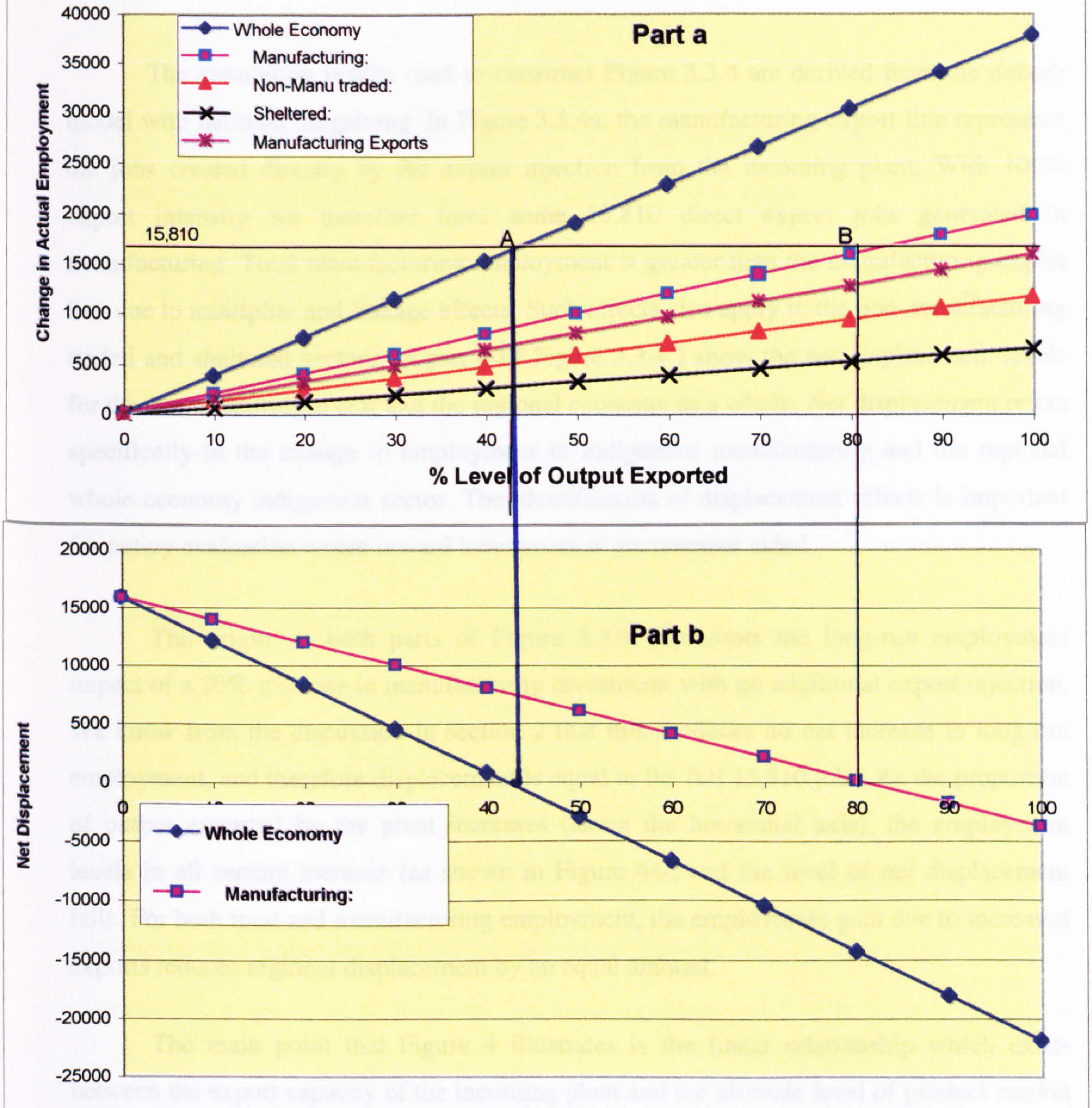
Where the labour market is passive, the model generates long-run equilibrium impacts of an I-O nature even though the system has neoclassical qualities, such as price endogeneity and flexible (constant elasticity of substitution, CES) technology. Moreover, these long-run equilibrium impacts are attained in a relatively short period of time, which suggests that I-O or Keynesian multipliers are appropriate forms of analysis in situations of this type. The main difficulties which arise from using an I-O approach stem from having to identify, *ex-ante*, the source and level of exogenous demand. However, the linearity of the I-O system allows the stimulus to be further broken down and analysed. For instance, in the following section I consider the relationship between product market displacement and the export intensity of the incoming plant.

3.3.5 Product Market Displacement.

In the previous sections, I have considered two extreme cases of 0% and 100% export-orientated firms.[11] In Figure 3.3.4 I investigate how long-run total employment and product market displacement varies with the degree of export intensity of the incoming

[11] This requires some further elaboration. In the simulations in Section 3.3.2 the key point is that FDI brings no additional export stimulus to the region and, in so far as the plant exports, it will, in the long-run, simply displace existing regional exports. In the simulations in Section 3.3.4 exports, in the long-run, expand by an amount equal to the capacity of the FDI.

Figure 3.3.4 - Change in long-run total and sectoral employment, for the range of plant export intensities



Long-run net displacement levels in manufacturing and the whole economy for the range of plant export intensities.

plant. It should be stressed that when I discuss displacement here, I mean net displacement. That is, I combine the displacement, linkage and Keynesian multiplier impacts on existing firms.

The simulation results used to construct Figure 3.3.4 are derived from the default model with national bargaining. In Figure 3.3.4a, the manufacturing export line represents the jobs created directly by the export injection from the incoming plant. With 100% export intensity we therefore have some 15,810 direct export jobs generated in manufacturing. Total manufacturing employment is greater than the manufacturing export line due to multiplier and linkage effects. Such effects also apply to the non-manufacturing traded and sheltered sectors. In part b of Figure 3.3.4 I show the net displacement levels for the manufacturing sector and the regional economy as a whole. Net displacement refers specifically to the change in employment in indigenous manufacturing and the regional whole-economy indigenous sector. The identification of displacement effects is important for policy evaluation where inward investment is government aided.

The origin, in both parts of Figure 3.3.4, represents the long-run employment impact of a 20% increase in manufacturing investment with no additional export injection. We know from the discussion in section 2 that this produces no net increase in long-run employment, and therefore displacement is equal to the full 15,810 jobs. As the proportion of output exported by the plant increases (along the horizontal axis), the employment levels in all sectors increase (as shown in Figure 4a), and the level of net displacement falls. For both total and manufacturing employment, the employment gain due to increased exports reduces regional displacement by an equal amount.

The main point that Figure 4 illustrates is the linear relationship which exists between the export capacity of the incoming plant and the ultimate level of product market displacement, and the significant role of linkage and multiplier effects in determining the magnitude of the employment impact. The total employment change, T, produced by an increase in export employment, X, is determined by an I-O multiplier process, so that:

$$T = X(1 + \Sigma\lambda_i) \qquad (1)$$

where λ_i is the employment multiplier in sector i for a change in manufacturing exports, $\lambda_i \geq 0$. Similarly, the increase in manufacturing employment, M, equals;

$$M = X(1 + \lambda_m) \qquad (2)$$

If total employment in the FDI plant is Y, then indigenous total and indigenous manufacturing employment change J^T, J^M is given by equations.

$$J^T = X(1 + \Sigma\lambda_i) - Y \qquad (3)$$

$$J^M = X(1 + \lambda_m) - Y \qquad (4)$$

Setting J^T and J^M equal to zero in equations (3) and (4), and then solving for $\frac{X}{Y}$ gives the FDI export intensities $\left[\frac{X}{Y}\right]^T, \left[\frac{X}{Y}\right]^M$ above which there will be no total and manufacturing net displacement respectively. This gives the result:

$$0 < \frac{1}{(1+\sum\lambda_i)} = \left[\frac{X}{Y}\right]^T < \left[\frac{X}{Y}\right]^M = \frac{1}{1+\lambda_m} < 1 \qquad (5)$$

Equation (5) indicates that there is always some FDI export intensity, $\left[\frac{X}{Y}\right]^M$, above which there is no net manufacturing displacement and that this is greater than the export intensity, $\left[\frac{X}{Y}\right]^T$ for which there is no total displacement. The export intensities $\left[\frac{X}{Y}\right]^T, \left[\frac{X}{Y}\right]^M$ correspond to points A and B in Figure 3.3.4. Given the present configuration of the model, the export intensity of the incoming foreign-owned manufacturing plant has to be 80% (point B), before indigenous manufacturing activity benefits. However, whole economy net displacement (point A) is eliminated where the export intensity of the incoming plant is 40%.

This section has focussed on the role of exports for a regional economy. Of equal importance is the level of import substitution within the region. I do not deal with this aspect of FDI here. However, if the incoming firm reduced the level of imports within the region, this would generate the same qualitative results as the export stimulus.

3.4. Labour Market Effects of FDI.

In the previous section I used the fixed nominal wage as the appropriate labour market closure. This was motivated, in part, by the common view that regional wages are determined within a spatially-integrated national bargaining system. This implicitly assumed a passive labour market as the determination of the regional wage rates was exogenous to the region. Accordingly, changes in local economic conditions had no impact on the determination of local or regional labour market conditions. However, recall from Chapter 1 that FDI can have significant labour market effects (Cambridge Economic Consultants, 1995; Driffield, 1995a).

In this section, I replace the fixed nominal wage closure with the Layard, Nickell and Jackman (LNJ) (1991) regional bargained real wage (BRW) function in order to demonstrate the potential impact of a non-passive labour market in which wages are sensitive to regional labour market conditions. In this relationship, the regional real-consumption wage is negatively related to the regional unemployment rate. This real wage function is econometrically parameterised using UK data (LNJ, 1991).

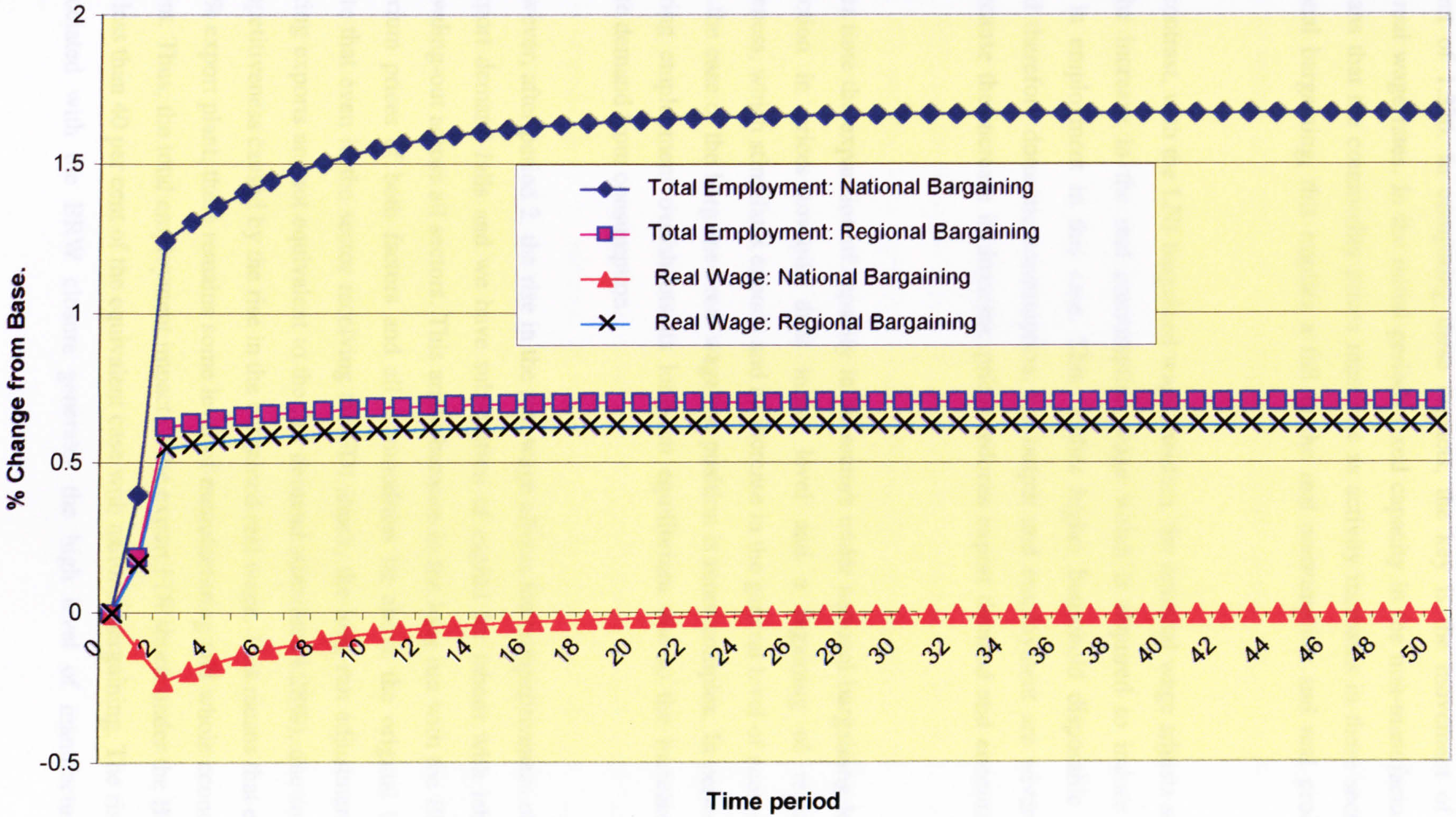
3.4.1 - Layard, Nickell & Jackman Bargaining Real Wage Curve.

The simulation results presented here are for a 100% export plant. That is to say, I use the same 20% manufacturing investment shock together with a 4.28% export stimulus. The results are presented in Table 3.4.1 and Figure 3.5 compares the total employment and real wage effects using both the fixed nominal wage and the bargained real wage labour market closures.

From Figure 3.5, note that the long-run (period 40) results, for both closures, show an increase in total employment above base levels. With the national bargaining closure, the FDI and export stimulus generates 37,744 jobs in total. In the LNJ case, the equivalent

Table 3.4.1 - 20% increase in Manufacturing Investment and 4.28% Export Shock with LNJ Regional Bargaining					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.17	0.64	0.73	0.75	0.76
Consumption	0.37	1.01	1.08	1.10	1.11
Investment	5.48	1.02	1.01	1.01	1.01
Nominal before-tax wage	0.34	0.93	0.94	0.94	0.94
Real B-Tx consumption wage	0.17	0.55	0.61	0.63	0.63
Total employment (000's):	0.19	0.62	0.69	0.71	0.71
Manufacturing:	-0.14	2.75	2.73	2.74	2.74
Non-Manu traded:	0.01	0.04	0.18	0.22	0.22
Sheltered:	0.57	-0.09	-0.05	-0.04	-0.04
Unemployment rate (%)	-1.45	-4.76	-5.25	-5.39	-5.40
Labour participation rate (%)	0.04	0.14	0.16	0.16	0.16
Total population (000's)	0.00	0.00	0.00	0.00	0.00
Net in-migration (000's)	--	--	--	--	--
Price of value added:					
Manufacturing	0.23	0.73	0.78	0.78	0.78
Non-Manu traded	0.35	0.98	0.78	0.72	0.72
Sheltered	0.65	0.88	0.84	0.83	0.83
Capital rental rates:					
Manufacturing	-0.14	0.11	0.26	0.26	0.26
Non-Manu traded	0.36	1.07	0.45	0.28	0.27
Sheltered	2.25	0.63	0.33	0.27	0.26
Consumer price index	0.18	0.38	0.32	0.31	0.31
Value-added:					
Manufacturing	-0.11	2.81	2.78	2.78	2.79
Non-Manu Traded	0.00	0.03	0.23	0.28	0.29
Sheltered	0.47	-0.07	-0.02	-0.01	0.00
Commodity Output:					
Manufacturing	-0.07	2.93	2.92	2.92	2.92
Non-Manu Traded	0.03	0.11	0.29	0.34	0.35
Sheltered	0.49	-0.05	0.00	0.02	0.02
Capital stocks:					
Manufacturing	0.00	3.00	2.94	2.94	2.94
Non-Manu Traded	0.00	0.00	0.32	0.42	0.42
Sheltered	0.00	0.00	0.13	0.16	0.17
Exports to RUK:					
Manufacturing	-0.21	3.60	3.56	3.56	3.56
Non-Manu Traded	-0.51	-1.41	-1.13	-1.05	-1.04
Sheltered	-1.18	-1.59	-1.51	-1.50	-1.50
Nominal income:					
Households disposable	0.55	1.39	1.41	1.42	1.42
Firms disposable	0.70	1.48	1.37	1.35	1.34
Firms disposable	0.70	1.48	1.37	1.35	1.34

Figure 3.3.5: Percentage change in total employment and the real wage, relative to the base year values for a 100% export plant with National Bargaining and the LNJ bargained real wage labour market closures



combined FDI and export stimulus produces some 14,440 total jobs, around 38 per cent of the employment impact generated for the fixed nominal wage closure, with net displacement of 1,370. In comparing these impacts, the key is the movement of the respective real wage rates. In the initial periods fixed capacity in the non-manufacturing sectors means that the commodity prices must rise as activity increases in these sectors. With national bargaining, this implies a fall in the real consumption and real product wages.

In contrast, with the LNJ bargained wage function, the nominal wage adjusts so as to allow the increase in the real consumption wage which is required to induce the expansion in employment in this case. This implies higher household disposable real income and therefore domestic consumption, but output and employment are adversely affected because the increase in domestic prices reduces export demand and encourages imports.

Over time the expansion of capacity in all sectors under national bargaining leads to a reduction in prices towards their initial level and a regaining of regional competitiveness, which stimulates exports and an increase in the general level of economic activity. In the case of the bargained real wage the position is more complex. In period 2, manufacturing employment overshoots its long-run equilibrium due to the increase in intermediate demand from consumption.

However, after period 2, the rise in the real wage affects the competitiveness of all sectors. Export demand falls and we have substitution of capital for labour with labour market crowding-out across all sectors. This arises because in the long run with the BRW the equilibrium prices of both factors and all commodities lie above the original base values. Note that even in the sector receiving the FDI shock, the long-run adjustment in manufacturing exports are not equivalent to the full demand stimulus (4.28%), due to the loss in competitiveness caused by the rise in the bargained real wage. This means that even with a 100% export plant, there remains some level of manufacturing and whole economy displacement. Thus, the total employment impact of the export FDI shock under the BRW function is less than 40 per cent of the equivalent case with national bargaining. The rise in wages associated with the BRW closure generates the high level of manufacturing displacement and crowding out in the sheltered sector. Note that the non-manufacturing traded is the only sector where employment in indigenous plants rises as the result of FDI.

In summary, there are two key points illustrated by this simulation. The first is the heavy preponderance of the long-run employment impact in manufacturing: nearly all of the employment increase is located in this sector. The second is the crowding-out of activity across sectors as a result of a change in the labour market conditions within the region.

3.4.2. BARGAINED REAL WAGE AND MIGRATION EFFECTS.

In the previous simulations, the economic impacts of the FDI and export stimuli were considered in isolation of migration. However, we know that migration can have important effects on the regional response to a demand disturbance (McGregor *et al*, 1995b). In this section, I incorporate the econometrically parameterised LNJ (1991) regional migration function, in which regional net in-migration is positively related to the regional relative real wage and negatively related to the relative unemployment rate.

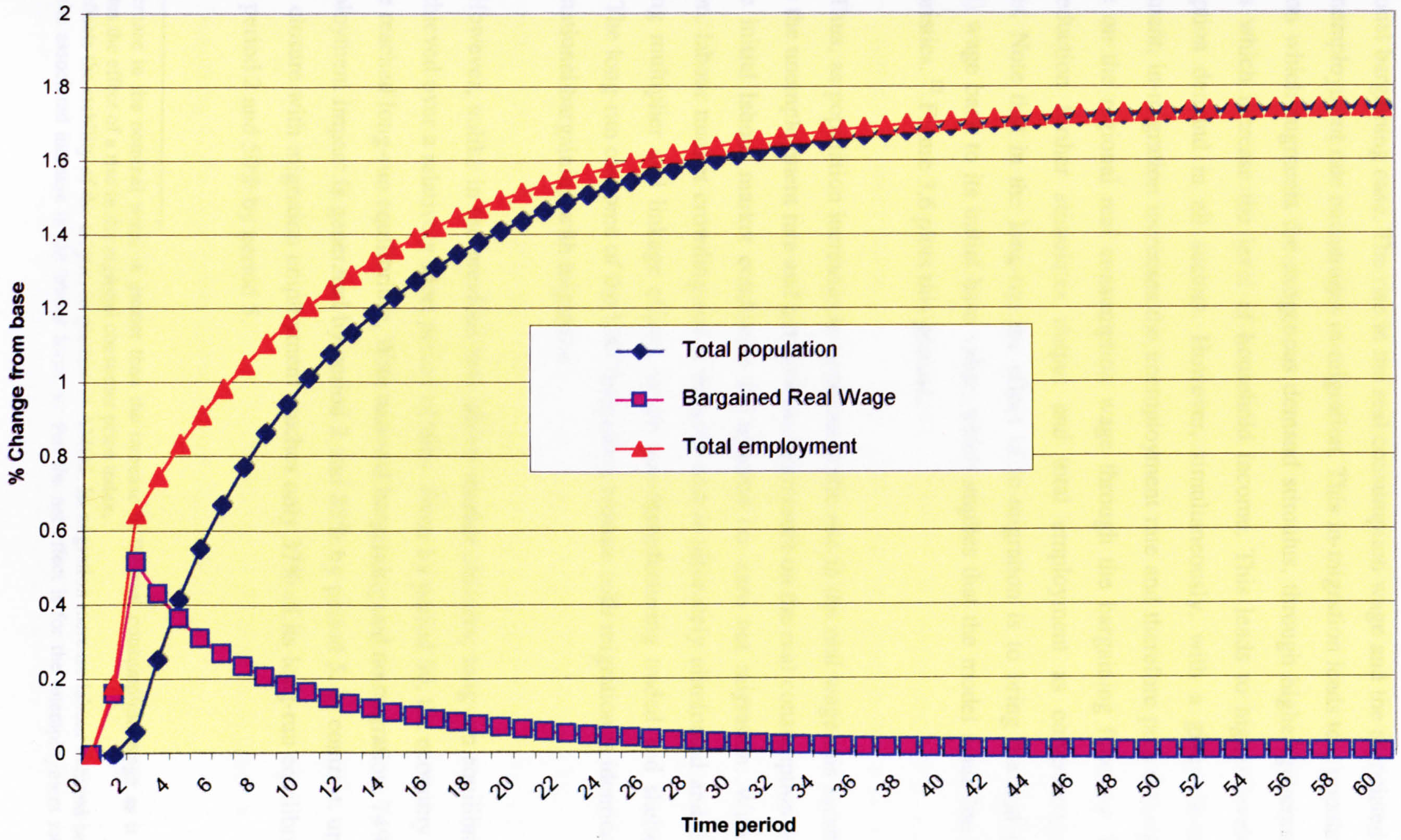
When the LNJ migration function is adopted with national bargaining, the additional economic stimulus is fairly small with in-migration generating 1,824 additional jobs. This is because in this case migration has only demand-side effects; the sole impact of a rise in population is an increase in regional income generated through higher government transfers. However with the LNJ bargained real wage and migration function we obtain substantially larger additional employment impacts because both demand and supply-side expansionary population effects operate in this case.

I again simulate the case of a 100% export FDI plant and, in Table 3.4.2, report the changes in key economic variables for the initial (period 1) impact effect and for subsequent periods 2, 15, 30 and 60. This analysis is simulated over 60 periods due to the longer adjustment process required to restore equilibrium. The period 1 impact for employment and the real wage is unchanged from the standard LNJ bargaining wage closure (Table 3.4.1, Column 1).

Table 3.4.2 - 20% increase in Manufacturing Investment and 4.28% Export shock with LNJ Regional Bargaining and Migration

	Period 1	Period 2	Period 10	Period 25	Period 60
GDP (income measure)	0.17	0.66	1.18	1.58	1.74
Consumption	0.37	1.03	1.36	1.63	1.73
Investment	5.48	1.06	1.53	1.75	1.83
Nominal before-tax wage	0.34	0.89	0.36	0.10	0.01
Real B-Tx consumption wage	0.17	0.52	0.17	0.04	0.00
Total employment (000's):	0.19	0.65	1.21	1.60	1.75
Manufacturing:	-0.14	2.78	3.26	3.61	3.75
Non-Manu traded:	0.01	0.07	0.76	1.27	1.47
Sheltered:	0.57	-0.06	0.41	0.71	0.82
Unemployment rate (%)	-1.45	-4.49	-1.47	-0.39	-0.02
Labour participation rate (%)	0.04	0.13	0.04	0.01	0.00
Total population (000's)	0.00	0.06	1.02	1.55	1.75
Net in-migration (000's)	475982	1766675	1037845	--	--
Price of value added:					
Manufacturing	0.23	0.72	0.40	0.12	0.01
Non-Manu traded	0.35	0.97	0.52	0.15	0.01
Sheltered	0.65	0.86	0.39	0.11	0.01
Capital rental rates:					
Manufacturing	-0.14	0.16	0.55	0.19	0.01
Non-Manu traded	0.36	1.12	0.85	0.26	0.01
Sheltered	2.25	0.68	0.55	0.15	0.00
Consumer price index	0.18	0.37	0.19	0.06	0.00
Value-added:					
Manufacturing	-0.11	2.83	3.24	3.61	3.75
Non-Manu Traded	0.00	0.05	0.71	1.26	1.47
Sheltered	0.47	-0.05	0.40	0.70	0.82
Commodity Output:					
Manufacturing	-0.07	2.95	3.31	3.63	3.75
Non-Manu Traded	0.03	0.12	0.76	1.27	1.47
Sheltered	0.49	-0.03	0.41	0.71	0.82
Capital stocks:					
Manufacturing	0.00	3.00	3.20	3.59	3.75
Non-Manu Traded	0.00	0.00	0.61	1.22	1.47
Sheltered	0.00	0.00	0.35	0.69	0.82
Exports to RUK:					
Manufacturing	-0.21	3.61	3.90	4.17	4.27
Non-Manu Traded	-0.51	-1.40	-0.76	-0.22	-0.01
Sheltered	-1.18	-1.55	-0.71	-0.20	-0.01
Nominal income:					
Households disposable	0.55	1.40	1.56	1.69	1.74
Firms disposable	0.70	1.51	1.79	1.82	1.82
Firms disposable	0.70	1.51	1.79	1.82	1.82

Figure 3.3.6: Percentage change in population, bargained real wage and employment, relative to base year values, for a 100% export plant with LNJ regional bargained wage and migration functions.



With regional bargaining note that there is an initial increase in the real wage as the unemployment rate falls as a result of the FDI.[12] The increase in the real wage reduces regional competitiveness and therefore limits the expansion in employment as compared to the national bargaining case. The rise in the real consumption wage and the associated fall in the unemployment rate encourages in-migration. This in-migration leads to a population expansion which augments the exogenous demand stimulus, through higher government transfers which increase the level of household income. This leads to higher levels of consumption demand in all sectors. However, simultaneously, with a given level of employment, in-migration increases the unemployment rate and therefore puts downward pressure on the regional real consumption wage through the bargaining function. This wage reduction further stimulates output and total employment as competitiveness improves. Note that in the long-run the effect of in-migration is to bring the real (and nominal) wage back to its initial base value, which implies that the model again has I-O characteristics. [13] Figure 3.6 plots this process.

Thus, as population increases in response to the rise in the real wage this serves to increase the unemployment rate and put downward pressure on the real consumption wage until the initial labour market conditions are restored i.e. zero net migration. With in-migration, labour market crowding-out is reduced and is ultimately eliminated and there are strong multiplier and linkage effects in the non-manufacturing traded and sheltered sectors. The long-run outcome of the LNJ bargaining closure with migration is identical to that for national bargaining with migration.

However, unlike in the previous two labour market closures, long-run equilibrium is not achieved over a relatively short period of time. Even by period 50, the economy has not quite reached long-run equilibrium. With national bargaining and no migration, 74% of this employment impact is generated by period 2 and 85% by period 5. In contrast, under the LNJ closure with migration employment reaches only 37% of its long-run equilibrium level by period 2 and 50% by period 5.

[12] The increase in the nominal wage is greater than the increase in the real consumption wage as it also incorporates the effect of a rise in the regional consumer price index.

[13] This reflects the stability of the migration process in AMOS. In-migration increase labour demand but by less than the associated increase in the labour force, so that the net effect is for the unemployment rate to

This section has illustrated the importance of the labour market when considering the regional impact of FDI. The effects of increased population mitigate much of the inflationary pressures caused through higher real wages where regional bargaining occurs, although the time period of adjustment over which these affects work may be relatively long. With the changing location patterns and different forms of FDI - in particular, the increasing number of high-technology firms and the labour skills content they require - labour market issues must be considered, together with the adverse impacts that may arise. In such cases, an assumption of a non-passive labour market and an allowance for migration flows are likely to be more appropriate when considering the impact of FDI on a regional economy.

3.5 – Efficiency Spillover Effects.

In this section I consider the system-wide impact of 'efficiency spillovers' arising from the presence of more productive foreign plants entering Scottish manufacturing. From Chapter 1, the FDI literature points to the apparent ability of foreign firms to prosper outwith their own home market. It is accepted that positive efficiency differences exist between multinational firms and indigenous plants and that through linkages or information flows the performance of the indigenous sector can be enhanced.

However, within the UK manufacturing sector, efficiency spillover effects have been reported but not reliably quantified (PA Cambridge Economic Consultants Ltd, 1993; 1995; Barrel & Pain, 1998). Although there is evidence that foreign-owned firms have an absolute efficiency advantage over indigenous firms, there is less clear understanding of what this actually entails and whether such an advantage could be wholly transferable. The key factors, which would determine this type of efficiency impact are the actual size of any potential efficiency transfer and the extent to which indigenous firms actually take-up or adopt these methods or practices. Given the dearth of clear empirical work relating to these points, the simulations in this section should be considered as illustrative. (I again assume national bargaining as the appropriate labour market closure.)

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increase. Migration therefore plays an equilibrating role in labour market adjustment (McGregor *et al*, 1995b).

For the simulations in this section, I assume that any efficiency spillover is restricted to the manufacturing sector and its size is positively related to both the scale of the FDI injection and the efficiency differential which exists between foreign-owned and indigenous plants. The relationship between the scale of efficiency spillovers and the efficiency difference between foreign-owned and indigenous firms is not straight forward. For instance, Blomstrom (1991), Haddad & Harrison (1992) and Perez (1995) argue that where the efficiency differences are large, technology transfers are likely to be small. I adopt the following multiplicative functional form.

$$e = A\, s^{\gamma}\, d^{\varepsilon}$$

where e is the change in efficiency in the indigenous manufacturing sector, s represents the relative size of the externally-owned sector in manufacturing, d is the efficiency differential between the externally-owned and indigenous sectors and A, γ and ε are parameters.

In the simulations in the earlier sections of the Chapter, the standard default FDI shock increased manufacturing capacity by 3 per cent. For the estimate of the efficiency difference I use the figure of 20% derived by Davies and Lyons (1991).[14] This implies that $s = 0.03$, $d = 0.20$. The parameters A, γ and ε are set equal to 1 indicating unitary scale and elasticity effects. The change in the efficiency in the indigenous manufacturing sector e is therefore equal to 0.6% which I assume to be Hicks neutral. This implies that the productivity of both capital and labour increase by 0.6%. Table 3.5.1 reports the change in key economic variables and Figure 3.7 reports the percentage changes in GDP, manufacturing exports, capital stocks and value-added prices, relative to the base year values.

The increase in efficiency boosts manufacturing output directly as the unit inputs of both capital and labour are reduced. In the short run, this supply-side improvement leads to an immediate, period 2, fall in manufacturing value-added prices (0.59%) which generates an increase in exports and an accompanying 0.61% rise in value-added. The stimulus, although concentrated in the manufacturing sector, generates strong linkage and multiplier effects. (Figure 3.8 shows the absolute changes in total and sectoral employment.)

Table 3.5.1 - 0.6% Hicks neutral increase in Manufacturing Efficiency with National Bargaining					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.19	0.20	0.24	0.25	0.26
Consumption	0.06	0.07	0.10	0.11	0.11
Investment	0.11	0.11	0.11	0.11	0.11
Nominal before-tax wage	0.00	0.00	0.00	0.00	0.00
Real B-Tx consumption wage	-0.01	-0.01	0.01	0.02	0.02
Total employment (000's):	0.06	0.07	0.10	0.12	0.12
Manufacturing:	0.01	0.02	0.03	0.03	0.04
Non-Manu traded:	0.11	0.12	0.18	0.20	0.21
Sheltered:	0.05	0.05	0.07	0.08	0.08
Unemployment rate (%)	-0.47	-0.53	-0.78	-0.88	-0.88
Labour participation rate (%)	0.01	0.02	0.02	0.03	0.03
Total population (000's)	0.00	0.00	0.00	0.00	0.00
Net in-migration (000's)	--	--	--	--	--
Price of value added:					
Manufacturing	-0.59	-0.59	-0.59	-0.60	-0.60
Non-Manu traded	0.12	0.10	0.02	0.00	0.00
Sheltered	0.03	0.02	0.00	0.00	0.00
Capital rental rates:					
Manufacturing	0.04	0.03	0.01	-0.01	-0.02
Non-Manu traded	0.35	0.30	0.07	-0.01	-0.01
Sheltered	0.15	0.12	0.01	-0.01	-0.02
Consumer price index	0.01	0.01	-0.01	-0.02	-0.02
Value-added:					
Manufacturing	0.61	0.61	0.63	0.64	0.64
Non-Manu Traded	0.07	0.09	0.18	0.20	0.21
Sheltered	0.04	0.05	0.07	0.08	0.08
Commodity Output:					
Manufacturing	0.51	0.51	0.53	0.54	0.54
Non-Manu Traded	0.08	0.10	0.18	0.20	0.21
Sheltered	0.04	0.05	0.07	0.08	0.08
Capital stocks:					
Manufacturing	0.00	0.00	0.03	0.04	0.04
Non-Manu Traded	0.00	0.03	0.16	0.21	0.21
Sheltered	0.00	0.01	0.07	0.08	0.08
Exports to RUK:					
Manufacturing	0.53	0.53	0.54	0.54	0.54
Non-Manu Traded	-0.17	-0.14	-0.03	0.00	0.01
Sheltered	-0.05	-0.04	-0.01	0.00	0.00
Nominal income:					
Households disposable	0.08	0.08	0.09	0.09	0.09
Firms disposable	0.18	0.17	0.13	0.12	0.12
Firms disposable	0.18	0.17	0.13	0.12	0.12

Figure 3.3.7: Percentage changes in GDP, manufacturing exports, capital stocks and value-added prices, relative to base year values, for a 0.6% Hicks-neutral increase in efficiency in manufacturing, with national bargaining.

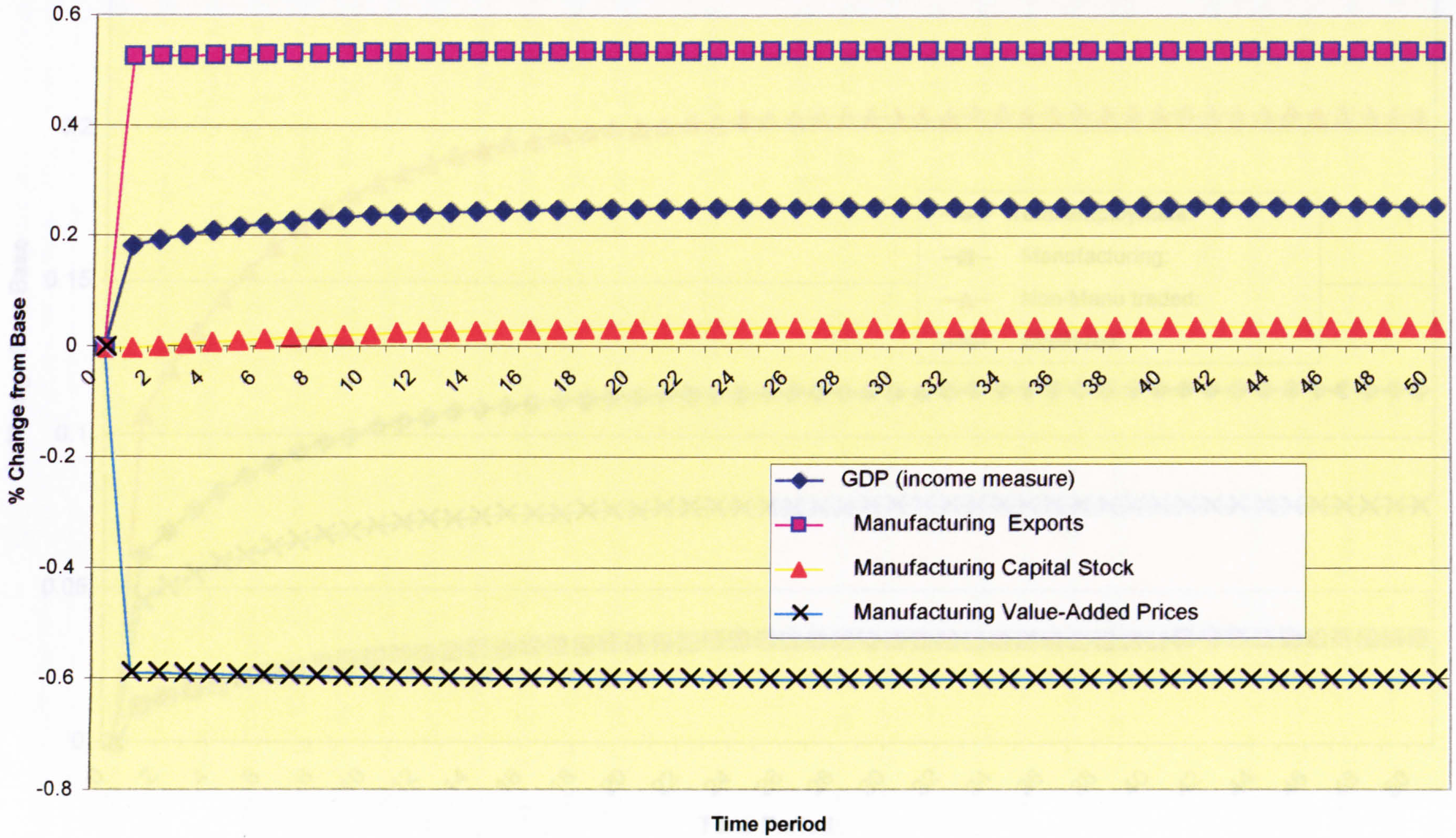
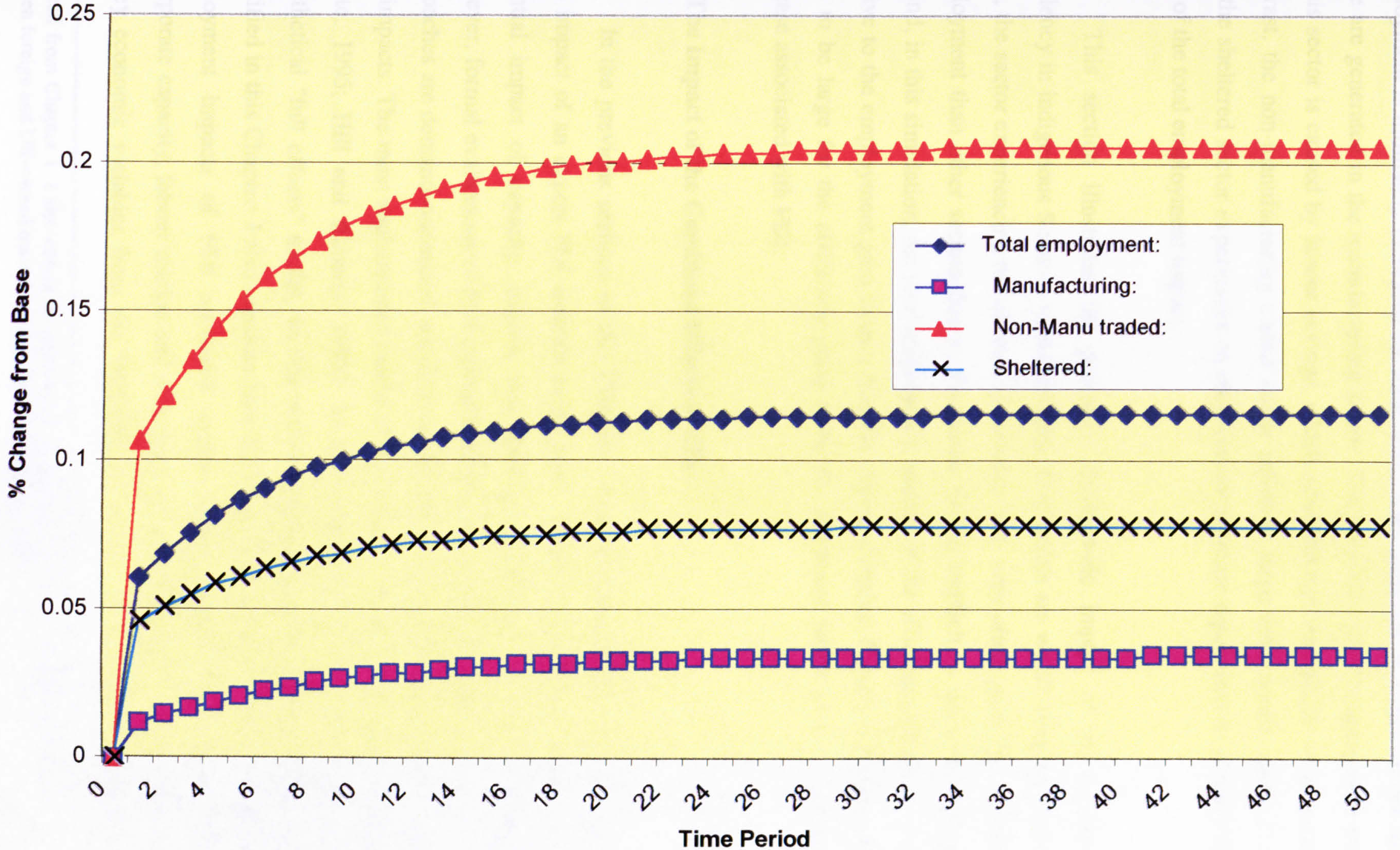


Figure 3.3.8: Absolute changes in total and sectoral employment, relative to the initial base values, for a 0.6% Hicks-neutral increase in efficiency.



The efficiency stimulus has a positive employment impact in all sectors. Total employment is ultimately increased by some 2,612 jobs, although less than 10 per cent of these are generated in the manufacturing sector. The relatively small employment impact in this sector is caused by labour savings, which arise through the efficiency stimulus. In contrast, the non-manufacturing traded sector achieves large employment gains (1,741) and the sheltered sector experiences an employment increase equivalent to around 25 per cent of the total employment impact.

This section illustrates the potential system-wide impact of an increase in efficiency in indigenous Scottish manufacturing. Two points are worth stressing however. First, the sector experiencing the efficiency stimulus will, very often, gain less in terms of employment than other sectors due to the labour saving implicit in the efficiency gain. Second, in this simulation, the total employment impact of the efficiency stimulus is small relative to the employment gain from a feasible export stimulus. Clearly diffusion effects have to be large for the efficiency gains to be the dominant factor in the employment increase associated with FDI.

3.6. The Impact of the Combined Effects of FDI.

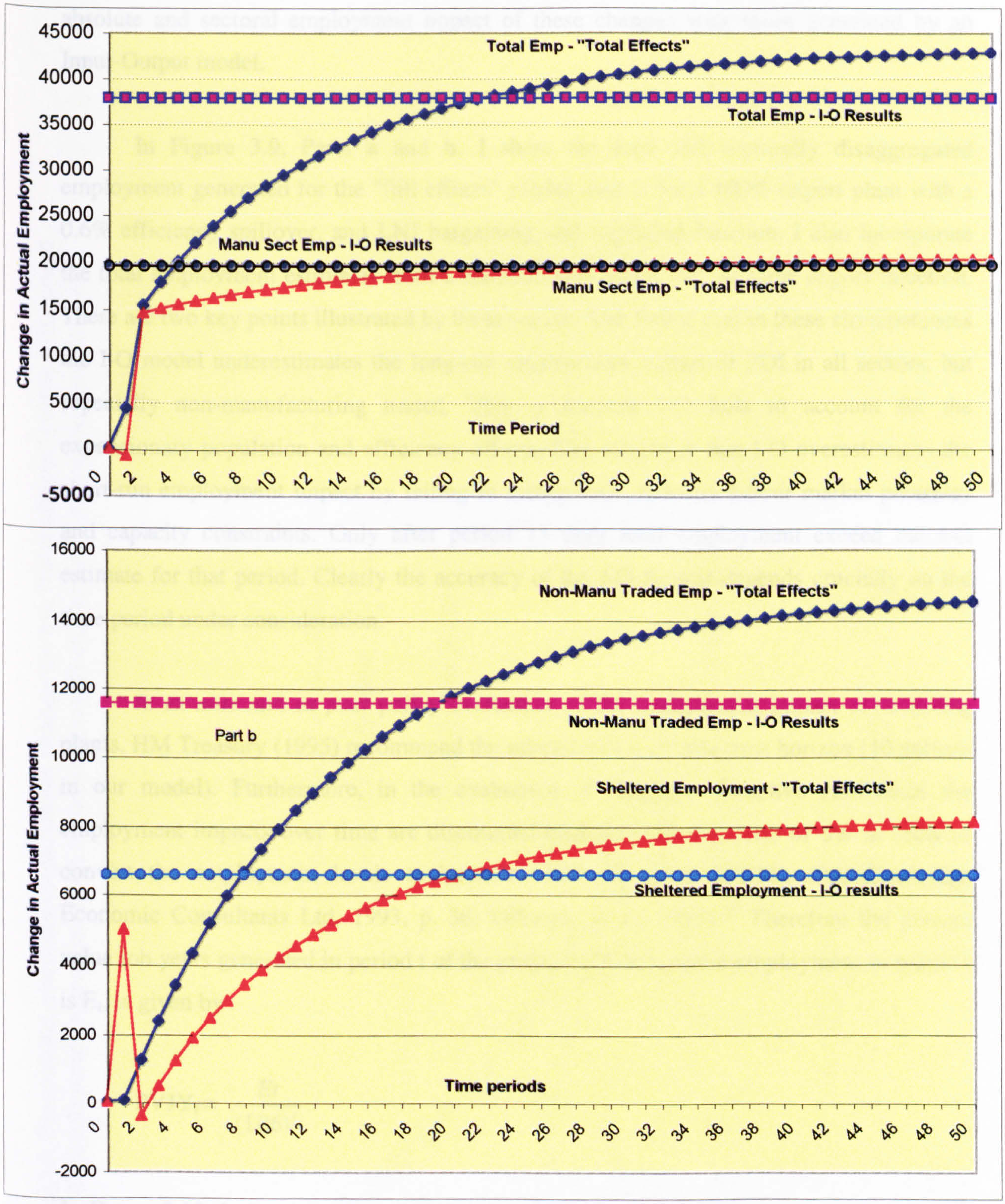
In the previous sections of this Chapter, I have considered the potential system-wide impact of an export FDI manufacturing plant. In particular, I have considered the potential impact of capacity, export, wage-setting, migration and efficiency effects. However, formal evaluations of FDI typically neglect many of these effects because these approaches are demand-orientated, which severely restricts their ability to analyse supply-side impacts. The most sophisticated model of this type is I-O analysis (e.g. Alexander & Whyte, 1995; Hill and Roberts, 1995). In this section, I simulate the impact of a hypothetical "full effects" model. In this model I simultaneously impose all the effects identified in this Chapter. I also consider how accurately an I-O model would estimate the employment impacts of FDI measured against more general CGE models which incorporate capacity, labour market and efficiency effects. Table 3.6.1 reports the change in key economic variables from the "full effects" model and Figure 3.9 compares the

[14] Recall from Chapter 1, I also obtain an estimate of 20 per cent for the ownership differences that exist between foreign and UK-owned manufacturing plants in Scotland, 1989.

Table 3.6.1: Impact of the "Total Effects" Model: 100% Export FDI Plant and 0.6% Hicks Neutral Efficieny Shock with LNJ Regional Bargaining and Migration Functions.

	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.17	0.83	1.41	1.87	2.03
Consumption	0.37	1.09	1.47	1.77	1.88
Investment	5.48	1.13	1.64	1.89	1.97
Nominal before-tax wage	0.34	0.94	0.37	0.08	-0.02
Real B-Tx consumption wage	0.17	0.55	0.19	0.05	0.01
Total employment (000's):	0.19	0.68	1.30	1.74	1.90
Manufacturing:	-0.14	2.76	3.27	3.67	3.81
Non-Manu traded:	0.01	0.15	0.93	1.51	1.72
Sheltered:	0.57	-0.05	0.48	0.81	0.92
Unemployment rate (%)	-1.45	-4.73	-1.63	-0.43	-0.06
Labour participation rate (%)	0.04	0.14	0.05	0.01	0.00
Total population (000's)	0.00	0.06	1.09	1.68	1.89
Net in-migration (000's)	475981.8	1861164.32	1149538.69	--	--
Price of value added:					
Manufacturing	0.23	0.15	-0.18	-0.49	-0.61
Non-Manu traded	0.35	1.10	0.56	0.14	-0.01
Sheltered	0.65	0.92	0.41	0.09	-0.02
Capital rental rates:					
Manufacturing	-0.14	0.14	0.58	0.19	0.00
Non-Manu traded	0.36	1.43	0.96	0.28	0.01
Sheltered	2.25	0.78	0.60	0.15	0.00
Consumer price index	0.18	0.39	0.18	0.03	-0.02
Value-added:					
Manufacturing	-0.11	3.43	3.88	4.29	4.44
Non-Manu Traded	0.00	0.10	0.88	1.49	1.71
Sheltered	0.47	-0.04	0.47	0.80	0.92
Commodity Output:					
Manufacturing	-0.07	3.46	3.85	4.20	4.33
Non-Manu Traded	0.03	0.19	0.92	1.50	1.71
Sheltered	0.49	-0.01	0.48	0.81	0.92
Capital stocks:					
Manufacturing	0.00	3.00	3.21	3.64	3.81
Non-Manu Traded	0.00	0.00	0.76	1.45	1.71
Sheltered	0.00	0.00	0.41	0.78	0.92
Exports to RUK:					
Manufacturing	-0.21	4.14	4.45	4.74	4.85
Non-Manu Traded	-0.51	-1.59	-0.82	-0.21	0.01
Sheltered	-1.18	-1.65	-0.74	-0.17	0.03
Nominal income:					
Households disposable	0.55	1.48	1.66	1.80	1.86
Firms disposable	0.70	1.66	1.93	1.96	1.97
Firms disposable	0.70	1.66	1.93	1.96	1.97

Figure 3.39 - Absolute and sectoral employment change for the "total effects" (100% FDI export plant and 0.6% efficiency stimulus with LNJ labour market closures and migration function) and I-O estimates.



absolute and sectoral employment impact of these changes with those generated by an Input-Output model.

In Figure 3.9, Parts **a** and **b**, I show the total and sectorally disaggregated employment generated for the "full effects" model, that is for a 100% export plant with a 0.6% efficiency spillover, and LNJ bargaining and migration function. I also incorporate the total employment estimates from a standard I-O model for the same export injection. There are two key points illustrated by these results. The first is that in these circumstances the I-O model underestimates the long-run employment impact of FDI in all sectors, but especially non-manufacturing traded. This is because I-O fails to account for the expansionary population and efficiency effects. The second is that I-O overestimates the short-run employment impact by failing to incorporate short-run labour market pressures and capacity constraints. Only after period 15 does total employment exceed the I-O estimate for that period. Clearly the accuracy of the I-O figures depends crucially on the time period under consideration.

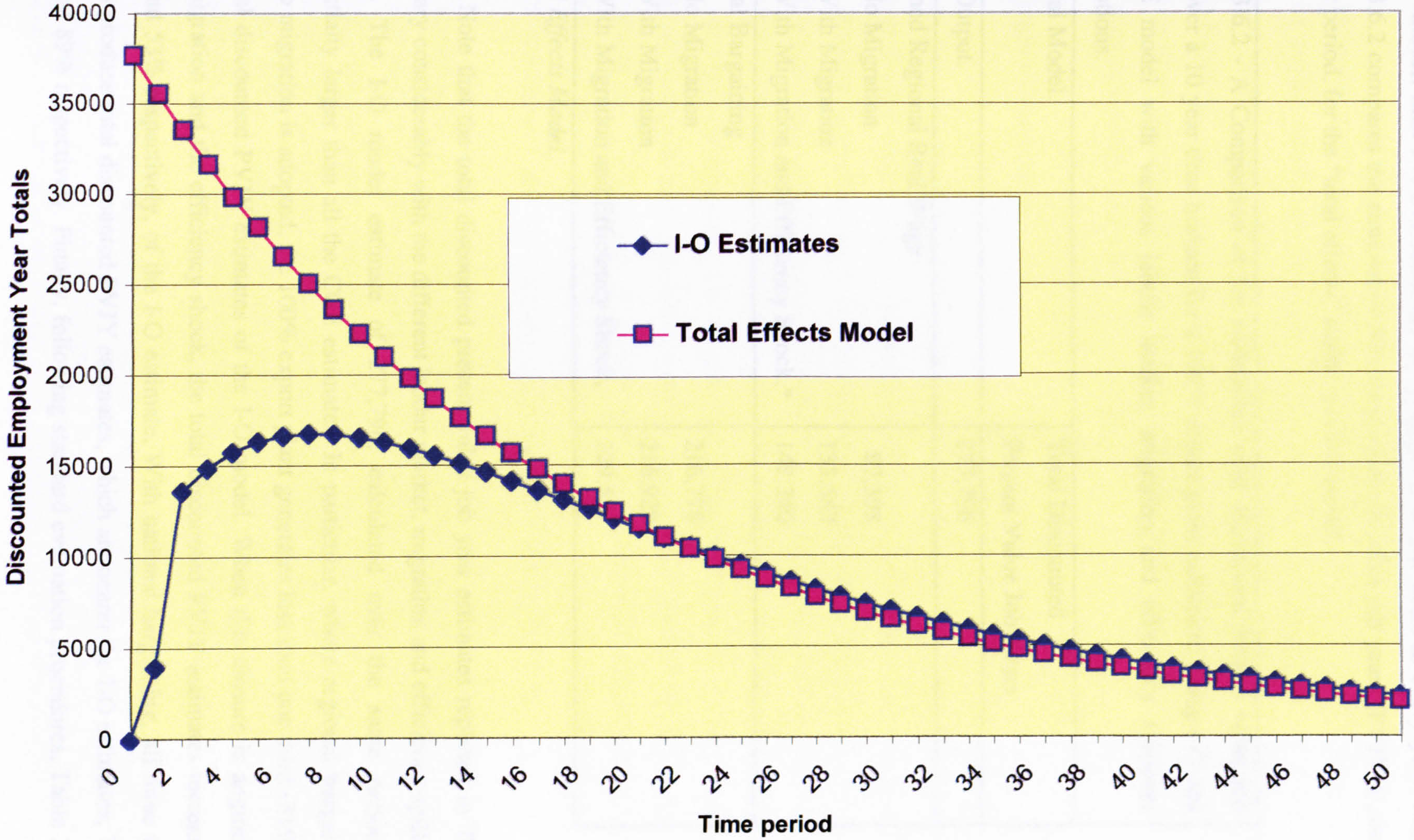
In *ex ante* and *ex post* policy evaluation of the employment impact of incoming plants, HM Treasury (1995) recommend the adoption of a 10 year time horizon (10 periods in our model). Furthermore, in the evaluation of Regional Selective Assistance the employment impacts over time are discounted back at a discount rate of 6% in order to convert the employment levels to 'present value job years' (PVJY) (PA Cambridge Economic Consultants Ltd, 1993, p. 38; Gillespie *et al*, 1998).[15] Therefore the present value job years generated in period t of the project ($PVJY_t$), where employment in period t is E_t, is given by

$$PVJY_t = \frac{Et}{(1.06)^t}.$$

In Figure 3.10, I plot the value of $PVJY_t$ for each year for both the "total effects" model, and an I-O estimate. (Note that the figure given for any particular year is the value for that year only, not the cumulative total up until that year.)

[15] Gillespie, McGregor, Swales and Yin (1998) provide a CGE analysis of the evaluation of the impact of RSA induced employment in Scotland, 1989.

Figure 3.3.10: Discounted absolute employment change for the "total effects" (100% FDI export plant, a 0.6% efficiency stimulus, and LNJ labour market closure and migration function) and comparable I-O estimates.



It is clear from Figure 3.3.10 that if we take a 10 year time horizon and the true model, in terms of the range of FDI impacts and labour market conditions, is the "total effects" model, then I-O overestimates the present value job years in every year. Finally, Table 3.6.2 compares the cumulative discounted present value job years (PVJY's), over a 10 year period, for the "total effects" model and I-O model.

Table 3.6.2 - A Comparison of the cumulative total discounted present value job years over a 10 year time horizon for a 100% export plant calculated using I-O and a CGE model with various labour market, migration and efficiency spillover assumptions.

Regional Model.	Total Discounted Present Value Job Years
Input-Output.	277,796
Bargained Regional Real Wage	
No Migration	87,398
With Migration	135,582
With Migration and Efficiency Shock.*	148,340
National Bargaining	
No Migration	216,778
With Migration	216,928
With Migration and Efficiency Shock.	229,551

* *Total Effects Model.*

Note that the total discounted present value job year estimates reported in Table 3.6.2 vary considerably with the different labour market, migration and efficiency spillover effects. The I-O model estimate of 277,796, calculated over the same period, is substantially larger than all the CGE estimates. In particular, where regional bargaining with no migration is adopted, the 100% export plant generates less than one third (31%) of the total discounted PVJY estimates of the I-O model. When this closure is augmented with migration and the efficiency shock, the total discounted PVJY estimates increase to 49% and 53% respectively, of the I-O estimate. With national bargaining, all three CGE options produce total discounted PVJY estimates, which are nearer the I-O estimates; 78%, 80% and 89% respectively. Finally, following standard evaluation procedures, Table 3.6.2

highlights the important role that supply-side impacts can have on the estimated total discounted PVJY's. Note that radical differences arise even when the long-run equilibria are the same between models.

However, recall from the earlier discussion that the speed of adjustment in the period by period simulations in the AMOS model is determined by the parameter and adjustment values used in the calibration of the capital stock, investment and population updating equations. Accordingly, in terms of policy recommendations, the adjustment path implied by these results should be viewed as illustrative as these adjustment values are not wholly econometrically estimated.

3.7 - Chapter Conclusions.

In this chapter, I have used a CGE model to examine the potential system-wide impacts of inward investment on the recipient region. In particular, I have identified the effects working through: changes in capacity; the expansion of exports; the impact on regional wage-setting and migration; and efficiency spillovers. However, in this analysis I was unable to accommodate certain key structural differences in the production process which are typically exhibited by foreign and domestically-owned plants, which are normally, at least to some extent, incorporated in demand-side approaches (Hill & Roberts, 1995). Moreover, I have had to assume that the behavioural characteristics of all manufacturing plants are identical. Clearly, from the earlier discussion of the FDI literature, in chapter 1, this assumption is particularly difficult to motivate.

However the novelty of the analysis in this Chapter is in the attempt to quantify the supply-side impacts of FDI which are typically ignored in both academic and government-sponsored, demand-based evaluations. Moreover, the strong assumptions required to motivate the FDI simulations in this Chapter are apparent in the FDI literature (Alexander & Whyte, 1995). Accordingly the analysis in this chapter should be viewed as complementary to the existing more standard demand-side approaches.

Accepting these important limitations and those implicit in CGE modelling, the chapter simulations are however informative in a number of important areas. Note that bargaining in the regional labour market has a potentially important effect on the time path of the increase in regional employment. Therefore, if inward investment does put upward pressure on wages, significant labour-market displacement is likely to occur, at least in the short-run. Moreover, the admittedly speculative estimates of impacts arising from efficiency spillovers from externally-owned plants, provides employment effects which are markedly lower than those associated with plausible export injections accompanying inward investment. The induced employment impacts from efficiency spillovers are typically larger in other sectors, due to implicit labour savings, than the sector that benefits directly from the shock.

The comparison of the employment effects generated by the "total effects" model, and a variety of CGE closures, against an I-O evaluation, provides some interesting results. Thus, in such a scenario, I-O overestimates the employment effects in the short to medium run but underestimates these effects in the long-run. Even adopting the 10 year time horizon recommended for official evaluations, the use of I-O significantly overestimates the total discounted present value job years for the incoming FDI plant. However, more importantly, by using an I-O model we are restricted to only demand-side impacts.

In conclusion, this chapter has sought to identify the potential use of CGE analysis for evaluating the potential impact of FDI. Although partial, in terms of incorporating the implicit structural and behavioural characteristics of foreign-owned plants, the CGE framework can identify system-wide impacts that are typically neglected in traditional demand-side approaches.

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CHAPTER 4 - Construction of an Ownership-Disaggregated Input-Output Table for Scotland (1989).

4.1. Introduction

The previous chapter provided an overview of the use of the CGE model AMOS to evaluate the system-wide impact of foreign direct investment in Scotland. One of the major limitations of the analysis is that the model database did not distinguish or capture the key structural characteristics of both foreign and UK-owned manufacturing firms within the model. In this chapter I outline how I construct an ownership-disaggregated I-O Table that is based on the original Scottish I-O Table for 1989. The published I-O accounts for Scotland for 1989 provide the main source of data for the Social Accounting Matrix (SAM) used in the AMOS model. A full survey-based Scottish I-O Table is now published every five years. However, these published I-O accounts do not distinguish production sectors by ownership (HMSO, 1994; 1997).

The only other I-O table that I am aware of that has some form of ownership-disaggregation is the Welsh I-O Table for 1993 that was constructed by Hill and Roberts (1995). However, the ownership-disaggregation (foreign-owned sectors in the Welsh I-O table) relate only to a small sample of inward investors i.e. 25 per cent of foreign-owned manufacturing plants in Wales. The approach used in the construction of the Welsh I-O Table is discussed in the following section. Section 4.2 and 4.3 provide an overview of the methodology and strategy I follow in the construction of the I-O Table. Section 4.4 details the construction of the Table which is split into three main sub-sections: Value Added, Final Demands and Intermediate Block. Section 4.5 provides a short conclusion. The final section discusses the different data sources used in the analysis.

4.2. - Overview of Methodology and I-O Model Construction.

4.2.1 - Methodological issues relating the construction of regional I-O Tables.

There is an extensive I-O literature relating to the construction of regional I-O

Tables using both partial and non-survey methods. Richardson (1985) provides a comprehensive review of this literature. The approach I follow combines both survey-based data with non-survey techniques. I use the Scottish Input-Output Table for Scotland (1989) as my main database and I draw on relevant Scottish data sources that are disaggregated by ownership, to augment this framework. At the time of undertaking this project, the Scottish Input-Output Tables for 1989 was the most recent full survey-based I-O table. The Scottish Input-Output tables for 1994 have only recently been made available (HMSO, 1997). However, at present the additional ownership-disaggregated Scottish data sources that I used to construct the ownership-disaggregated Scottish I-O Table for 1989 are currently not available for the 1994 I-O Table. For instance, the results from the manufacturing trade flow survey data for 1994 are not in the public domain.

Initially, I explored the possibility of using the Welsh I-O data, from the Table constructed by Hill and Roberts (1995), in the construction of the ownership-disaggregated Scottish I-O Table. The Welsh I-O table is derived from the UK I-O table 1990, which was regionalised to Wales, and re-based to 1993 prices. The disaggregation of Welsh manufacturing by ownership is based on a survey of 25% of foreign-owned plants in Wales in 1993. The Welsh I-O Table consists of seven sectors, with three of these sectors covering manufacturing. The three manufacturing sectors in the Table are disaggregated between 'indigenous' and foreign-owned (or inward investors). However, the three foreign-owned sectors relate only to the sample of 'inward investors' and not the actual scale of foreign-ownership in that particular sector. However, as these data related to a recent survey of 'inward investors' in Wales I considered using these data to provide information for Scottish based multinationals in similar sectors in Scotland.

Using an approach developed in the I-O literature (Isard & Romanoff; 1968; Tiebout; 1969; Hewings 1977 and Richardson, 1985), it is possible to use coefficients from a similar table (Welsh I-O Table) in the construction of a Table for a another (similar) region. This approach was developed in the US to generate or explore the possibilities for utilising survey-based input-output models developed for one State or region in another. The approach involves using coefficients from a survey-based Table in conjunction with some local survey data or control totals and a RAS type adjustment procedure. The motivation for the development of partial and non-survey techniques stems from the costs and time incurred in construction of regional I-O Tables.

The results from these studies indicated that borrowing regional coefficients is possible although much of the success depends on how accurate the other components of the Input-Output Table are as the rows and columns are balanced using a RAS type adjustment method[1] (Hewings, 1977; Thumann; 1978). Using this method, the control totals (or additional survey-based data) are particularly important as the 'borrowed' coefficients are adjusted to conform with these totals. The reliability of such a method increases in proportion to the amount of other information available. Using the Welsh coefficients with Scottish I-O control totals, derived from ownership-disaggregated Scottish ACOP data for the foreign-owned sectors, provided one method. However, I rejected this approach for the ownership-disaggregated Scottish I-O Table because of a number of factors that related specifically to the Welsh data and constructed I-O Table.

The Welsh coefficients applied to the Scottish I-O Table aggregated to the same format, generated results which where markedly different from the Scottish control totals for these sectors, that were based on ownership-disaggregated Scottish survey-data. This essentially was because the actual foreign-owned sectors in the Welsh I-O Table did not consist of all foreign-owned plants in Wales. Instead the foreign sectors related only to the sample of foreign investors in that sector, with the remaining foreign-owned sectors included with the 'indigenous' sectors firms. The survey entailed 25% of foreign-owned plants in Wales. However, the results were not grossed up to represent the actual scale of these sectors in the Table. Therefore, the coefficients from the foreign-owned sectors in the Welsh table related only to surveyed 'inward investors'. The indigenous component of each manufacturing sector also consisted of foreign-owned plants.

The Welsh I-O Table was constructed essentially to highlight the importance of linkages and regional sourcing for inward investors. It is not an ownership-disaggregated I-O Table in the sense that it does not consider all foreign-owned manufacturing in Wales or even capture the aggregate scale of the sector. Instead it incorporates a disaggregation

[1] This is a mechanical, iterative procedure, which involves balancing firstly the rows and then the columns of the matrix. As each row and column are balanced, the other rows and columns no longer balances and so this process continues until the row and columns move closer together. After a number of iterations they

based more on an organisation type, .i.e. a small sample of inward investors in Wales, rather than trying to actually model or capture the foreign-owned manufacturing sector separately. Moreover, in order to use the Welsh coefficients in the ownership-disaggregated Scottish I-O Table I had to adopt the same sectoral classification as the Welsh I-O Table which consisted of three broad manufacturing sectors. This was considered too aggregate to capture fully the structural diversity of the foreign-owned manufacturing sectors in Scotland.

Finally, Scotland is better served in terms of available regional data. For instance, the Scottish Input-Output Tables are published regularly by the Scottish Office, whereas Hill & Roberts (1995) had to use the UK I-O Table for 1990 as their starting point, and then regionalise this Table to Wales.[2] There also appears to be better secondary data in Scotland because of the process of regularly constructing and updating Input-Output Tables. The main attraction of the Hill & Roberts (1995) Table was that it did incorporate a partial survey of inward investors in their Table as well as attempting some form of ownership-disaggregation. However, the Table did not capture or reflect the aggregate foreign-owned manufacturing sector in Wales. Accordingly, my approach is to use the existing survey-based Scottish I-O Table for Scotland for 1989 and augment this by using additional Scottish data (rather than the Welsh coefficients) as is discussed in the following section.

4.2-2 – Overview of Model Construction.

The main data-base for the ownership-disaggregated Scottish I-O table is the Scottish I-O table for 1989 (HMSO, 1994). This table consists of 114 industrial sectors. Within each sector the information comprises survey-based data for both UK-owned and foreign-owned plants. I begin by arithmetically aggregating these data to eleven industrial sectors: seven manufacturing and four non-manufacturing. The level of aggregation of the ownership-disaggregated Scottish data was dictated, primarily, by the sectoral aggregation

eventually converge and balance.

[2] The Welsh Input-Output Tables for 1994 are now available and published by the University of Wales Press, Cardiff. These Tables do not distinguish production sectors by ownership and are derived from the UK Input-Output Tables for 1990, which are updated to 1994 and regionalised and adjusted to Wales using Welsh survey data (Hill & Roberts; 1996). However, this process should improve the reliability of such tables.

of the additional ownership-disaggregated Scottish data. The aggregation scheme is reported in Table 4.1.

Table 4.1 - Sectoral aggregation for the ownership-disaggregated Scottish I-O Table (1989).

	Industrial Sectors in Ownership-disaggregated Scottish I-O Model.	Original I-O Groupings (1989)	Standard Industrial Classification 1980. (2 digit level)
1	Agriculture	1-5	01,02 & 03
2	Energy + Water	6-11	15, 16 &17
3	Chemicals	22-30	25 & 26
4	Food Drink Tobacco	58-71	41 & 42
5	Textiles & Clothing	72-83	43-45
6	Mechanical Engineering	35-43	32
7	Electronics & Inst. Eng.	44-52 & 57	33, 34 & 37
8	Paper, Printing & Publishing	84-86	47
9	Other Manufacturing	12-21, 31-34, 53-56 & 87-89	11-14, 21-24, 31, 35&36, 46, 48&49.
10	Construction	90	50
11	Services	91-114	61-67, 71, 72, 74, 76, 77, 79, 81-85, 91-99.

The third column of Table 4.1 shows the numbering or I-O groupings for the sectors following the Scottish 1989 I-O table classification. The fourth column shows these sectors using the 1980 standard industrial classification (SIC) at the two digit level.

In this analysis, when I use the term sector I mean one of these industrial sectors. I disaggregate each of the seven manufacturing sectors into two divisions on the basis of ownership: UK-owned and foreign-owned. The definition of foreign-owned manufacturing followed in this analysis refers to all manufacturing companies in Scotland in which an overseas-owned company holds more than 50% of its share capital, (Scottish Office, 1995). This is the same definition of foreign-ownership that is used by the Annual Census of Production (ACOP) and covers both foreign direct investment (FDI) and takeovers of indigenous companies by overseas-owned companies. However, as noted in chapter 1, there are alternative definitions of what determines foreign ownership. For instance, the OECD uses 10% of share capital to indicate that a company is overseas owned. Other studies have used the location of the headquarters of the company as an indicator of the origin of the company. Essentially as the disaggregation uses ownership-disaggregated

ACOP data, this is the implicit definition used in this analysis.

The ideal approach to the construction of the seven foreign-owned manufacturing divisions would entail a census or a survey of foreign-owned manufacturing plants in those sectors. The survey data would provide detailed linkage and sourcing information that would augment the existing survey-based data from the original Scottish I-O table. However, a full survey of foreign-owned manufacturing activity is not feasible given resource constraints and the time lag from 1989. Furthermore, it is not possible to separate out the original 1989 survey data between domestic and foreign-owned manufacturing plants. Therefore I use Scottish Annual Census of Production (ACOP) and Manufacturing Trade Flow Survey (MTFS) data that are disaggregated by ownership to disaggregate the 1989 I-O table by ownership. Before detailing the actual construction of the Table, I illustrate the general approach and principals I follow.

For convenience, I start by re-ordering the aggregated Scottish I-O Table by putting the manufacturing sectors together, followed by the non-manufacturing sectors. This provides a clearer framework for explaining the disaggregation process. Table 1 provides a schematic overview of the ownership-disaggregated Scottish I-O table and can be viewed in terms of two aggregate sectors (manufacturing and non-manufacturing) and three main components: intermediate flows (A), value added (V) and final demands (F).

Table 4.2 - Outlay of the ownership-disaggregated Scottish I-O Table (1989).

	Manufacturing	Non-Manufacturing	TIS	Fin Demand	GO
Manufacturing	A_{mm} (14 * 14)	A_{mn} (14 * 4)	TISm (14 * 1)	F_m (14 * 3)	GOm (14 * 1)
Non-Manufacturing	A_{nm} (4 * 14)	A_{nn} (4 * 14)	TISn (4 * 1)	F_n (4 * 3)	GOnm (4 * 1)
TID	TIDm (1 * 14)	TIDn (1 * 4)	TID	Tot IFD (1* 3)	TGO
Value-Added	V_m (3 * 14)	V_n (3 * 4)	TIVA (1 * 3)	Z (3 * 3)	VA (1 * 3)
GI	GIm (1 * 14)	GIn (1 * 4)	TGI	TFD (1 * 3)	X

Where:

A_{mm} - 14 by 14 matrix of intermediate flows from manufacturing sectors to manufacturing sectors.

A_{mn} - 14 by 4 matrix of intermediate flows from manufacturing to non-manufacturing sectors.

A_{nm} - 4 by 14 matrix of intermediate flows between the non-manufacturing and manufacturing sectors.

A_{nn} - 4 by 4 matrix of intermediate flows from the non-manufacturing sectors to the non-manufacturing sectors.

FD - Final demands for sectors, includes consumer expenditure, other final demand and exports.

Fm - 14 by 3 matrix of final demands for the manufacturing sectors.

Fn - 4 by 3 matrix of final demands for the non-manufacturing sectors.

GI - Gross Inputs consists of total intermediate demand and total primary inputs.

GI_m - Vector of gross inputs for the manufacturing sectors

GI_n - Vector of gross inputs for the non-manufacturing sectors

GO - Gross Output consists of total intermediate sales and total final demand.

GO_m - Vector of gross outputs for the manufacturing sectors.

GO_n - Vector of gross outputs for the non-manufacturing sectors.

Man - Seven manufacturing sectors each disaggregated by ownership.

N-Man- Four non-manufacturing sectors

TFD - Total final demands for all sectors.

TGO - Total Gross Outputs for all sectors.

TGI - Total Gross Inputs for all sectors.

TID - Total Intermediate Demand (purchases of intermediate inputs) by sectors.

TID_m - Vector of total intermediate demands for the manufacturing sectors.

TID_n - Vector of total intermediate demands for the non-manufacturing sectors

TIFD - Total final demands for all intermediate goods.

TIS - Total Intermediate Sales (sales of intermediate inputs) by sector.

TIS_m - Vector of total intermediate sales for the manufacturing sectors

TIS_n - Vector of total intermediate sales for the non-manufacturing sectors

TIVA - Total value added for all intermediate goods.

TVA - Total value added for all sectors.

VA - Value added includes intermediate imports, income from employment and other value added.

Vm - 4 by 14 matrix of value added components for the manufacturing sectors

Vn - 4 by 4 matrix of value added components for the non-manufacturing sectors

X - Total Output.

Z - Final Demands for value added components i.e. imports etc.

The strategy I adopt in constructing the ownership-disaggregated Scottish I-O Table is that where entries are for non-manufacturing or flows between non-manufacturing sectors these data remain unchanged. These data are represented by the shaded area in Table 4.2 and include the matrices A_{nn}, V_n, F_n and Z. The data in the remaining sections must be disaggregated by ownership division. In disaggregating these matrices (A_{mm}, A_{nm}, A_{mn}, V_m and F_m), where an entry in any cell or row or column total of the original I-O table is disaggregated by ownership, the entries for the two divisions must sum to the original entry. That is to say, the combined totals for both the foreign and UK-owned components of each manufacturing division must sum to the original I-O values for the sector as a whole. This constraint maintains the integrity of the original I-O table. In the ownership-disaggregated I-O table the A_{mm} matrix is disaggregated by column and row, the A_{nm} matrix and value added matrix V_m are just disaggregated by column and the A_{mn} matrix and final demand matrix F_m are disaggregated by row.

Of the four components of Table 4.2, the value added section (V_m) is perhaps the most important part and it is this section that I have the most additional data for, i.e. Scottish I-O, ACOP and MTFS data. I start by generating the gross input (output) totals for the UK and foreign-owned manufacturing divisions in both the value added and final demand sections (GI_m and GO_m). These provide the control totals for the ownership-disaggregated manufacturing sectors and are calculated by applying gross output shares by ownership, obtained from ACOP, to 1989 I-O table aggregates. From the ownership-disaggregated input totals, I disaggregate the remaining components of the value added matrix (that includes total intermediate demands) using ACOP and MTFS data. The MTFS data is used to identify the share of total purchases for each manufacturing division that are accounted for by local intermediate purchases and imported intermediates. The ownership-disaggregated estimates for total intermediate demand (TID_m) are subsequently used as control totals in the intermediate flows section (A) of the table.

The final demands section (F_m) of the table (including total intermediate sales) are disaggregated by ownership using ACOP data. The intermediate sales totals (TIS_m) that are estimated in this section are used as control totals in the intermediate flows section (A), that captures the linkages both within and between manufacturing and non-manufacturing sectors. These intermediate linkages are captured in four matrices: A_{mm}, A_{mn}, A_{nm} and A_{nn}. The dimensions of these matrices reflect the aggregation of manufacturing and non-manufacturing within the ownership-disaggregated Scottish I-O Table. The intermediate linkages for these sectors are generated using the totals for intermediate demand and sales that were calculated in the value added and final demands sections. A full discussion of the different adjustment methods and data sources that are used to generate the ownership-disaggregated Scottish I-O table are illustrated in the proceeding sections of this chapter.

4.3 – Model Construction.

The ownership-disaggregated table is based on the Scottish I-O table for 1989 (HMSO, 1994), which is the main database. This table is constructed using Scottish survey data for 1989 which includes a sample of all plants (including foreign-owned) in Scotland, Scottish ACOP, MTFS and other data sources. Volume 2 of the Scottish Input-output Tables for 1989 details the sources and methods used by the Scottish office in constructing the table (HMSO, 1994). The two ownership-disaggregated Scottish data sources I use to disaggregate the manufacturing sectors by ownership are:

1. Scottish Annual Census of Production (ACOP) data, for 1989, provide disaggregated data that relate specifically to the Scottish I-O groupings and provide information on the value of gross output, other value added, wages and salaries and total purchases for the seven indigenous and foreign-owned manufacturing divisions. The ACOP data are available (subject to disclosure restrictions) at the same level of aggregation as the full Scottish I-O table for 1989.
2. The Manufacturing Trade Flow Survey (MTFS), for 1989, provides information relating to the proportion of total purchases sourced within Scotland by indigenous and foreign-owned plants for the seven manufacturing sectors outlined in the ownership-disaggregated Scottish I-O table. The MTFS (1989) is the only Scottish data source for 1989 that considers explicitly the purchasing behaviour of foreign and UK-owned plants in Scotland. To maximise the use of this survey, the ownership-disaggregated I-O table has adopted the same sectoral aggregation as that used in the MTFS.

The presentation of the model construction follows the outline provided in the schematic overview (Table 4.2). The three main components of the Table are the value added (V_m), final demands (F_m) and intermediate flows sections (A_{mm}, A_{mn} & A_{nm}). Each adjustment method is discussed in detail at the appropriate section. I now deal with each in turn.

4.3-1 - Value Added Matrix (V_m).

The value added (payments) matrix consists of total intermediate demand (TID), imports, wages and salaries and other value added,[3] as is shown in Table 4-3 below. The task here, as in all three sections, is to disaggregate the original Scottish I-O data between the indigenous and foreign-owned division of each manufacturing sector. The data in the non-manufacturing sectors remain unchanged (V_n). For this section I use two different adjustment methods and data sources. The ACOP data for gross output, wages and salaries and other value added are used to disaggregate these I-O values in each sector. The manufacturing trade flow survey (MTFS) provides data on the proportion of total purchases that are allocated to imports and total intermediate demand for each manufacturing division.

Table 4-3 - Value Added (payments) sector of ownership-disaggregated Scottish I-O Table.

	Chemicals		Food D &T		Text & Cloth		Mech Engin		Elect & IE		PPP		Other Manuf		NON-MANUFACTURING				
	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	Agr	E+ W	Const	Serv	TID
TID	604		3264		808		650		791		472		1700		795	1944	1408	3591	16027
Imports	724		1413		740		625		3320		737		2045		290	2127	871	2021	14912
W+S	372		914		707		743		951		692		1496		403	910	1090	16721	24999
OVA	207		555		143		75		365		137		122		368	623	390	5770	8754
Total Inputs	1907		6145		2397		2094		5427		2038		5363		1855	5605	3758	28103	64692

As noted previously, the Scottish ACOP data, for 1989, are disaggregated by ownership and aggregated to the same format as the I-O groupings in the re-structured Scottish I-O Table (Table 4-1). However, the ACOP and Scottish I-O data differ otherwise the ACOP data could be used directly to provide the disaggregated values for these variables. The differences between the totals for the I-O and ACOP data are due to the

[3] The other value-added total consists of other value added, sales by final demand, taxes on expenditure and subsidies, from the original 1989 I-O Table. The sales by final demand row incorporate the sale and disposal of goods and services from final demand accounts. These goods are sold domestically to other industries and are viewed as an input into the production process of these industries (HMSO, 1994).

different collection methods employed. The differences are however relatively small and these are discussed in the data appendix of this chapter. This, in part, is why I adopted the Scottish I-O Table as the main data-base with these data essentially used as control totals.

In the first adjustment method, I use the ACOP data to provide shares for disaggregating the Scottish I-O data between the indigenous and foreign-owned divisions. For instance, taking gross output as an example, by applying gross output shares by ownership, obtained from ACOP, to 1989 I-O table aggregates I obtain the estimated output values for the indigenous and foreign-owned divisions of each of the seven manufacturing sectors. Formally, total output in the indigenous (XIO_i^{UK}) and foreign-owned (XIO_i^F) manufacturing divisions of sector i are calculated as follows:

$$XIO_i^{UK} = XIO_i\left[\frac{XACOP_i^{UK}}{XACOP_i}\right] \quad \text{and} \quad XIO_i^F = XIO_i\left[\frac{XACOP_i^F}{XACOP_i}\right] \quad (1)$$

Where XIO_i is the original Scottish I-O value for total output in manufacturing sector i, $XACOP_i$ is the total ACOP value for gross output in sector i and $XACOP_i^{UK}$ and $XACOP_i^F$ are the ACOP values for gross output in the UK and foreign-owned manufacturing divisions of sector i. The original Scottish I-O totals for wages and salaries and other value added in the seven manufacturing sectors are disaggregated between the indigenous and foreign-owned divisions in a similar manner. Recall that I impose the constraint that the values for gross output, wages and salaries and other value added for each manufacturing division must sum to the original I-O value for the sector. This is ensured given the chosen method of allocating the original I-O totals between the indigenous and foreign division of each sector. The results of applying this procedure are shown in Table 4.4.

Table 4.4 - The I-O values for total output, wages and salaries and other value added for the indigenous and foreign divisions of the seven manufacturing sectors (£m).

	Chemicals		Food D &T		Text & Cloth		Mech Engin		Elect & IE		PPP		Other Manuf	
	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For
TID														
Imports														
Total Purchases	840	488	4145	532	1311	236	922	353	703	3408	815	395	2813	932
W+S	246	126	815	99	643	64	565	178	481	470	485	207	1216	279
OVA	133	75	453	102	122	20	56	19	131	234	96	41	97	25
Total Inputs	1218	689	5413	733	2076	320	1544	550	1315	4112	1395	643	4126	1236

I next consider the method used to generate the estimated I-O values for total intermediate demand and imports in both divisions of the seven manufacturing sectors. First, total purchases can be calculated for each manufacturing division by subtracting the estimated wages and salaries and other value-added figures from total inputs for that division. These estimated I-O values are shown in Table 4.4. It should be noted that this procedure results in the estimated sectoral values for total purchases, that is the combined value of total purchases in both the indigenous and foreign manufacturing division of each sector, being equal to the corresponding original survey-based Scottish I-O values.

Total purchases equal total intermediate demand plus intermediate imports. These indicate the different sources of intermediate purchases by indigenous and foreign-owned manufacturing divisions in Scotland. Intermediate purchases are produced and sourced within Scotland while imports are produced outwith Scotland. Estimating these values accurately for the indigenous and foreign-owned manufacturing divisions is important as they have a significant impact on the relative size of sectoral multipliers, particularly the output multiplier. Moreover, these values are often used as a relative measure of how integrated or embedded a sector is within a region (Turok; 1993). However, there are no Scottish ACOP data that separately calculates imports and total intermediate demand for the indigenous and foreign-owned manufacturing divisions in Scotland.[4]

To calculate total intermediate demand and imports I use 1989 Scottish I-O, ACOP and MTFS data. For each manufacturing sector the problem is as identified in Table 4.5.

[4] Comprehensive statistics on the purchasing behaviour of foreign and UK-owned plants are not available. However, periodic studies of the electronics industry and its sourcing patterns have been undertaken by Scottish Enterprise National as part of their strategy for developing supplier networks in Scotland (Jackson & Patel, 1996).

The ownership-disaggregated control totals (Z_1 & Z_2) are taken from Table 4.4 where they were calculated using I-O and ACOP data. Control totals Z_3 and Z_4 are taken from the original 1989 Scottish I-O Table and represent the original I-O values for intermediate demand and imports for the sector as a whole.

Table 4.5 - Disaggregation of total purchases for each manufacturing sector.

	Manufacturing (UK)	Manufacturing (Foreign)	Original Sectoral I-O Value
Total Intermediate Demand	*a*	*b*	Z_3
Imports	*c*	*d*	Z_4
Total Purchases	Z_1	Z_2	

The values in Z_1 to Z_4 are therefore known for each Scottish manufacturing sector. The problem is to obtain values for the individual cells in Table 4.5. This is done using the MTFS data, which provides information on the purchasing behaviour of indigenous and overseas-owned firms in Scotland for 1989 (Statistical Bulletin No 1995/D2.5; Scottish Office Industry Department, 1995). However, the MTFS survey-data are not wholly representative of both indigenous and overseas-owned plants in Scotland and it is recommended as a general indicator of the relative purchasing behaviour of both sectors, rather than a definitive source (Jackson & Patel, 1996). However, the adjustment method I use is aimed at maintaining the integrity of the existing I-O data and would be followed regardless of the estimated accuracy of the MTFS data. The method is illustrated in Table 4.6.

Table 4.6 - Illustration of the method used to disaggregate total purchases between the indigenous and foreign-owned division of each manufacturing sector.			
	Indigenous Division	Foreign Division	Original Sectoral I-O Value
Total Intermediate Demand	$a = \left[\frac{\alpha Z_1}{\alpha Z_1 + \beta Z_2}\right] * Z_3$	$b = \left[\frac{\beta Z_2}{\alpha Z_1 + \beta Z_2}\right] * Z_3$	Z_3
Imports	$c = Z_1 - a$	$d = Z_2 - b$	Z_4
Total Purchases	Z_1	Z_2	

Where, α and β are the share of total purchases accounted for by total intermediate demand, for the UK and foreign-owned manufacturing divisions, as indicated by the Manufacturing Trade Flow Survey (MTFS) for 1989. I allocate the proportion of total purchases (αZ_1 & βZ_2) that intermediate demand accounts for, to the indigenous and foreign-owned division of each manufacturing sector, subject to the constraint that the sectoral values for intermediate demand and imports are equal to the original sectoral I-O values ($a + b = Z_3$: $c + d = Z_4$). Essentially, the estimated values for intermediate demand (αZ_1 and βZ_2) are used to determine the shares of sectoral intermediate demand that are allocated to each division. These shares are then used to distribute the original Scottish I-O value (Z_3) between the indigenous and foreign-owned divisions. Once the TID figures are calculated, the values for imports are determined.[5] Table 4.7 illustrates a numerical example from the ownership-disaggregated I-O table for the electrical and instrumental engineering (E&IE) sector.

[5] It makes no difference to the values for intermediate demand and imports whether you allocate imports from the MTFS first rather than intermediate demand. Thus, if intermediate purchases accounts for 30% of total purchases then imports account for the remaining 70%.

Table 4.7 - The estimated values for intermediate demand and imports generated following the adjustment method outlined in Table 4.6.			
	Indigenous Division ($\alpha = 40\%$)	Foreign Division ($\beta = 21\%$)	Original Sectoral I-O Value
Total Intermediate Demand	£223m *(£135m)*	£568m *(£656m)*	£791m
Imports	£480m *(£568)*	£2840m *(£2752m)*	£3320m
Total Purchases	£703m	£3408m	**£4111m**

From the MTFS data, α & β are equal to 40 and 21 per cent, respectively, that indicates the proportion of total purchases in the indigenous and foreign-owned divisions of the E&IE sector that are sourced from within Scotland (intermediate purchases). The estimated values for total purchases, Z_1 and Z_2 (£703m & £3408m), are taken from Table 4.4 and the original Scottish I-O totals for intermediate demand and imports, Z_3 and Z_4 (£791m and £3,320m), are taken from Table 4.3. The estimated values shown for intermediate demand and imports in Table 4.7 are then calculated following the method outlined in Table 4.6. Note that (subject to rounding) the rows and columns sum to the corresponding control totals. Following the method outlined above and the requirement of I-O balancing the values for α & β, for the indigenous and foreign-owned divisions of the E&IE sector, are now equal to 32 and 17 per cent respectively.

The values in parenthesis reported in Table 4.7 are the estimated values that are calculated for total intermediate demand and imports without using the MTFS data. These cells would have had to been generated proportionately using the ratios Z_1 to Z_2 and Z_3 to Z_4 (as the intermediate flows data are generated in section A). Following this method alpha and beta are both equal to 19 per cent and cell a would be generated as follows: $a = \left[\frac{Z_1}{Z_1 + Z_2}\right]$. The additional component that the MTFS data adds to the adjustment in cell a is $\left[\frac{\alpha}{\alpha\ Z_1 + \beta\ Z_2}\right]$.

In summary, the MTFS data provide an indication of the typical linkage structure of each manufacturing division and the original I-O values provide a control total to ensure the overall totals for both intermediate demand and imports are equal to the original survey-based I-O values for the sector. The MTFS data indicates that indigenous-owned manufacturing companies source around 47 per cent of total supplies from within Scotland, compared with 24 per cent for foreign-owned companies (Jackson and Patel, 1996). In the ownership-disaggregated Scottish I-O table, the averages for UK-owned and overseas-owned companies are 56 and 28 per cent, respectively. The MTFS data are discussed further in the data appendix of this chapter. The estimated I-O values for the value added matrix (V_m) are shown in Table 4.8.

Table 4-8 - Estimated I-O values for the value added matrix (V_m)

	Chemicals		Food D &T		Text & Cloth		Mech Engin		Elect & IE		PPP		Other Manuf	
	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For
TID	395	210	3049	215	700	107	508	142	223	568	322	150	1389	311
Imports	445	279	1095	318	611	129	414	211	480	2840	493	244	1425	620
W+S	246	126	815	99	643	64	565	178	481	470	485	207	1216	279
OVA	133	75	453	102	122	20	56	19	131	234	96	41	97	25
Total Inputs	1218	689	5413	733	2076	320	1544	550	1315	4112	1395	643	4126	1236

This matrix is now complete. The total intermediate demand figures (TID) are used subsequently as control totals for the intermediate flows sector of the table (A_{mm} and A_{nm}) that is discussed in section 4.3-4.

4.3-3 - Final Demand Matrix (Fm).

This section of the I-O table details the different sources of final demand for the output of the sectors of the ownership-disaggregated table. These are intermediate sales, other final demand, consumer expenditure and exports. Other final demand consists of general government final consumption, gross domestic fixed capital formation, stocks and tourist expenditure.

However, unlike the previous section (value added) there are no ownership-disaggregated Scottish data that relate specifically to the sources of final demand. Therefore, in this section I use a single adjustment method to allocate the original Scottish sectoral I-O values for the four different sources of final demand between the indigenous and foreign-owned divisions. This adjustment method is similar to a process employed in earlier studies which generated regional I-O tables by aggregating national coefficients using regional structural weights. This procedure essentially derived regional I-O coefficients from national I-O tables following the structure of the region .i.e. where a national industry was situated within a region, the national coefficient for that industry was used in the I-O table for the region (Isard and Kuenne, 1953; Miller, 1957).

Table 4.9 - Final Demand Matrix.

	TIS	Cons Exp	OFD	Exports	OUTPUT
Chem (UK)	453	24	36	1395	1218
Chem (For)					689
FD&T (UK)	1051	1135	-17	3975	5413
FD&T (For)					733
T&CI (UK)	669	157	116	1455	2076
T&CI (For)					320
MEng (UK)	243	10	182	1659	1544
MEng (For)					550
E&IE (UK)	585	156	176	4510	1315
E&IE (For)					4112
PPP (UK)	830	141	52	1016	1395
PPP (For)					643
Ot Man(UK)	1713	126	353	3171	4126
Ot Man(For)					1236
Agr	1337	144	85	290	1855
E+ W	2167	1338	189	1911	5605
Const	991	83	2373	311	3758
Serv	5990	8434	9986	3693	28103
Total	16027	11747	13531	23386	64692

Table 4.9 shows the original Scottish I-O data for this section. The data that appear in the UK-owned division of each manufacturing sector represents the original I-O total for that source of final demand, for both the indigenous and foreign-owned manufacturing divisions in each sector (original 1989 Scottish I-O values). The lower part of Table 4-8 shows the values for the different sources of final demand for the non-manufacturing sectors (F_n). These data remain unchanged. Note that the final demand (column) totals that are taken from the original Scottish I-O Table (IFD) also remain unchanged. The output totals for the indigenous and foreign-owned manufacturing divisions are already incorporated in this matrix. These values were generated using the ownership-disaggregated ACOP data for Gross Output in the same manner as total inputs were

generated for each manufacturing division in the value added matrix.[6] The data shown in Table 4.9 must be disaggregated between the indigenous and foreign-owned division in each manufacturing sector.

Recall that the seven manufacturing sectors in the ownership-disaggregated Scottish I-O table are each aggregations of the more separate detailed I-O sectors from the original survey-based Scottish I-O table. This aggregation procedure was outlined in Table 4-1. The ownership-disaggregated ACOP data for gross output are given at the same level of aggregation as the full survey-based Scottish table. I illustrate the adjustment method I follow with the example of allocating exports between the indigenous and foreign-owned divisions of the seven manufacturing sectors. Within each manufacturing sector assume that there are n industries (sub-sectors) designated by subscript i. The original Scottish I-O values for exports in each sub-sector are allocated between the indigenous and foreign-owned division on the basis of the share of gross output that each division accounts for. This is indicated by the disaggregated Scottish ACOP gross output data.

$$EXP_i^{UK} = IOEXP_i \left[\frac{ACOPX_i^{UK}}{ACOPX_i} \right] \quad \& \qquad EXP_i^{F} = IOEXP_i \left[\frac{ACOPX_i^{F}}{ACOPX_i} \right] \quad (2)$$

Where $IOEXP_i$ is the original I-O value for exports in sub-sector i that incorporates both indigenous and foreign activity, $ACOPX_i$ is the ACOP value for total output in sub-sector i and (UK) and (F) denote the indigenous and foreign-owned manufacturing divisions.

Using this adjustment method I obtain expected values for exports, for both the indigenous and foreign-owned divisions, in all of the sub-sectors of each manufacturing sector. By summing the estimated values for the sub-sectors that make up each of the seven manufacturing sectors, I obtain total expected values for exports, in both the indigenous and foreign-owned divisions for each of the seven manufacturing sectors. For instance, for the E&IE sector I sum together the estimated values for exports in the sub-sectors that make up the aggregate sector as outlined in the ownership-disaggregated I-O table. (Recall

[6] This is simply because in an input-output framework, the double entry system ensures that the vector totals for total inputs and outputs are equal for each manufacturing division. Therefore, the ACOP shares allocated to total output in the payments matrix are the same as those allocated in this section. The actual values for

from Table 4.1 that the electronics sector in the ownership-disaggregated I-O Table consists of 9 sub-sectors.)

$$EXP^{UK} = \sum_{i=i}^{n} EXP_i^{UK} \quad \& \quad EXP^{F} = \sum_{i=j}^{n} EXP_i^{F} \quad (3)$$

From the sum of the estimated export values in both divisions of each manufacturing sector, the aggregate share of total sectoral exports that each manufacturing division account for, is used to disaggregate the original Scottish I-O values for exports, for each manufacturing sector as a whole (Table 4.9). Equation 4 outlines this procedure.

$$IOEXP^{UK} = IOEXP \left[\frac{EXP^{UK}}{EXP^{UK} + EXP^{F}} \right]$$

and (4)

$$IOEXP^{F} = IOEXP \left[\frac{EXP^{F}}{EXP^{UK} + EXP^{F}} \right]$$

In each of the seven manufacturing sectors, the I-O values for exports ($IOEXP^{UK}$ + $IOEXP^{F}$) sum to the original I-O value for the sector as a whole. This is simply because the original I-O values for exports in each sector (reported in Table 4.0) are disaggregated using the weights from the estimated I-O values (equation 4) for the indigenous and foreign-owned divisions in each manufacturing sector. I use the same method to apportion the I-O values for intermediate sales, consumer expenditure and other final demand, also reported in Table 4.9, between both components of each manufacturing sector. However, note that this adjustment method does not capture the intra-industry differences that exist at the highest level of sectoral disaggregation between manufacturing plants within the different divisions. Instead, the adjustment process is essentially determined by the characteristics of the industrial sectors, rather than ownership. Thus, the high export-intensity observed for the foreign-owned sector is in this case a result of the different industrial composition of foreign-owned manufacturing plants in Scotland.

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output in each manufacturing division are the same in both parts of the table.

The proportions of each source of final demand that are allocated to each manufacturing division, based on this adjustment method, are shown in Table 4.10.

Table 4.10 - The proportions of each source of final demand allocated to both components of each manufacturing sector, based on the adjustment method outlined.

	Intermediate Sales %		Consumer Expenditure %		Other Final Demand %		Exports		ACOP Gross Output Shares.	
	UK	For	UK	For	UK	For	UK	For	UK	For
Chemicals	66	34	76	24	72	28	63	37	64	36
FD&T	88	12	87	13	87	13	88	12	88	12
T&CL	86	14	86	14	85	15	87	13	87	13
Mech. Eng.	75	25	74	26	73	27	74	26	74	26
Elect & I.E.	34	66	27	73	46	54	22	78	24	76
PPP	69	31	67	33	69	31	68	32	68	32
Other Manuft.	84	16	70	30	73	27	74	26	77	23

The final column of Table 4.10 shows the aggregate ACOP Gross Output shares for the indigenous and foreign-owned manufacturing divisions in each sector. Recall that these shares were initially used to generate the gross output totals in each division. Note that the ACOP gross output shares are different, in most cases, from the shares that are generated for the four different sources of final demand in each manufacturing division. By using the ACOP data at its most disaggregate level I have been able to pick up differences in the shares of final demand that are attributable to the different distribution of indigenous and foreign-owned plants, within each sector. For instance within some of the sub-sectors that form the different manufacturing sectors in the ownership-disaggregated Scottish I-O Table, there is no foreign-owned activity. Accordingly, following the adjustment method outlined for exports, each source of final demand for this sub-sector would be attributed wholly to the UK-owned division. [7] In order to conform with the control totals a slight adjustment had to made in three of the sectors.[8] However, note the difference proportions

[7] However, it should be noted that it may have been better to continue to work at the highest possible level of disaggregation, particularly for exports.

[8] For balancing this matrice (F_m), there was a slight adjustment required for the chemicals, mechanical engineering and other manufacturing divisions. In these divisions, the sum of intermediate and final demands did not equal gross output in each division. In each manufacturing sector, the residual (difference) for both

allocated to the different sources of final demand, compared with ACOP gross output shares.

These are most apparent in the chemicals, electrical and instrumental engineering (E&IE) and other manufacturing sectors, due to the different distribution of foreign and UK firms within these sectors. For example, intermediate sales and other final demand are less significant sources of final demand for the foreign-owned division of the E&IE sector while consumer expenditure and exports are more significant. Note that there is less variation in the proportionate shares of each source of final demand in the food, drink and tobacco, textiles and clothing, mechanical engineering and the paper, printing and publishing sectors. The estimated values generated for the Final Demand Matrix are shown in Table 4.11.

Table 4.11 - Final Demand Matrix (F_m).

	TID	Cons Exp	OFD	Exports	OUTPUT
Chem (UK)	298	18	26	877	1218
Chem (For)	155	6	10	518	689
FD&T (UK)	922	992	-14	3513	5413
FD&T (For)	129	143	-2	462	733
T&Cl (UK)	576	136	99	1266	2076
T&Cl (For)	93	21	17	189	320
MEng (UK)	182	7	133	1222	1544
MEng (For)	61	3	50	437	550
E&IE (UK)	197	43	81	994	1315
E&IE (For)	388	113	95	3516	4112
PPP (UK)	570	94	35	695	1395
PPP (For)	260	46	16	321	643
Ot Man(UK)	1431	88	259	2348	4126
Ot Man(For)	282	37	94	823	1236
Agr	1337	144	85	290	1855
E+ W	2167	1338	189	1911	5605
Const	991	83	2373	311	3758
Serv	5990	8434	9986	3693	28103
TID	16027	11747	13531	23386	64692

These are the final values for this matrix. In each case these values sum to the

divisions was exactly equal to the corresponding difference in the other division. These small residual differences were adjusted using exports in each division. These adjustment were required to conform with I-O balancing.

column total. The intermediate sales vector is used in the final section of the table to generate the intermediate flows between the manufacturing and non-manufacturing sectors. The adjustment method adopted in this section reflects the paucity of independent data. Although the approach again maintains the integrity of the original Scottish I-O data totals, ownership-disaggregated export data would have greatly enhanced this section.

4.3.4 - Transactions Matrix.

This matrix captures the intermediate purchases and sales of the foreign and indigenous manufacturing divisions with the other sectors of the model. From the final payment and demand matrices (Sections **4.3.2** & **4.3.3**) I have the vector totals for intermediate purchases and sales, for each division, for the seven manufacturing sectors. These vector totals are used as control totals for this matrix. Table 4.12 illustrates the components of this matrix and the I-O data available.

Table 4.12 - Transactions Matrix.

	Chemicals		Food D &T		Text & Cloth		Mech Engin		Elect & IE		PPP		Other Manuf		NON-MANUFACTURING				
	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	Agr	E+W	Const	Serv	TID
Chem (UK)	200		14		19		1		2		9		118		62	9	3	18	298
Chem (For)																			155
FD&T (UK)	5		584		39		1		2		10		4		172	8	3	224	922
FD&T (For)																			129
T&Cl (UK)	1		3		340		0		0		14		13		27	3	167	100	576
T&Cl (For)																			93
MEng (UK)	3		6		1		76		5		16		48		4	37	32	15	182
MEng (For)																			61
E&IE (UK)	5		9		4		48		315		6		86		2	34	11	65	197
E&IE (For)																			388
PPP (UK)	27		230		12		6		43		182		57		5	23	11	234	570
PPP (For)																			260
Ot Man(UK)	35		268		28		233		140		12		509		46	19	294	127	1431
Ot Man(For)																			282
Agr	0		1143		90		0		0		3		2		60	2	1	34	1337
E+W	204		175		55		59		53		51		241		92	1026	14	197	2167
Const	7		27		12		8		10		15		50		40	101	548	172	991
Serv	118		805		208		216		222		154		573		285	682	323	2405	5990
TID	395	210	3049	215	700	107	508	142	223	568	322	150	1389	311	795	1944	1408	3591	16027

The task in this part of the table is to generate the intermediate linkage flows that exist between the eleven sectors of the matrix, including the foreign-owned manufacturing divisions. The I-O values shown in Table 4.12 are the original sectoral values for intermediate purchases and sales, for the seven manufacturing sectors, that are taken from the original Scottish I-O table for 1989. Note that these data incorporate both indigenous and foreign-owned activity. Recall from Table 4.2 (schematic overview) that the data in the matrix A_{nn} (shaded area) remain unchanged. These data represent the intermediate flows between the non-manufacturing sectors and are taken directly from the 1989 Scottish I-O

Table. The adjustment method used in this matrix uses the ratios of total intermediate demand (TID) and total intermediate sales (TIS) between the domestic and foreign-owned divisions in each sector to apportion the original I-O figures. Note that the sectoral I-O values for the seven manufacturing sectors (A_{mm}) must be disaggregated between the four elements of the indigenous and foreign-owned manufacturing divisions. An example of this process is shown for the intermediate flows between the indigenous and foreign-owned divisions of the chemicals sector.

From Table 4-12, the sectoral I-O value for Chemicals (£200m) must be apportioned between the four elements of the indigenous and foreign manufacturing divisions. I use the vector totals for intermediate demand and sales, for each manufacturing division in the chemicals sector, to generate the proportions of intermediate demand and sales that are allocated between both components. I denote α as the proportion of a sector's total demand for intermediate goods that the UK-owned manufacturing division accounts for and (1-α) as the foreign-owned division's share. Similarly, I denote β as the proportion of a sector's total intermediate sales that the UK-owned manufacturing division account for and (1-β) the foreign-owned division's share.

$$\alpha = \frac{IOTID_{Chem}^{UK}}{IOTID_{Chem}} \quad \text{and} \quad \beta = \frac{IOTIS_{Chem}^{F}}{IOTIS_{Chem}} \quad (5)$$

Where $IOTID^{UK}{}_{Chem}$ and $IOTIS^{F}{}_{Chem}$ are respectively the estimated I-O values for intermediate demand and sales by the UK and foreign-owned divisions of the chemicals sector. Recall that these values were generated in the previous sections (value added and final demand) for both divisions of the seven manufacturing sectors. $IOTID_{Chem}$ and $IOTIS_{Chem}$ are the original Scottish I-O totals for intermediate demand and sales for the chemicals sector as a whole. I also denote the original sectoral I-O value for intermediate purchases and sales (flows) between the chemicals sector as N_1 (£200m). Using these proportions the original I-O value (N_1) is allocated between the four elements of the sector as is shown in Table 4.13.

Table 4.13 - How the matrix of intermediate flows are generated for the indigenous and foreign-owned manufacturing divisions of the chemicals sector.			
	Chemicals UK-owned	Chemicals Foreign-owned	Total Intermediate Sales
Chemicals UK-owned	$N_1\alpha\beta$ (£86m)	$N_1(1\text{-}\alpha)\beta$ (£46m)	$N_1\beta$ (£132m)
Chemicals Foreign-owned	$N_1\alpha(1\text{-}\beta)$ (£45m)	$N_1(1\text{-}\alpha)(1\text{-}\beta)$ (£24m)	$N_1(1\text{-}\beta)$ (£69m)
Total Intermediate Demand	$N_1\alpha$ (£131m)	$N_1(1\text{-}\alpha)$ (£70m)	N_1 (£200m)

The values generated in these four elements of the matrix sum to the original sectoral I-O value (N_1) and the elements of each vector sum to the vector total. The intermediate flows between the seven manufacturing sector are calculated in this manner. However, there are also intermediate flows between the manufacturing and non-manufacturing sectors. The original I-O values for intermediate purchases by the manufacturing sectors, from the non-manufacturing sectors, are allocated between both manufacturing divisions using the proportions α and (1-α). Similarly, the original I-O value for intermediate sales from the manufacturing to non-manufacturing sectors are allocated between both manufacturing divisions using the proportions β and (1-β). By following this method all column and row totals automatically balance. Table 4.14 reports the completed Transactions matrix.

Table 4.14 - Completed Transactions Matrix.

	Chemicals		Food D &T		Text & Cloth		Mech Engin		Elect & IE		PPP		Other Manuf		NON-MANUFACTURING				
	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	Agr	E+ W	Const	Serv	TID
Chem (UK)	86	46	8	1	11	2	0	0	0	1	4	2	63	14	40	6	2	12	298
Chem (For)	45	24	4	0	6	1	0	0	0	0	2	1	33	7	21	3	1	6	155
FD&T (UK)	3	1	479	34	30	5	1	0	0	1	6	3	3	1	151	7	3	196	922
FD&T (For)	0	0	67	5	4	1	0	0	0	0	1	0	0	0	21	1	0	28	129
T&Cl (UK)	1	0	2	0	254	39	0	0	0	0	8	4	9	2	23	3	144	86	576
T&Cl (For)	0	0	0	0	41	6	0	0	0	0	1	1	1	0	4	0	23	14	93
MEng (UK)	1	1	4	0	1	0	45	12	1	2	8	4	30	7	3	28	24	11	182
MEng (For)	0	0	1	0	0	0	15	4	0	1	3	1	10	2	1	9	8	4	61
E&IE (UK)	1	1	3	0	1	0	13	4	30	76	1	1	24	5	1	12	4	22	197
E&IE (For)	2	1	5	0	2	0	25	7	59	150	3	1	46	10	2	23	7	43	388
PPP (UK)	12	7	148	10	7	1	3	1	8	21	85	40	32	7	4	16	7	161	570
PPP (For)	6	3	67	5	3	1	2	0	4	10	39	18	14	3	2	7	3	73	260
Ot Man(UK)	19	10	209	15	20	3	152	43	33	84	7	3	347	78	38	16	246	106	1431
Ot Man(For)	4	2	41	3	4	1	30	8	7	17	1	1	68	15	8	3	48	21	282
Agr	0	0	1068	75	78	12	0	0	0	0	2	1	2	0	60	2	1	34	1337
E+ W	133	71	164	12	47	7	46	13	15	38	35	16	197	44	92	1026	14	197	2167
Const	5	2	25	2	10	2	7	2	3	7	10	5	41	9	40	101	548	172	991
Serv	77	41	752	53	180	28	169	47	63	159	105	49	468	105	285	682	323	2405	5990
TID	395	210	3049	215	700	107	508	142	223	568	322	150	1389	311	795	1944	1408	3591	16027

Table 4.15 - Ownership-disaggregated Scottish I-O Table (1989).

	Chemicals		Food D &T		Text & Cloth		Mech Engin		Elect & IE		PPP		Other Manuf		NON-MANUFACTURING								
	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	Agr	E+ W	Const	Serv	TID	Cons Exp	OFD	Exports	OUTPUT
Chem (UK)	85.7	45.5	8.3	0.6	10.9	1.7	0.3	0.1	0.3	0.9	4.0	1.9	63.3	14.2	60.6	12.6	213.7	33.1	298	18.1	25.8	876.6	1218
Chem (For)	44.7	23.7	4.3	0.3	5.7	0.9	0.1	0.0	0.2	0.4	2.1	1.0	33.0	7.4	14.8	3.1	52.3	8.1	155	5.7	9.9	518.4	689
FD&T (UK)	2.7	1.4	478.8	33.7	29.5	4.5	0.9	0.2	0.4	1.1	5.9	2.8	2.6	0.6	150.8	6.7	2.7	196.4	922	992.4	-14.3	3512.8	5413
FD&T (For)	0.4	0.2	67.2	4.7	4.1	0.6	0.1	0.0	0.1	0.1	0.8	0.4	0.4	0.1	21.2	0.9	0.4	27.6	129	143.1	-2.2	462.5	733
T&Cl (UK)	0.5	0.3	2.4	0.2	253.9	38.9	0.1	0.0	0.1	0.2	8.1	3.8	9.1	2.0	23.3	2.7	143.8	86.3	576	135.6	99.0	1265.6	2076
T&Cl (For)	0.1	0.0	0.4	0.0	41.0	6.3	0.0	0.0	0.0	0.0	1.3	0.6	1.5	0.3	3.8	0.4	23.2	13.9	93	21.4	16.9	189.2	320
MEng (UK)	1.4	0.7	3.9	0.3	0.5	0.1	44.5	12.5	1.0	2.5	8.1	3.8	29.6	6.6	2.3	24.0	22.2	8.6	182	7.1	132.9	1222.3	1544
MEng (For)	0.5	0.2	1.3	0.1	0.2	0.0	15.0	4.2	0.3	0.8	2.7	1.3	9.9	2.2	0.7	7.2	6.6	2.6	61	2.5	49.6	436.5	550
E&IE (UK)	1.1	0.6	2.7	0.2	1.2	0.2	12.7	3.6	29.9	76.2	1.3	0.6	23.5	5.3	1.3	14.9	5.5	25.4	197	42.9	81.3	993.9	1315
E&IE (For)	2.1	1.1	5.4	0.4	2.3	0.3	25.1	7.0	58.9	149.8	2.5	1.2	46.3	10.4	2.2	25.5	9.3	43.4	388	113.3	94.9	3515.8	4112
PPP (UK)	12.3	6.5	147.6	10.4	7.2	1.1	3.4	1.0	8.3	21.0	85.1	39.8	31.7	7.1	3.5	15.7	7.4	161.0	570	94.3	35.5	695.4	1395
PPP (For)	5.6	3.0	67.3	4.7	3.3	0.5	1.6	0.4	3.8	9.6	38.8	18.1	14.5	3.2	1.6	7.2	3.4	73.4	260	46.2	16.0	320.9	643
Ot Man(UK)	19.1	10.1	209.5	14.7	20.5	3.1	152.3	42.7	33.0	84.0	7.1	3.3	347.3	77.8	25.3	9.9	24.5	81.6	1431	88.4	259.0	2348.2	4126
Ot Man(For)	3.8	2.0	41.3	2.9	4.0	0.6	30.0	8.4	6.5	16.6	1.4	0.7	68.5	15.3	6.8	2.7	6.6	22.1	282	37.5	93.9	822.6	1236
Agr	0.2	0.1	1067.9	75.1	78.1	12.0	0.3	0.1	0.1	0.3	2.3	1.1	1.6	0.4	60.0	1.6	1.4	33.9	1337	143.6	84.9	289.9	1855
E+ W	133.2	70.8	163.7	11.5	47.4	7.3	46.4	13.0	14.9	37.9	34.7	16.2	196.6	44.0	91.7	1026.3	13.9	197.1	2167	1337.8	189.4	1911.4	5605
Const	4.6	2.4	25.4	1.8	10.1	1.6	6.5	1.8	2.8	7.2	10.4	4.8	41.1	9.2	39.8	101.5	547.5	172.1	991	83.1	2373.0	311.2	3758
Serv	76.8	40.8	751.8	52.9	180.3	27.7	168.8	47.3	62.7	159.4	105.2	49.1	468.2	104.9	284.9	681.5	323.2	2404.7	5990	8434.4	9985.8	3693.1	28103
TID	395	210	3049	215	700	107	508	142	223	568	322	150	1389	311	795	1944	1408	3591	16027	11747	13531	23386	64692
Imports	445	279	1095	318	611	129	414	211	480	2840	493	244	1425	620	290	2127	871	2021	14912	9556	9422	0	33890
W+S	246	126	815	99	643	64	565	178	481	470	485	207	1216	279	403	910	1090	16721	24999	0	0	0	24999
OVA	133	75	453	102	122	20	56	19	131	234	96	41	97	25	368	623	390	5770	8754	3371	-523	867	12470
Total Inputs	1218	689	5413	733	2076	320	1544	550	1315	4112	1395	643	4126	1236	1855	5605	3758	28103	64692	24675	21928	25120	136051

Finally, Table 4.15 reports the ownership-disaggregated Scottish I-O Table for 1989.

4.4 – Chapter Conclusion.

In summary, this chapter has outlined the process followed in constructing the ownership-disaggregated Scottish Input-Output table for 1989. All additional data sources used in the model construction are Scottish and all adjustments are based on the original survey-based Scottish I-O data for 1989. The adjustment methods adopted in each part of the table reflect the availability of appropriate Scottish data. Where data were unavailable, other adjustment methods were used. In each section of the Table, I have generated the ownership-disaggregated data in the most consistent manner possible. Regional data are typically scarce, particularly ownership-disaggregated data, and the adjustment methods reflect the availability of such data. At the outset, I decided to main the integrity of the existing Scottish I-O Table for 1989 because the survey-based Table was constructed using data that related to UK and foreign-owned manufacturing plants.

The general purpose for generating the ownership-disaggregated Scottish Table is to capture the structural characteristics of the UK and foreign-owned manufacturing sectors within an I-O database. The strength of my approach is that it reconciles various data sources within a coherent framework. However, in doing so I have had to accept the data in the original Scottish I-O Table for 1989 as the base data and reconcile the ownership-disaggregated data within this framework. This, in part, reflects the differences that exist between Scottish I-O and ACOP data. In parts of the Table I have had generate the ownership-disaggregated data using somewhat mechanical procedures. For instance, the allocation of exports between the UK and foreign-owned manufacturing sectors reflects the industrial composition of these sectors rather than actual ownership characteristics. However, throughout the whole process and even where additional data where available (MTFS), I have adopted a consistent procedure which maintained the integrity of the existing Scottish I-O Table. This approach, I believe, is important particularly where the input-output table is to form the base of a computable general equilibrium (CGE) model.[9]

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[9] Research by Coomes *et al* (1991) and Israilevich *et al* (1995) demonstrate that the choice of input-output

Finally, the ownership-disaggregated Scottish I-O Table provides a unique database that captures both UK and foreign-owned manufacturing within a coherent framework. Future Scottish I-O tables can be disaggregated in a similar manner. In the proceeding chapter, I illustrate the structural differences that exist between both sectors using the ownership-disaggregated Scottish I-O Table as both an accounting framework and model.

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table does matter when they are incorporated in general equilibrium models.

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4.6 – Data Appendix.

In this section I provide a discussion about the relative data sources used in the construction of the ownership-disaggregated Scottish I-O Table. The most striking point is the differences that exist between Scottish I-O and ACOP data that relate to the same sectors.

4.6.1 Scottish Input-Output and ACOP Data for 1989.

ACOP is a large enquiry of companies, in the UK, which come under the definition of the production industries. The Scottish Input-Output table for 1989 uses a variety of data sources including ACOP. For instance, the sources of estimates of the total output and total purchases of these industries in the I-O accounts are the Annual Census of Production. In this section I report on the perceived reliability of the ownership-disaggregated data sources and the differences between these data sources and the published Scottish I-O accounts. For a full discussion of the data sources and methods currently employed in the construction of the Scottish Input-Output Tables for both 1989 and 1994 see Volume 2 of the Scottish Input-Output Tables for 1989 (HMSO, 1994).

The I-O and ACOP data used in the ownership-disaggregated Scottish I-O Table are directly comparable as both data sets refer to the same I-O groupings (industries). However, the disparities in the data between the same divisions are nonetheless quite significant. Table 4.15 shows both ACOP and I-O data for gross output and wages and salaries for the manufacturing sectors in the ownership-disaggregated Scottish I-O table.

Table 4.16 - Comparison of I-O and ACOP data for Gross Output and Gross Wages and Salaries for the manufacturing sectors in the ownership-disaggregated Scottish I-O Table.

Sector	GROSS OUTPUT		GROSS WAGES + SALARIES	
	I-O DATA	ACOP DATA	I-O DATA	ACOP DATA
Chem (UK)	1,218	1,135	246	174
Chem (For)	689	642	126	89
FD&T (UK)	5,413	5,043	815	573
FD&T (For)	733	683	99	69
T&CL (UK)	2,076	1,966	643	479
T&CL (For)	320	303	64	48
Meng (UK)	1,544	1,464	565	416
Meng (For)	550	521	178	131
E&IE (UK)	1,315	1,265	481	339
E&IE (For)	4,112	3,954	470	331
PPP (UK)	1,395	1,293	485	300
PPP (For)	643	596	207	128
O Man (UK)	4,126	3,922	1,216	800
O Man (For)	1,236	1,175	279	184

In all cases the I-O data are larger than the equivalent ACOP data. The differences in the I-O and ACOP data for gross output are not as large as the differences in the data for gross wages and salaries. However, the shares that each division (UK and foreign) account for are relatively similar as is shown in Table 4.16. Due to the actual differences in ACOP and I-O data, I have used ACOP shares in the construction of the ownership-disaggregated Scottish I-O table. Recall that the I-O data for total purchases was estimated using the ACOP shares for total purchases.

Table 4.17 – Comparison of total purchases I-O and ACOP data, and shares, for the manufacturing sectors in the ownership-disaggregated Scottish I-O Table.				
	TOTAL PURCHASES		SHARES OF TOTAL PURCHASES	
	I-O DATA	ACOP DATA	I-O DATA	ACOP DATA
Chem (UK)	840	613	63%	58%
Chem (For)	488	435	37%	42%
FD&T (UK)	4145	2985	89%	90%
FD&T (For)	532	345	11%	10%
T&CL (UK)	1311	1166	85%	88%
T&CL (For)	236	164	15%	12%
Meng (UK)	922	615	72%	68%
Meng (For)	353	287	28%	32%
E&IE (UK)	703	675	17%	18%
E&IE (For)	3408	3102	83%	82%
PPP (UK)	815	591	67%	68%
PPP (For)	395	275	33%	32%
O Man (UK)	2813	1976	75%	72%
O Man (For)	932	769	25%	28%

The I-O total purchase data are larger than the equivalent ACOP data. Note that the actual shares of total purchases that each sector account for is relatively close. Table 4.17 reports Census of Employment and ACOP employment data and the different estimates of sectoral wages using ACOP data for Gross Wages and Salaries and equivalent I-O data (income from employment), from the ownership-disaggregated Scottish I-O Table.

Table 4.18 - Comparison with Census of Employment and ACOP Employment Data and sectoral wages using both I-O and ACOP data.				
	EMPLOYMENT		WAGES + SALARIES	
Manufacturing Division	I-O Employment	ACOP Employment	I-O Wages + Salaries	ACOP Wages + Salaries
Chem (UK)	13,504	13,000	18,189	13,369
Chem (For)	6,544	6,300	19,285	14,175
FD&T (UK)	59,458	62,700	13,714	9,132
FD&T (For)	5,785	6,100	17,035	11,344
T&CL (UK)	63,236	61,600	10,327	7,774
T&CL (For)	5.557	5,500	11,521	8,673
Meng (UK)	44,949	33,400	12,572	12,458
Meng (For)	12,785	9,500	13,894	13,768
E&IE (UK)	31,726	29,500	15,159	11,481
E&IE (For)	27,209	25,300	17,274	13,083
PPP (UK)	25,153	25,300	19,273	11,874
PPP (For)	8,451	8,500	24,520	15,106
O Man (UK)	71,222	70,100	17,079	11,414
O Man (For)	15,748	15,500	17,744	11,858

Note that the sectoral wage rates vary significantly. This again stems from the larger I-O estimates of wages and salaries.

4.6.2 - Manufacturing Trade Flow Survey (MTFS) Data.

Table 4-18 reports the manufacturing trade flow data. This survey is undertaken each time that a full survey-based Scottish I-O Table is constructed. The survey aims to capture inter-regional trade between Scotland and the rest of the UK and the Rest of the World.

Table 4.19 - The percentage of Total Purchases that are sourced from within Scotland, based on the MTFS data (Jackson & Patel; 1996).		
	Total Intermediate Demand (Local Sourcing)	Imports as a percentage of Total Purchases.
Sector	%	%
Chem (UK)	29	61
Chem (For)	27	73
FD&T (UK)	73	27
FD&T (For)	40	60
T&CL (UK)	24	76
T&CL (For)	22	78
Meng (UK)	41	59
Meng (For)	30	70
E&IE (UK)	40	60
E&IE (For)	21	79
PPP (UK)	28	72
PPP (For)	28	72
O Man (UK)	34	66
O Man (For)	23	77

The source of inputs varies between the indigenous and foreign-owned manufacturing divisions and across the different manufacturing sectors. Note that in some sectors, the sourcing patterns of the indigenous and foreign-owned manufacturing divisions are relatively similar. Figure 4.1 illustrates the sourcing patterns of UK-owned and Overseas-owned plants in Scotland, based on the MTFS data for 1989.

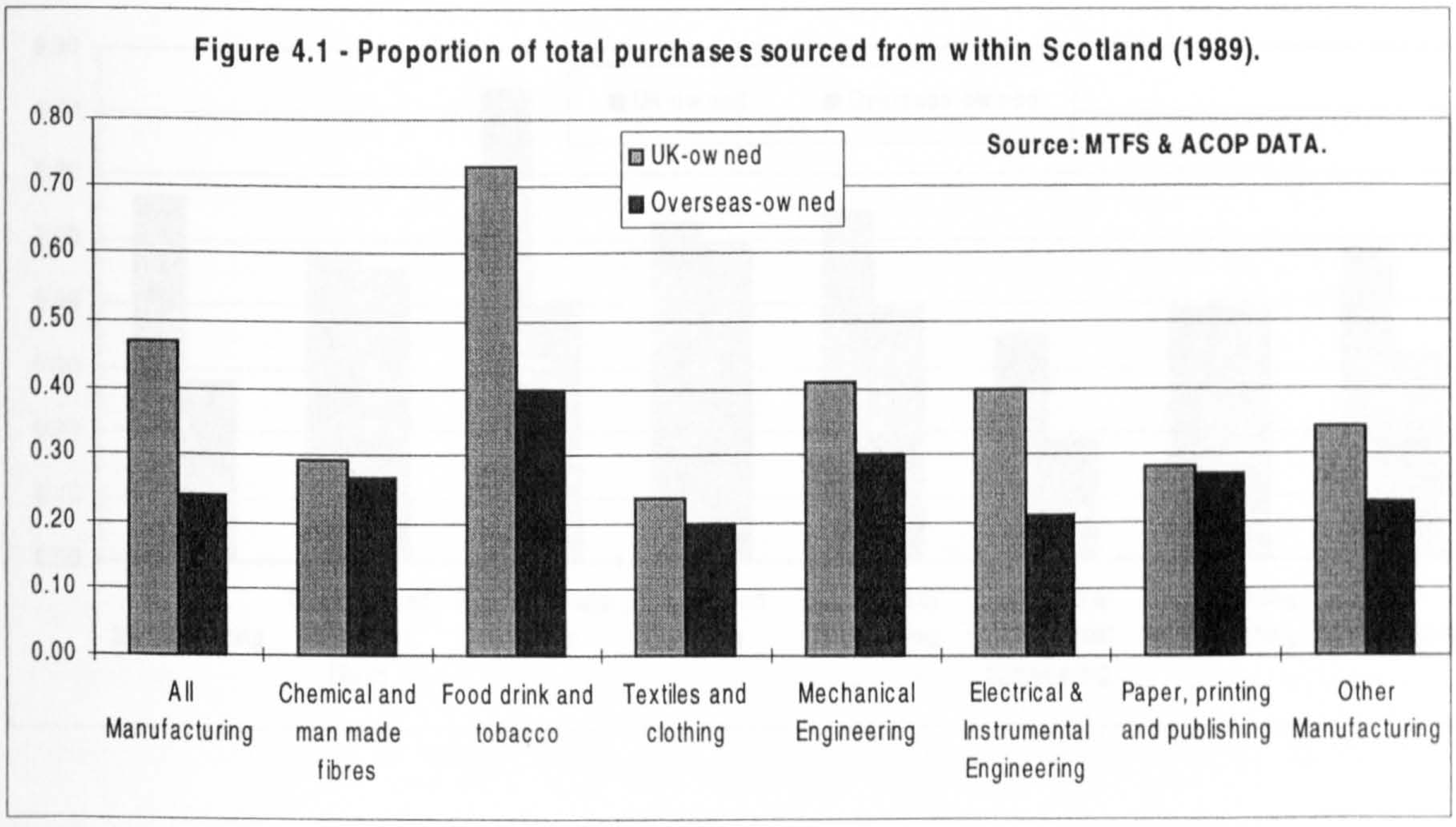
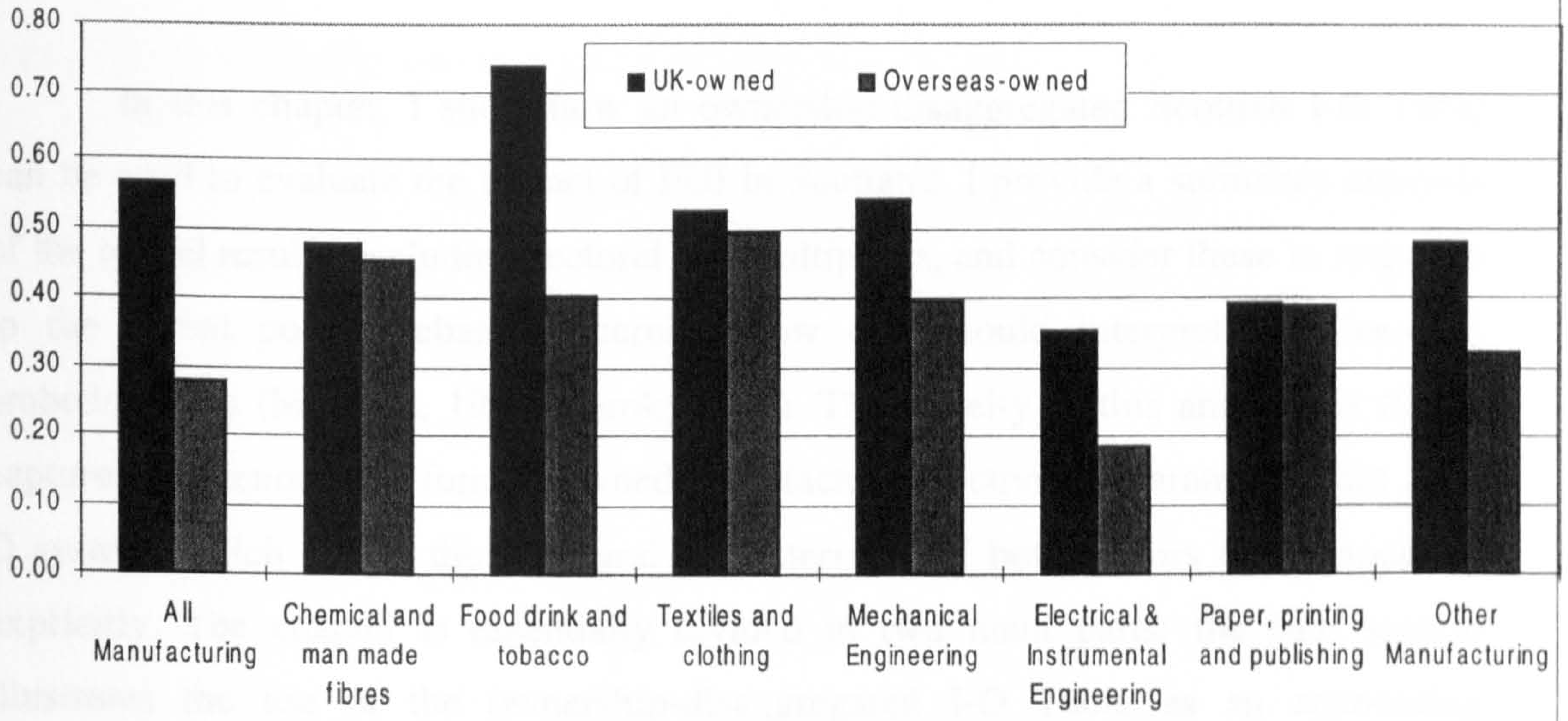


Figure 4.1 indicates that, on average, overseas-owned manufacturing companies source around 24 per cent of total supplies (intermediate purchases) from within Scotland, compared with 47 per cent for UK-owned companies. Following the adjustment method outlined in Tables 4-7 to 4-9, the proportion of total purchases allocated to intermediate demand for the indigenous and foreign-owned manufacturing divisions of the ownership-disaggregated Scottish I-O table (1989) are illustrated in Figure 4.2.

Figure 4.2: Proportion of total purchases sourced from within Scotland in ownership-disaggregated Scottish I-O model (1989).



Recall that the average level of supplies sourced in Scotland from the MTFS data was 46 per cent for UK-owned divisions and 24 per cent for overseas-owned divisions. In the ownership-disaggregated Scottish I-O table the averages for UK-owned and Overseas-owned manufacturing divisions are 56 and 28 per cent, respectively.

CHAPTER 5 – Interpretation of the Results from the Ownership-Disaggregated Scottish I-O Database.

In this chapter, I show how an ownership-disaggregated Scottish I-O Table can be used to evaluate the impact of FDI in Scotland. I provide a summary analysis of the model results, including sectoral I-O multipliers, and consider these in response to the recent policy debate concerning how one should interpret and measure embeddedness (McCann, 1997; Turok; 1997). The novelty of this analysis is that it captures indigenous and foreign-owned manufacturing activity separately within an I-O system, which allows the structural characteristics of both sectors to be modelled explicitly. The chapter is essentially divided in two main parts: the first section illustrates the use of the ownership-disaggregated I-O Table as an accounting framework. The second reports the results from using the I-O Table to form the basis of an I-O model.

5.1 – Introduction

As noted in chapter 2 (section 2.4), input-output (I-O) models are commonly used for regional policy evaluation, as well as local and regional impact analysis. One of the strengths of the I-O approach is that it provides an accounting and modelling framework that encapsulates an extensive level of industry-specific detail (Alexander and Whyte, 1995; Hill and Roberts, 1995). The apparent restrictions (assumptions) required to motivate this type of analysis have been well documented in the I-O and related literature, as was discussed in section 2.4.2 of chapter 2.

However, as such, an I-O system can provide a useful benchmark case for quantifying the demand-side effects of inward investment. The major difficulty with using the I-O approach to evaluate FDI is that most I-O Tables do not distinguish production sectors by ownership. For instance, it is well known that foreign-owned plants exhibit significant capital intensity, local linkage and wage level differentials as against locally owned plants and all of these will have an effect on any impact evaluation. Therefore, to accurately estimate the impact of FDI using an I-O framework, the model ought to be able to capture the production processes and industrial structure of the foreign and UK-owned plants separately (Foster & Malley, 1988). In this chapter I provide such an analysis.

5.2. - The Ownership-Disaggregated Accounting Results.

In this section, I demonstrate how the ownership-disaggregated I-O table can be used to provide detailed information about the structure of indigenous and foreign-owned manufacturing in Scotland. These results are essentially derived from viewing the I-O table as an accounting framework.

5.2.1. - Composition of Gross Output.

Foreign-owned manufacturing accounted for over a third and one fifth, respectively, of Scottish manufacturing output and employment in 1989. Table 5.1 summarises the characteristics of the seven ownership-disaggregated manufacturing sectors in terms of the size and composition of gross output in each manufacturing division i.e. intermediate purchases and intermediate imports and gross value added. Gross value added consists of two elements: income from employment and other value added.

Table 5.1 – Composition of Gross Output for the manufacturing sectors in Scotland, based on the ownership-disaggregated Scottish I-O Table for 1989.						
	Gross Domestic Output £m	Intermediate Purchases £m	Imports £m	Gross Value Added £m	Income from Employment	Other Value Added
Chem (UK)	1,218	395	445	378	246	133
Chem (For)	689	210	279	201	126	75
FD&T (UK)	5,413	3,049	1,095	1,268	815	453
FD&T (For)	733	215	318	201	99	102
T&CL (UK)	2,076	700	611	765	643	122
T&CL (For)	320	107	129	84	64	20
Meng (UK)	1,544	508	414	621	565	56
Meng (For)	550	142	211	197	178	19
E&IE (UK)	1,315	223	480	612	481	131
E&IE (For)	4,112	568	2,840	704	470	234
PPP (UK)	1,395	322	493	580	485	96
PPP (For)	643	150	244	248	207	41
O Man (UK)	4,126	1,389	1425	1,313	1216	97
O Man (For)	1,236	311	620	305	279	25
Total Manu	25,371	8,289	9,603	7,478	5,874	1,604

Where:

Chem - Chemicals sector

FD&T - Food, Drink and Tobacco

T&Cl - Textiles and Clothing

Meng - Mechanical Engineering

E&IE - Electrical and Instrumental Engineering

PPP - Paper, Printing and Publishing

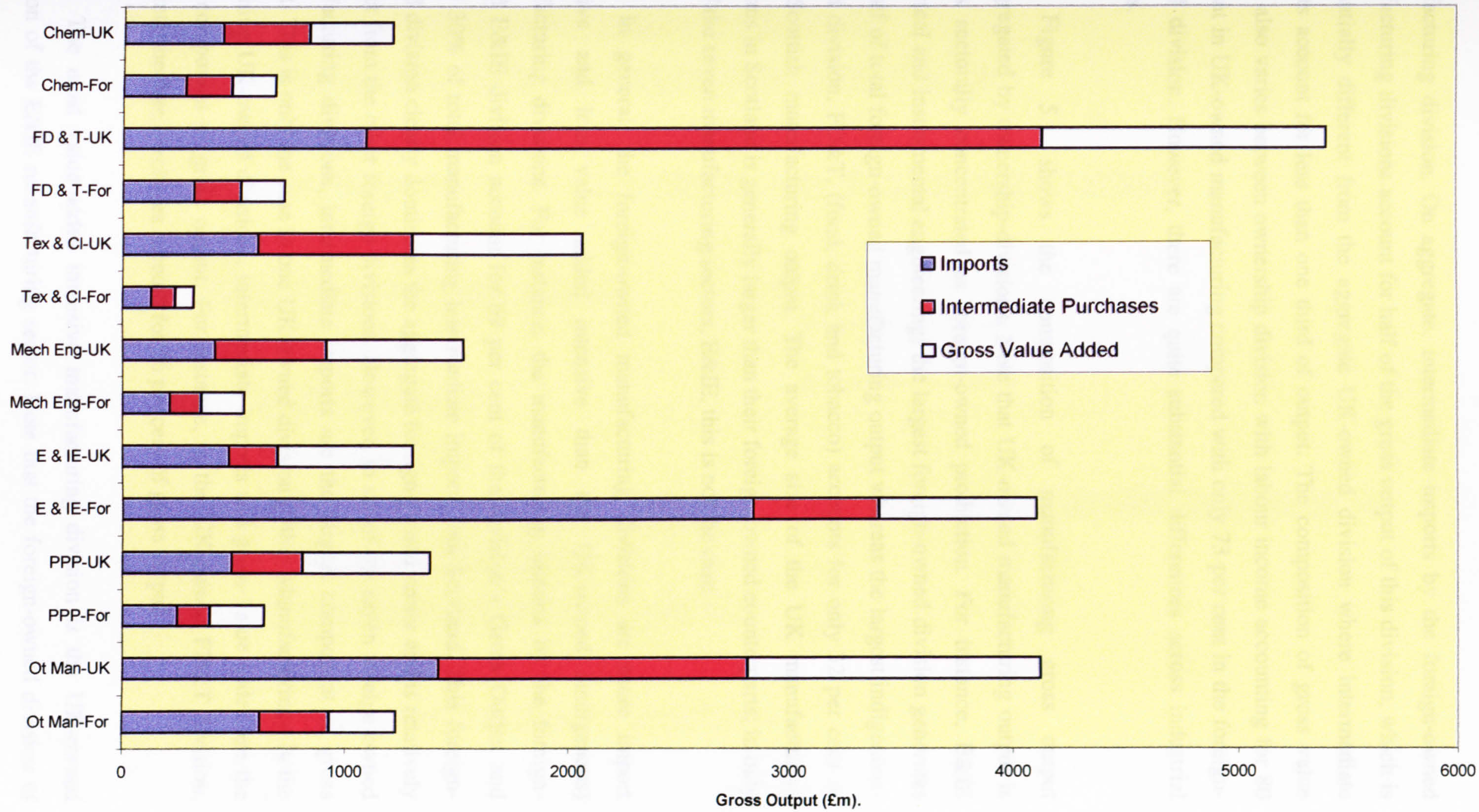
O Man - Other Manufacturing

UK - UK-owned

For - Foreign-owned

The components of Gross Output vary both between the aggregate UK and foreign-owned manufacturing division, and across these divisions. On aggregate, the share of manufacturing gross output going to value-added and local intermediate inputs is much greater for UK-owned plants in Scotland. Intermediate purchases, gross value added and imports account for 39, 32 and 29 per cent respectively for UK-owned manufacturing compared with 21, 23 and 56 per cent for the foreign-owned

Figure 5.1 - Composition of Gross Output for the UK-and foreign-owned manufacturing divisions in the ownership-disaggregated Scottish I-O Table.



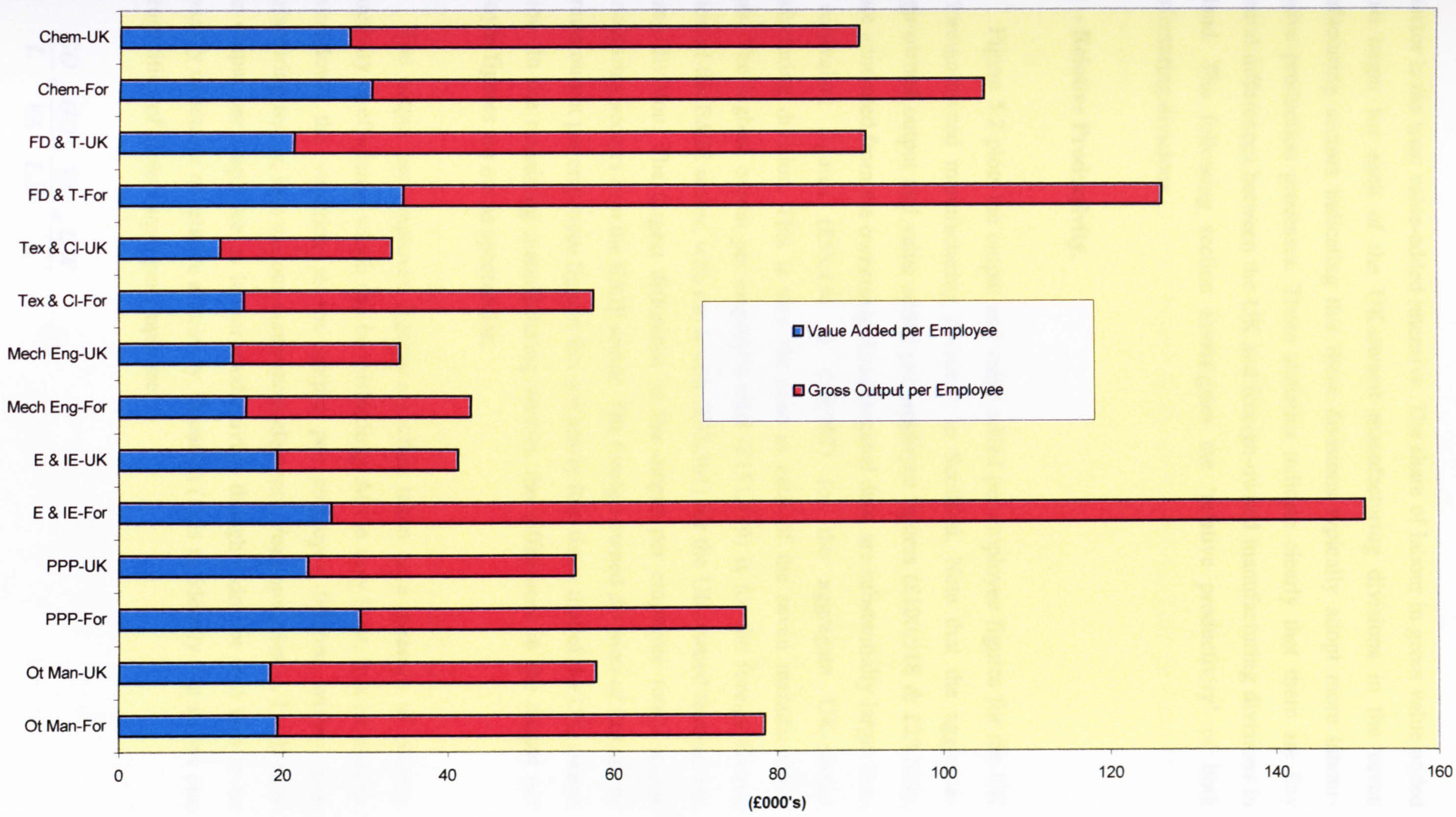
manufacturing division. On aggregate, intermediate imports by the foreign-owned manufacturing divisions account for half of the gross output of this division, which is substantially different from the aggregate UK-owned division where intermediate imports account for less than one third of output. The composition of gross value added also varies between ownership division with labour income accounting for 80 per cent in UK-owned manufacturing compared with only 73 per cent in the foreign-owned division. However, there are quite substantial differences across industrial sectors.

Figure 5.1 shows the composition of manufacturing gross output disaggregated by ownership-divisions. Note that UK-owned manufacturing output is not as sectorally concentrated as foreign-owned production. For instance, E&IE (electrical and instrumental engineering) the largest foreign-owned division generates one half of total foreign-owned manufacturing output whereas the largest indigenous-owned division, FD&T, (food, drink and tobacco) accounts for only 32 per cent of total Scottish manufacturing output. The average size of the UK manufacturing divisions in Scotland is generally larger than their foreign-owned counterparts: in only one of the seven manufacturing sectors, E&IE, this is not the case.

In general, the foreign-owned manufacturing divisions are more import intensive and less value added intensive than the UK-owned (indigenous) manufacturing divisions. For instance, the manufacturing imports by the foreign-owned E&IE division account for 69 per cent of the division's Gross Output and nearly 30% of total manufacturing intermediate imports into Scotland. This foreign-owned division clearly dominates the aggregate foreign-owned sector and is relatively distinct from the other foreign divisions. However, in six of the seven foreign-owned manufacturing divisions, intermediate imports are the largest component of gross output. This is only the case in one UK-owned division (Other Manufacturing). In the remaining UK-owned divisions, intermediate imports and gross value added are the main component of gross output. For instance, in the UK-owned FD&T division, local intermediate purchases account for 56 per cent of gross output.

The most value-added intensive manufacturing division is the UK-owned division of the E&IE manufacturing sector. Note that the foreign-owned division of

Figure 5.2 - Value added and output per employee totals for both the UK and foreign-owned manufacturing divisions.



this sector is the least value-added intensive. The share of labour in gross value added is also larger for each of the UK-owned manufacturing divisions in the seven manufacturing sectors indicating that these divisions typically adopt more labour-intensive production processes. These statistics indicate clearly that there are key structural differences between the UK and foreign-owned manufacturing divisions in Scotland. The following section investigates the 'relative productivity' of both manufacturing divisions.

5.2.2 - Relative Productivity.

Figure 5.2 plots the output and value added per employee figures for the UK and foreign-owned manufacturing divisions in Scotland. Note that the aggregate foreign-owned output and value added per employee figures (£100,918 & £23,629), that are generated from the ownership-disaggregated data, are substantially larger than the equivalent figures (£55,434 & £19,967) for the aggregate UK-owned manufacturing division. This is also the case in each of the seven manufacturing sectors. The highest output per employee total (£151,119) is for the foreign-owned division of the E&IE sector, with the lowest (£33,361) for the UK-owned textiles and clothing division. The largest difference in the output per employee totals within manufacturing sectors is in the E&IE sector. The foreign-owned division of this sector generates output per employee figures that are nearly four times that of the UK-owned division. In the remaining manufacturing sectors, the differences in the output per employee figures are not as spectacular.

The output per employee figures are often taken as a measure of relative productivity or efficiency which can be misleading. At the very least, it is instructive to breakdown the variation in the output per employee figures, within each manufacturing sector, into various component elements. For convenience, I will refer to the output per employee as labour productivity, though I do not take this to be necessarily indicative of relative efficiency. Equation (1) is an identity that shows one decomposition of gross output per employee:

$$\frac{GO}{L} = \frac{GO}{VA} * \frac{VA}{L.W} * \frac{L.W}{L} \qquad (1)$$

Where:

GO - Sectoral Gross Output

VA - Sectoral Value Added

L - Sectoral Employment

W - Sectoral Wages

The employment terms (L) in the last elements on the right hand side of equation (1) cancel to give:

$$\frac{GO}{L} = \frac{GO}{VA} * \frac{VA}{L.W} * W \qquad (2)$$

Where $\frac{GO}{VA}$ is a measure of the intermediate intensity of the sector, $\frac{VA}{L.W}$ is a measure of the capital intensity levels of the manufacturing sector and W refers to the sectoral wage. To calculate the impact of each of the components separately identified in equation (2), this expression can be expressed in log form for both the foreign and UK-owned divisions of the sector giving equation (3);

$$\log\left[\frac{GO/L^F}{GO/L^{UK}}\right] = \left[\log\left[\frac{VA}{GO}\right]^{UK} - \log\left[\frac{VA}{GO}\right]^{F}\right] + \log\left[\left[\frac{LW}{VA}\right]^{UK} - \log\left[\frac{LW}{VA}\right]^{F}\right]$$
$$+ [\log W^F - \log W^{UK}] \qquad (3)$$

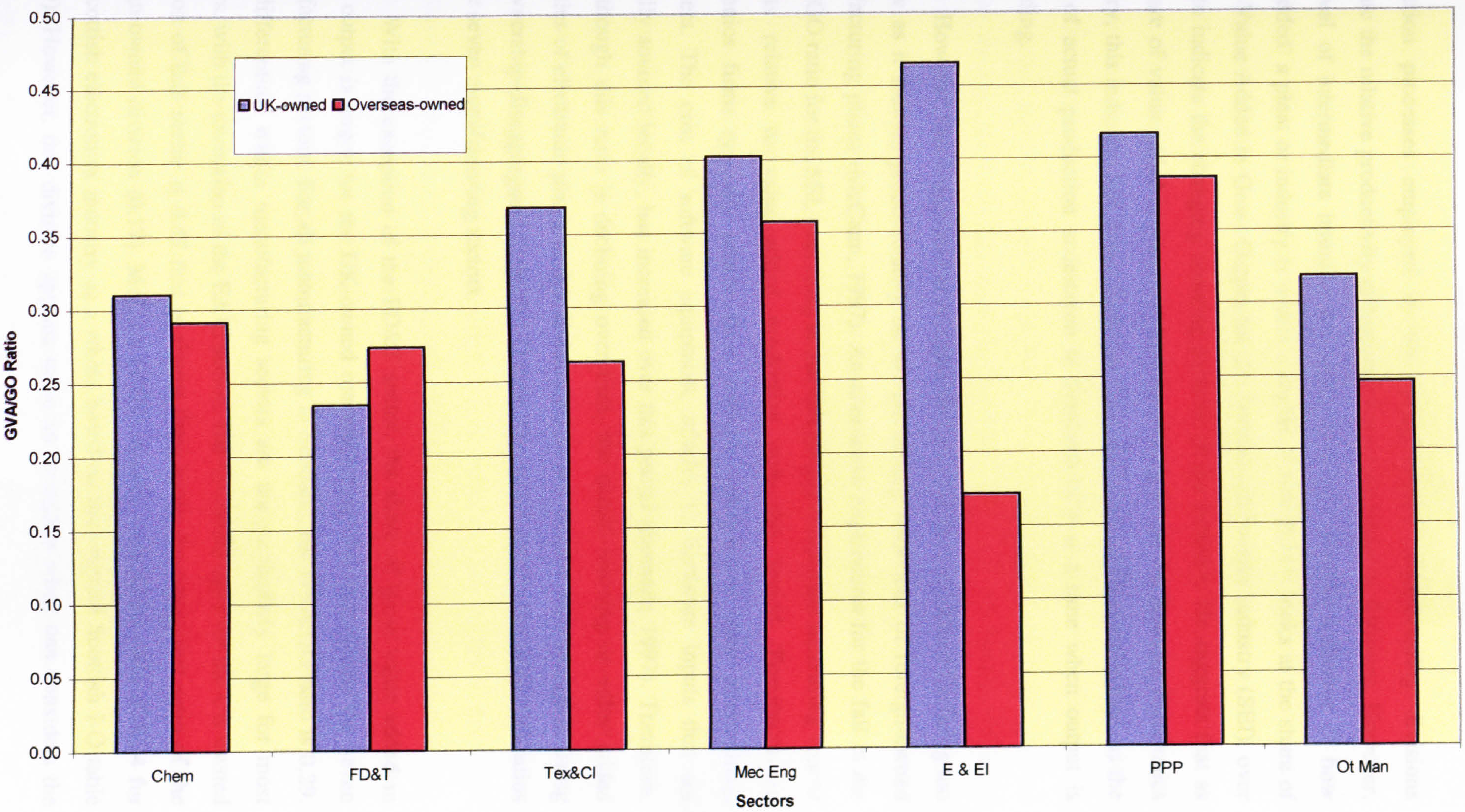
Equation (3) decomposes the elements of the labour productivity differential between foreign and UK-owned firms in any one sector into intermediate intensity, capital intensity and the relative wage effects. The results are reported in Table 2. In this table, the figures in brackets give the proportion of the difference between the foreign and UK-owned output per employee figure accounted for by that factor.

Table 5.2 - The components of the output per employee differentials that exist between the foreign and indigenous-owned manufacturing sectors in the ownership-disaggregated Scottish I-O Table for 1989.							
	Chem	FD&T	T&Cl	Mech Eng	E&IE	PPP	Ot Man
Log of GQ/L Differential	0.16	0.33	0.55	0.22	1.29	0.32	0.30
Intermediate Intensity	0.06	-0.16	0.34	0.12	1.00	0.07	0.26
(Proportions)	*(.41)*	*(-.47)*	*(.62)*	*(.52)*	*(.77)*	*(.23)*	*(.84)*
Capital Intensity	0.03	0.27	0.10	0.01	0.16	0.00	0.01
(Proportions)	*(.21)*	*(.81)*	*(.18)*	*(.3)*	*(.13)*	*(0)*	*(.3)*
Sectoral Wage	0.06	0.22	0.11	0.10	0.13	0.24	0.04
(Proportions)	*(.38)*	*(.66)*	*(.20)*	*(.44)*	*(.10)*	*(.76)*	*(.13)*

Across all sectors the foreign-owned manufacturing divisions generate a greater value of labour productivity than their UK-owned counterparts. Therefore, the logs of the productivity differentials between the foreign and UK divisions are positive across all manufacturing sectors. In five of the seven manufacturing sectors, intermediate intensity is the main component of this differential. In the Other Manufacturing and E&IE sectors it accounts for nearly all of the labour productivity differential (in proportionate terms 0.84 and 0.77 of the differential, respectively). The FD&T sector dominated in the UK-owned division by whisky production, is atypical. In this sector, the UK-owned division is more intermediate intensive than the foreign-owned division. The greater foreign-owned output per employee is the result in this case of higher capital intensity and wage. However, across the remaining manufacturing sectors, capital intensity does not have such a positive impact. Finally, foreign-owned wages are a positive component of the output per employee differential in all of the manufacturing sectors.

The results from Table 5.2 indicate that intermediate intensity is the main determinant of the existing labour productivity differentials within manufacturing sectors. The higher levels of intermediate intensity suggest that much of foreign-owned manufacturing consist of assembly type production units. Essentially, the

Figure 5.3 - Gross Value Added/Gross Output ratios for the manufacturing sectors in Scotland.



production processes employed in the foreign-owned manufacturing divisions generate the relative productivity differential that exists between divisions. However, the level of intermediate intensity has been used as a relative indicator of how 'embedded' a plant or industry is within a region. Turok (1993) looks at the share of Gross Value Added in Gross Output for the Scottish electronics industry (SEI), over time, to indicate the changing sourcing patterns of the industry. He suggests that as the share of value added in gross output falls over time, for the Scottish Electronics Industry, this indicates that these plants are typically becoming less embedded, as the value of actual production undertaken in Scotland falls at a time when output is expanding.

However, this interpretation of embeddedness has been criticised for being too narrow as it focuses predominately on the purchasing behaviour of foreign-owned manufacturing plants (McCann, 1997). An alternative explanation for the fall in the GVA/GO ratio for the SEI, over time, is that this simply reflects the increasing cost of imports relative to value added production over this period. Foreign-owned electronics firms typically source their software components from international suppliers. The cost of software equipment, relative to hardware inputs that are typically sourced locally, has increased over this period (Botham, 1997). Therefore, even though this ratio is declining over time, the actual sourcing or value added activities of electronic plants in this division might not actually have changed. Using the ownership-disaggregated Scottish I-O data, Figure 5.3 reports the GVA/GO ratios for the seven manufacturing sectors.

With the exception of the FD&T sector, the share of gross value added in gross output is larger for the UK-owned manufacturing divisions, across the seven manufacturing sectors. For all manufacturing in Scotland, the GVA/GO ratio is 0.29. The differentials within manufacturing sectors are not particularly large for most sectors, with the exception of the E&IE sector. The GVA/GO ratio for the UK-owned division of this sector is 0.47 that is almost three times the equivalent ratio of the foreign-owned division (0.17). McCann (1997) reports a GVA/GO ratio of 0.24 for the Scottish electronics industry as a whole based on the original Scottish I-O table (1989). However, this division appears to be an exception when one considers the

GVA/GO ratios for the other foreign-owned manufacturing divisions in Scotland (1989).

This may seem a surprising measure to use for 'embeddedness' given that it does not capture the source of intermediate inputs and is largely determined by the stage of the production chain the plant or industry is at. Rather, one may have assumed that a measure of 'embeddedness' would consist of a number of factors including the proportion of local intermediate inputs against imports, the level of intermediate linkages relative to value added or even the ability of an industry to generate local income (income multipliers). Alternative views of embeddedness consider the importance of locational characteristics that firms can benefit indirectly from rather than through the physical input-output ties of the region. Essentially this idea relates to the idea of industrial 'clusters' where firms benefit directly through different types of spillovers that are exclusive to that location and derived from the close proximity of similar, often specialised, plants. These type of effects would include agglomeration economies such as labour market pooling etc. (Recall that this literature was discussed in chapter 1).

In considering how embedded the foreign-owned electronics sector is in Scotland, the GVA/GO ratio is perhaps not a wholly satisfactory measure. It is an important regional measure for indicating the stage, or type of, production being undertaken within the plant or sector. For instance, even though the GVA/GO ratio indicates that the foreign electronics division is very intermediate intensive, the actual contribution of this division to the regional economy is substantial. Thus, intermediate purchases (£568m) and value added (£704m), by this foreign division, contributed over £1 billion in activity to the regional economy in 1989. Using this ratio without other data can give a misleading picture,

Finally, the level of intermediate intensity within a plant or sector can be interpreted in various ways. However, a more traditional measure of 'embeddedness' is typically captured by the proportion of local intermediate inputs to total purchases, within a plant or sector, that are sourced locally (Hirschman, 1958). The level of local sourcing was not directly included in the earlier decomposition of Gross Output. The following section now considers this issue in more detail.

5.2.3 - Local Intermediate Purchases (Backward Linkages).

The level of local intermediate purchases are obviously an important determinant of the impact of foreign-owned plants on the regional economy and these are often used as a relative indicator of how tied an industry or sector is to a region (Hill & Roberts, 1995). As well as comparing relative local intermediate intensity, it will be useful again to perform some decomposition. Formally, local intermediate linkages can be expressed as:

$$\frac{LI}{L} = \frac{LI}{GO} * \frac{GO}{L} \qquad (4)$$

Where:

LI - Local Intermediate Linkages

L – Employment

GO – Gross Output

Note that there are essentially two parts to equation (4). The first part captures the level of backward linkages, i.e. the ratio of total local intermediate purchases as a proportion of gross output, which I interpret as the 'physical linkage effect'. The second term refers to gross output per employee (labour productivity) which has been discussed already.

$\frac{LI}{GO}$ – measures the 'physical linkage effect'.

$\frac{GO}{L}$ – measures the 'labour productivity effect'.

Taking logs of equation 4 for both the foreign and UK-owned manufacturing divisions and subtracting gives:

$$\log\left[\frac{\frac{LI^F}{L}}{\frac{LI^{UK}}{L}}\right] = \left[\log\left[\frac{GO}{LI}\right]^{UK} - \log\left[\frac{GO}{LI}\right]^{F} + \left[\log\left[\frac{L}{GO}\right]^{UK} - \log\left[\frac{L}{GO}\right]^{F}\right]\right] \qquad (5)$$

Using data from the ownership-disaggregated I-O Table, I report the results for equation (5) for the manufacturing sectors in Table 5.3.

Table 5.3 - The components of the level of local intermediate linkages per employee for the foreign and indigenous-owned manufacturing sectors in the ownership-disaggregated Scottish I-O Table.

	Chem	FD&T	T&Cl	Mech Eng	E&IE	PPP	Ot Man
Log of LI/L Differential	0.09	-0.32	0.54	-0.02	1.09	0.33	0.01
Physical Linkage Effect	-0.06	-0.65	-0.01	-0.24	-0.21	0.01	-0.29
Labour Productivity Effect	0.16	0.33	0.55	0.22	1.99	0.32	0.30

The first row of Table 5.3 reports the log of the ratio of the value of intermediate linkages per employee in the foreign and UK-owned manufacturing divisions. A positive values indicate that local intermediate purchases (local linkages) per employee are higher in the foreign-owned manufacturing divisions. This is the case in five of the seven manufacturing sectors. Note the variation in results across these five sectors. The differential varies from 0.01 in the Other Manufacturing sector to 1.09 in the E&IE sector. In the FD&T and Mechanical Engineering sectors the negative differential indicates that local linkages per employee are larger for the UK-owned divisions of these two sectors. The composition of these differentials helps explain these results.

Firstly, note that in almost all sectors the 'physical linkage effect' is negative and the 'labour productivity effect' is positive. The negative 'linkage' effect implies that the UK-owned manufacturing divisions typically source a higher proportion of their intermediate inputs from within Scotland. Similarly, the positive 'productivity effect' generally reflects the higher levels of intermediate intensity in the foreign-owned manufacturing divisions. With the exception of FD&T, the differential attributable to differences in physical linkages within sectors is relatively small and in the paper, printing and publishing sector (PPP) this component is positive, reflecting the higher proportion of inputs that are sourced locally by the foreign-owned manufacturing division. In each manufacturing sector, the differences in local intermediate linkages per employee attributable to the 'physical linkage effects' are typically offset by the differences in 'productivity'.

In summary, the high levels of intermediate intensity by the foreign-owned manufacturing divisions are the main determinant of both the high values of output and local intermediate purchases, per employee, generated by these divisions. I next consider the potential trade effects generated by the different foreign-owned manufacturing divisions.

5.2.4 Trade Effects.

Foreign-owned plants are typically associated with exports and much of the recent FDI into Scotland and the other regions of the UK have been to provide an export base for the EU market (Neven and Siotis, 1994). Figure 5.4 shows the volume of exports for the manufacturing divisions in Scotland for 1989 (intermediate imports were reported earlier in Table 5-1). In total, 68 per cent of all manufacturing output in Scotland is exported outwith the region so that Scottish manufacturing is relatively export-intensive. In aggregate, foreign-owned manufacturing is more 'export-intensive'. However, the degree of export intensity varies across both the individual foreign and UK-owned manufacturing divisions. For instance, the foreign-owned textiles and clothing sector exports less than 60 per cent of its total output, which indicates that the remaining 40 per cent of its output is sold in Scotland. However, recall from the adjustment process used to allocate exports in Chapter 4 that the higher export intensity of the foreign-owned manufacturing sector reflects the industrial composition of this sector. Thus, foreign-owned manufacturing sector plants are typically located in high-export sectors.

Recall from the analysis in Chapter 3, which linked the export intensity of the incoming plant with the level of product market displacement. Given an export intensity of 60 per cent, the results imply that an expansion in the foreign-owned textiles division would lead to displacement of indigenous or other foreign-owned sales in Scotland.

Figure 5.4 - Exports by manufacturing sector in Scotland (1989)

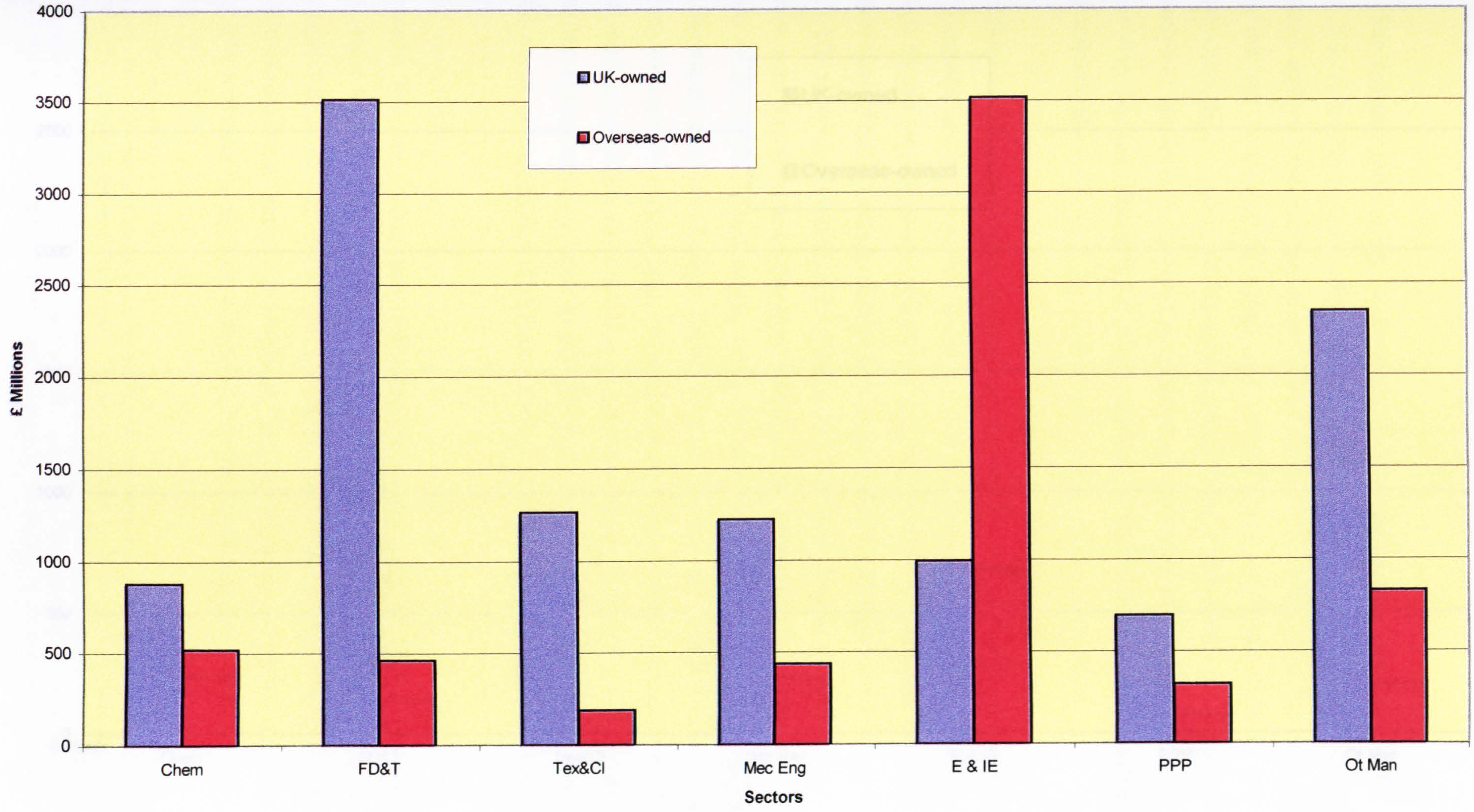
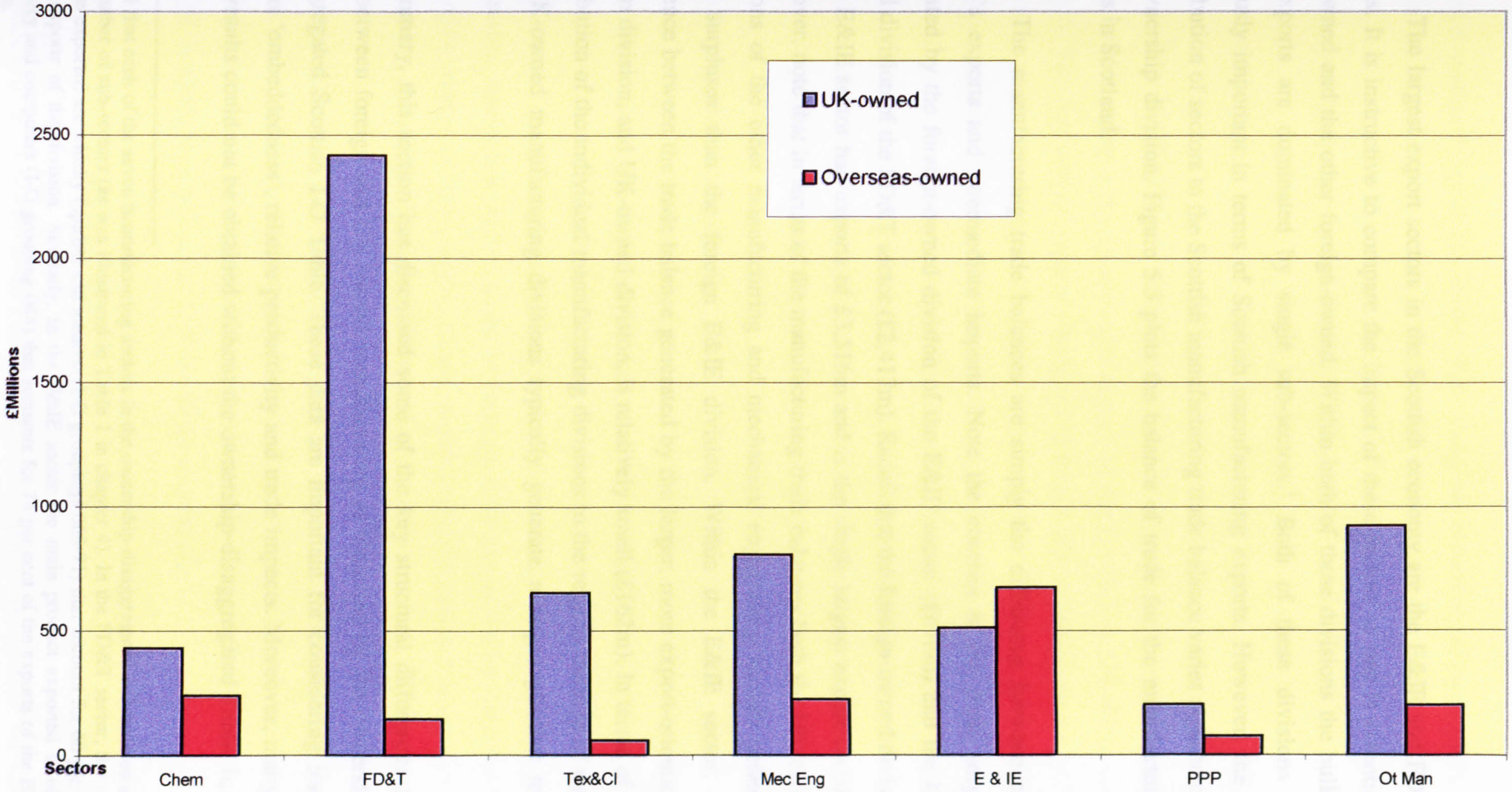


Figure 5.5 - Balance of Trade for the manufacturing sectors in the ownership-disaggregated Scottish I-O Table.



The largest export sectors in the Scottish economy are the E&IE and FD&T sectors. It is instructive to compare the impact of these sectors as one is essentially UK-owned and the other foreign-owned. Within both of these divisions the bulk of the exports are dominated by single sub-sectors.[1] Both of these divisions are obviously important in terms of Scottish manufacturing exports. However, the net contribution of sectors to the Scottish manufacturing trade balance varies significantly by ownership division. Figure 5.5 plots the balance of trade for the manufacturing sectors in Scotland.

The manufacturing trade balances are simply the difference between each sector's exports and intermediate imports. Note the contrast in the trade surplus generated by the foreign-owned division of the E&IE sector (£676m) and the UK-owned division of the FD&T sector (£2,417m). Recall that the foreign-owned division of the E&IE sector had exports of £3,516m and is the single largest export division. Moreover, note that in terms of the manufacturing trade balances both the UK-owned divisions of the other manufacturing and mechanical engineering sectors generate larger surpluses than the foreign E&IE division. Within the E&IE sector, the difference between the trade balance generated by the larger, more export-orientated, foreign division, and UK-owned division, is relatively small (£162m). In terms of the contribution of the individual manufacturing divisions to the regions balance of trade, the UK-owned manufacturing divisions typically generate a larger positive trade surplus.

In summary, this section has discussed some of the key structural differences that exist between foreign and UK-owned manufacturing as indicated by the ownership-disaggregated Scottish I-O Table. These data are important for considering issues such as 'embeddedness', relative productivity and trade impacts. Moreover, many of these results could not be obtained without the ownership-disaggregated Table. In the

[1] Recall that each of the seven manufacturing sectors in the ownership-disaggregated I-O table consists of a number of sub-sectors (as was illustrated in Table 1 in chapter 4). In the FD&T sector, the main products exported are whisky (spirits) and tobacco (I-O groupings 068-71) that account for 60 per cent of the exports of the division. Similarly, in the E&IE sector the main product exported is office machinery and computers (I-O grouping 044) that accounts for 74 per cent of the exports of the E&IE division.

following section I report the results from using the ownership-disaggregated I-O Table as an I-O model.

5.3 – Ownership-Disaggregated Scottish I-O Model For 1989.

5.3.1 – Introduction.

In this section I report how the ownership-disaggregated Scottish I-O model can be used to capture the system-wide impact of foreign-owned manufacturing in Scotland. The first section reports standard I-O output and employment multipliers and discusses the interpretation of both. Following on, I simulate an aggregate 10 per cent export shock to both the UK-owned and foreign-owned manufacturing divisions and consider the impact on both total Scottish output and employment. In the final section, I consider the total linkage of the foreign-owned manufacturing sector in Scotland and its impact on output and employment using an application of 'the hypothetical extraction method' (Lahr & Miller; 1998).

5.3.2 - Sectoral I-O Multipliers.

It is conventional to use the I-O table as a basis for an I-O model. Within this framework, input-output multipliers capture the system-wide impact of an expansion of final demand for the output of one sector or industry within a region, given a set of assumptions. Recall that the I-O model is based on a number of limiting assumptions i.e. passive supply-side and no price effects. Accordingly, the results generated by the model in this and preceding sections must be viewed in this context.

Multipliers are generally used to estimate the effects of exogenous demand changes on regional output, income and employment. In this section I discuss only output and employment multipliers.[2] As noted in chapter 2, the link between output and final demands in an I-O model is given by the expression:

$$X = (I - A)^{-1} F \qquad (6)$$

[2] The derivation of the sectoral I-O multipliers, used in this section, follows the exposition and notation

Where, $(I-A)^{-1}$ is the Leontief inverse, F is a vector of final demands and X is the vector of gross outputs. I denote the Leontief inverse of the model as L. The element L_{ij} indicates the amount of industry i's output that is required per final demand unit of industry j. The Leontief inverse of the model captures the direct and indirect requirements needed to produce one unit of output for a given industry. The multiplier for industry j is equal to $\sum_{i=1}^{n} Lij$, that is the sum of each element of the jth column of the Leontief inverse, which gives the standard backward linkage Type 1 output multiplier for that sector. (This is similar to the expression derived by Rasmussen, 1956, which was discussed in Section 2.4.3 of Chapter 2.) The type II output multiplier, which incorporates the induced effect of additional consumption, is calculated in a similar manner, except that the model is now closed with respect to households.[3]

As the input-output model does not explicitly model the labour market, or include employment directly within the model, employment multipliers are calculated by incorporating output/employment coefficients for each sector in the multiplier model. The vector of coefficients (V) provide the link between employment and output for the n sectors in the I-O model.[4] For calculating sectoral I-O employment multipliers there is essentially two stages: In the first stage I calculate the employment/output multipliers, which capture the amount of employment required per unit of direct and indirect output. These are derived using the employment/output coefficients (V) and the Leontief Inverse (L) of the model. The employment/output multiplier, E_j, for sector j is then calculated as follows.[5]

$$E_j = \sum_{i=1}^{n} Lij * V_i \qquad (7)$$

given in Miller and Blair (1985).

[3] The income from employment row and consumer expenditure column from the ownership-disaggregated Scottish I-O table are included in the A matrix of technical coefficients which allows the additional income and consumption effects (induced) to be incorporated in the output multiplier.

[4] The employment/output coefficients are the inverse of the output per employee totals reported earlier.

[5] Again the type II employment/output multiplier is calculated in the same manner except that an extra column and row are added to the Leontief inverse of the model as it is closed with respect to households.

From equation (7), the total employment multiplier for sector j (W_j) is calculated as,

$$W_j = \frac{\sum_{i=1}^{n} Lij * V_i}{V_j} \qquad (8)$$

5.3.3. - Output Multipliers.

Table 5.4 reports type I and II sectoral output multipliers for the manufacturing sectors in the ownership-disaggregated Scottish I-O table.[6] In five of the seven manufacturing sectors the type I backward-linkage output multipliers are larger for the UK-owned divisions. In the textiles and clothing sector (T&CL) both manufacturing divisions have the same backward linkage output multiplier and in the PPP sector the foreign divisions output multiplier is slightly larger. The largest type I output multiplier (1.84) is for the UK division of the FD&T sector. Recall that local intermediate linkages by this division were large relative to both the other UK and foreign-owned manufacturing divisions. The largest foreign-owned type I output multiplier (1.48) is for the foreign-owned division of the T&CL sector. The lowest foreign and UK-owned type I sectoral output multipliers are 1.17 and 1.21, respectively, for the E&IE sector. Overall the type I sectoral output multipliers for both divisions of each manufacturing sector are fairly similar.

Table 5.4 – Type I & II Output multipliers for the manufacturing sectors based on the ownership-disaggregated Scottish I-O Model for 1989.

	Chemicals		FD & T		T & CL		M. Eng		E & IE		PPP		Ot Man	
	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For	UK	For
I	1.45	1.42	1.84	1.44	1.48	1.48	1.44	1.34	1.21	1.17	1.30	1.31	1.45	1.34
II	2.19	2.10	2.77	2.04	2.53	2.28	2.61	2.34	2.18	1.56	2.33	2.28	2.46	2.11

It is the case that for type II output multipliers, the incorporation of the induced household effects always increases the UK-owned type II output multipliers

[6] In the data appendix for this chapter, Table 10 reports the type I and II output, income and

by more than the foreign-owned multipliers. Essentially there are two issues here that effect the size of the type II output multipliers. Type II output multipliers incorporate wages. The impact of this will be less for foreign-owned firms because both the share of value added in gross output and labour income in value added are relatively low. Recall from the earlier analysis that both the $\frac{VA}{GO}$ and $\frac{L.W}{VA}$ ratios were lower for the foreign-owned divisions. Therefore, even though the foreign-owned manufacturing plants typically pay higher wages, an expansion in output in these sectors requires less labour for each unit of output produced, which generates a lower type II output multiplier for these manufacturing divisions.

It is possible to decompose the type II output multiplier further into the direct, indirect and induced output effects. The direct effect shows the impact of the one unit increase in final demand within that particular industry. The indirect output effect captures the impact on other industries that supply inputs to that particular industry and the induced impact shows the additional output generated by the increase in household income and consumption. Table 5.5 reports the decomposed type II output multipliers for the UK and foreign-owned manufacturing divisions.

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employment multipliers for all sectors in the ownership-disaggregated Scottish I-O Table.

Table 5.5 – Decomposition of type II output multipliers for the UK and foreign-owned manufacturing divisions.			
	Direct Effect	Indirect Effect	Induced Effect
Chem (UK)	1.00 *(0.46)*	0.73 *(0.33)*	0.46 *(0.21)*
Chem (For)	1.00 *(0.48)*	0.68 *(0.32)*	0.42 *(0.20)*
FD&T (UK)	1.00 *(0.36)*	1.19 *(0.43)*	0.58 *(0.21)*
FD&T (For)	1.00 *(0.49)*	0.66 *(0.32)*	0.38 *(0.19)*
T&CL (UK)	1.00 *(0.40)*	0.87 *(0.35)*	0.66 *(0.26)*
T&CL (For)	1.00 *(0.44)*	0.78 *(0.34)*	0.50 *(0.22)*
Meng (UK)	1.00 *(0.38)*	0.88 *(0.34)*	0.73 *(0.28)*
Meng (For)	1.00 *(0.43)*	0.72 *(0.31)*	0.62 *(0.27)*
E&IE (UK)	1.00 *(0.46)*	0.58 *(0.26)*	0.60 *(0.28)*
E&IE (For)	1.00 *(0.64)*	0.32 *(0.20)*	0.24 *(0.15)*
PPP (UK)	1.00 *(0.43)*	0.69 *(0.29)*	0.64 *(0.28)*
PPP (For)	1.00 *(0.44)*	0.67 *(0.29)*	0.61 *(0.27)*
O Man (UK)	1.00 *(0.41)*	0.83 *(0.34)*	0.63 *(0.26)*
O Man (For)	1.00 *(0.47)*	0.62 *(0.30)*	0.48 *(0.23)*

The vales in parenthesis (italics) indicate the proportion of the type II output multiplier that each component accounts for. Note that with I-O output multipliers the direct effect is always equal to unity, which simply reflects the unit increase in final demand for the output of that sector. This, in fact, accounts for the largest component of the output multiplier. As was noted in chapter 2 the first round or direct effects of any expenditure or changes in final demand are typically larger than subsequent rounds. Of the indirect and induced multiplier effects, the indirect multiplier effects are the largest component in eleven of the twelve manufacturing divisions. UK-owned Electronics is the only manufacturing division where the induced multiplier effects are larger.

Moreover, the indirect multiplier effects are larger for the UK-owned division in six of the seven manufacturing sectors. (The indirect effect accounts for the same proportion of the total output multipliers in both ownership divisions of the PPP sector.) The indirect component of the output multiplier is determined essentially by the ratio of local intermediate purchases to total output, which is typically lower in the foreign-owned manufacturing divisions. In contrast, the induced component of the type II output multiplier is determined by both the average wage rate for the division and the share of labour income in total value added. Sectors with large indirect effects include UK-owned FD&T division, UK-owned Mechanical Engineering and UK-owned TC&L. Sectors with large induced effects include both ownership divisions of Mechanical Engineering and PPP and the UK-owned Electronics division.

5.3.4 - Employment Multipliers.

Recall that there are two components required to derive employment multipliers: the vector of employment/output coefficients and the employment/output multipliers. Table 5.6 reports the employment/output coefficients and both the type I & II employment/output and total employment multipliers for the seven manufacturing sectors in the ownership-disaggregated Scottish I-O model. In calculating these sectoral I-O employment multipliers I have derived the employment data from the published Scottish I-O accounts (HMSO, 1994). To obtain full time equivalent employment data for all divisions in the ownership-disaggregated Scottish I-O table, I used ACOP employment data that are disaggregated by ownership to provide shares to split the original I-O sectoral employment data.

Table 5.6 - Components of the type II sectoral I-O employment multipliers for the manufacturing divisions in Scotland (1989).					
	Emp/Out Coeff's	Employment/Output Multipliers		Employment Multipliers	
	V_i	E_1	E_2	W_1	W_2
Chem (UK)	0.011	0.020	0.030	1.81	2.68
Chem (For)	0.009	0.018	0.027	1.89	2.82
FD&T (UK)	0.011	0.030	0.043	2.77	3.87
FD&T (For)	0.008	0.018	0.026	2.28	3.28
T&CL (UK)	0.030	0.043	0.057	1.45	1.90
T&CL (For)	0.017	0.031	0.041	1.77	2.37
Meng (UK)	0.029	0.041	0.056	1.41	1.93
Meng (For)	0.023	0.033	0.046	1.40	1.96
E&IE (UK)	0.024	0.029	0.042	1.21	1.73
E&IE (For)	0.007	0.011	0.016	1.62	2.38
PPP (UK)	0.018	0.026	0.039	1.45	2.19
PPP (For)	0.013	0.021	0.034	1.62	2.59
O Man (UK)	0.017	0.029	0.042	1.68	2.45
O Man (For)	0.013	0.022	0.032	1.69	2.48

The second column of Table 5.6 reports the employment/output coefficients. These simply reflect the labour intensity of the manufacturing sectors. Note that the UK-owned-division of the Textiles and Clothing sector is the most labour intensive division and the foreign-owned division of the E&IE sector is the least labour-intensive. The columns E^1_i and E^2_i refer to the type I and II employment/output multipliers. These indicate the amount of direct, indirect and, for type II multipliers, induced employment per unit of output in sector i. Note that across all manufacturing sectors, the employment/output multipliers are larger for the UK-owned manufacturing divisions. In contrast, the type I and II employment multipliers are larger for the foreign-owned manufacturing divisions in six of the seven manufacturing sectors. These employment multipliers provide an interesting and rather unexpected result. They suggest that an exogenous expansion in employment by a foreign-owned manufacturing division will, ceteris paribus, typically generate a larger system-wide employment impact than an equivalent expansion by an indigenous manufacturing division.

McCann (1997) uses the employment multiplier value as a direct measure of physical 'embeddedness'. He cites the large employment multipliers for sectors in the

Scottish Electronics industry, reported by Alexander & Whyte (1995), as evidence of how embedded these sectors are within the regional economy.[7] Such an interpretation is suspect. The differences in the employment multipliers between divisions can be accounted for by considering the components of the total employment multipliers. Using equation (8) and the same decomposition method that has been employed for labour productivity and local input intensity, I can explain the importance of the relevant components of the employment multipliers.

$$\log\left[\frac{W_i^F}{W_i^{UK}}\right] = \left[\log E_i^F - \log E_i^{UK}\right] + \left[\log V_i^{UK} - \log V_i^F\right] \qquad (9)$$

Using the data from the ownership-disaggregated Scottish I-O model, I report the results of the decomposition of equation 9 in Table 5.7.

Table 5.7 - The components of the employment multiplier differential that exists between the foreign and indigenous-owned manufacturing sectors in the ownership-disaggregated Scottish I-O Table.

	Chem	FD&T	T&Cl	Mech Eng	E&IE	PPP	Ot Man
$\log W_i^{2,For} - \log W_i^{2,UK}$	0.052	-0.165	0.221	0.015	0.317	0.167	0.013
$\log E_I^{2,For} - \log E_i^{2,UK}$	-0.103	-0.496	-0.327	-0.210	-0.977	-0.149	-0.291
$\log V_i^{For} - \log V_i^{UK}$	-0.155	-0.330	-0.547	-0.225	-1.294	-0.316	-0.304

The first row in Table 5.7 reports the log of the difference between the employment multipliers in the foreign and UK-owned division of each manufacturing sector. As reported, this difference is positive in six of the seven manufacturing sectors reflecting the larger foreign-owned employment multipliers. Note that, of the two components of the employment multiplier, one has a negative impact on the employment multiplier differential across all sectors and the other a positive impact. The log of the differential in the employment/output multipliers has a negative impact

[7] For instance, the Office Machinery and Computers division (I-O sector 44), which is the largest sub-sector of the Electronics Industry has a type II employment of 3.0.

on the employment multiplier differential, as these multipliers are larger across all UK-owned manufacturing divisions. In contrast, the log of the differential in the employment/output coefficients that reflects the low labour intensity of the foreign-owned divisions is the main determinant of the employment multiplier differentials.

Essentially, as a one unit increase in foreign-owned employment typically generates a larger associated increase in direct output than an equivalent expansion by a UK-owned manufacturing division, the indirect output effects are significant even though the actual proportion of intermediates sourced locally are typically lower than the UK-owned manufacturing divisions. Moreover, the labour intensity levels of the sectors that supply local intermediates to the foreign-owned divisions (typically UK-owned), are such, that the indirect output effects have a larger system-wide employment impact in these divisions.

5.3.5 - Output and Employment Multipliers for Total Exports disaggregated by ownership.

The individual output and employment multipliers for the UK and foreign-owned manufacturing divisions are important for distinguishing between the characteristics of the different manufacturing divisions. However, it is interesting to note the aggregate output and employment multipliers following an exogenous export shock to total UK and foreign-owned manufacturing exports. In this case, I simulate the impact of increasing the exports in each manufacturing division, for all the foreign and UK-owned sectors, by 10 per cent. The UK and foreign-owned output and employment multipliers, reported in Table 5.8, represent the aggregate multiplier for the total UK and foreign-owned sectors following a 10 per cent increase in exports in each manufacturing division.

Table 5.8 - Type I & II output and employment multipliers for the aggregate UK and foreign-owned manufacturing sectors following a 10 per cent increase in the exports of each manufacturing division (both UK and foreign-owned).

Aggegrate Sector.	Output Multiplier		Employment Multiplier	
	Type I	Type II	Type I	Type II
UK-owned Manufacturing	1.55	1.91	1.74	2.44
Foreign-owned Manufacturing	1.26	1.47	1.67	2.43

Note that the type I & II employment multipliers are relatively similar for both the UK and foreign-owned manufacturing sectors, with the UK-owned manufacturing export employment multiplier slightly larger. This reflects the weighting of the FD&T division within UK manufacturing and its relatively high export-intensity. Recall that this division had the largest type I & II employment multipliers. There is however a more marked difference in both the type I and II output multipliers for the UK and foreign-owned manufacturing exports. In both cases the figures for the UK-owned manufacturing export multipliers are substantially larger than the corresponding foreign-owned multipliers.

In summary, for an exogenous demand-side (output based) shock, the I-O employment/output multipliers provide an appropriate measure of the relative employment impact as this multiplier incorporates the variations in the labour intensity of the division. However employment multipliers are perhaps the most important (and widely used) multiplier, particularly in government appraisal and evaluation of regional and regenerational policy instruments where employment is the key objective and evaluation is on a cost per job basis.

5.3.6 – Hypothetical Extraction Method

The structural interdependence between the sectors of a region can be analysed in a number of ways. One of the strengths of I-O is that it clearly maps the linkages that exist between sectors within and outwith the region. In this section I consider the 'total linkage' of the foreign-owned manufacturing sector using a technique developed by Cella (1980), known as 'hypothetical extraction'. (Lahr and Miller (1998) provide a taxonomy of these various approaches and Gillespie *et al* (1998) provides a regional I-O application of this technique to the Oil and Gas Industry in Scotland. This technique was discussed in chapter 2.)

One important aspect of FDI is to consider the counterfactual i.e. what would have happened had the plant or industry not located in Scotland. However, this is very difficult to simulate, although by using the 'hypothetical extraction method', I can provide an indication of the relative importance, and total linkage, of the foreign-owned manufacturing sector in Scotland, by simulating the impact of removing this division from the regional economy. For each foreign-owned manufacturing division, I suppress all linkages (intermediate and final demands) within the I-O model, and then re-solve the model. The difference from the initial model results and the simulated model provides an indication of the total output and employment supported by each division in Scotland.

Motivating this type of total-linkage measurement is perhaps more applicable in the case of foreign direct investment, particularly at the plant or sectoral level. Thus, given the highly mobile nature of FDI plants and the organisational structure of the multi-national company (MNC), it is not unrealistic to assume that the MNC can switch production across plants in different locations or close plants entirely. Moreover, given the typically lower levels of linkages associated with foreign-owned plants, which are generally less integrated within the region, it is realistic to assume that any inputs the FDI plant supplies to other sectors in Scotland could be satisfied via imports. Therefore, by suppressing all linkages, or hypothetically removing a foreign-owned plant or sector, I can estimate the total contribution of this sector in terms of supported output and employment.

However, the use of I-O to investigate such an extreme outcome rather than its conventional use to examine the impact of changes at the margin necessitates caution in the interpretation of the results. Such an extreme shock is likely to cause further destabilising effects within the region, that cannot be captured within the I-O framework. i.e. such a shock would have potential supply-side impacts, particularly in the labour market. Accordingly, these results should be viewed as indicative of the total linkage measure of each foreign-owned manufacturing division rather than providing an accurate analysis of the total impact of the complete contraction of these divisions.

A major weakness of this technique is that if you suppressed each sector in the model, then the total contributions of all these sectors to say, employment generation, is greater than the figure for actual total Scottish employment. Therefore, I compare these results with the allocation of total Scottish activity and employment generated by the final demands for the foreign-owned manufacturing sectors. (Recall that the conventional assumption behind I-O is that exogenous final demand expenditures determine the total employment and economic activity within the region). This measure gives an indication of the relative importance of final demand in each foreign-owned division. Moreover, total Scottish (or foreign-owned employment in this case) can be attributed in terms of the direct, indirect and induced elements. The key difference between both of these measures is that the total suppression or 'hypothetical extraction' technique includes the additional impact of removing forward linkages.

Table 5.9 reports total supported output and employment from final market sales for each foreign-owned manufacturing division in Scotland as well as the implied 'total linkage' output and employment estimates obtained using the 'hypothetical extraction' technique.

Table 5.9 – Comparison of the results from simulating the impact of the complete absence of each foreign-owned manufacturing division with the total supported output and employment from attributing total final market sales for each foreign-owned manufacturing division.				
Foreign-owned Manufacturing Division	Supported Final Market Output £m	Supported Final Market Employment	'Total Suppressed' Output £m	'Total Suppressed' Employment
Chemicals	1,109	14,148	1,393	17,761
FD&T	940	11,924	1,480	18,766
T&CL	470	8,487	714	12,889
Mech Engineering	1,139	22,163	1,277	24,851
E&IE	5,619	56,859	6,148	62,216
PPP	768	11,462	1,417	21,158
Other Manufacturing	1,930	28,920	2,562	38,403
Total Foreign-owned	11,975	153,964	14,992	196,045

Note that the foreign-owned sector supports total Scottish output and employment, from final market sales, of nearly £12 billion and over 153 thousand employees. In total, foreign-owned manufacturing accounts for 13 and 8 per cent respectively of total Scottish output and employment. The largest foreign-owned sub-sector, on this measure, is Electronics whose external demands support 47 and 37 per cent of the total supported foreign-owned output and employment. Using the 'hypothetical extraction' method, total supported foreign-owned output and employment in Scotland increase by around 20 and 21 per cent respectively. Foreign-owned manufacturing supports nearly £15 billion of Scottish output and over 196 thousand jobs.

The 'hypothetical extraction' simulations obviously report an extreme case with the aggregate foreign manufacturing results indicating the impact of eliminating one third of total Scottish manufacturing output. However, it is perhaps not unrealistic to consider the demise or run down of a particular foreign-owned division, particularly in the dynamic or traditional industries such as electronics or textiles, which can be affected more easily by sudden downturns or changes in world demand. For instance, using this measure of total linkage, the foreign-owned electronics division supports over £6 billion of Scottish output and over 62 thousand jobs. Moreover, the closure of foreign-owned textiles sector in Scotland would imply a loss of £714 million of Scottish output and nearly 13 thousand jobs. Finally, these results provide an indication of the relative importance of the aggregate, and individual, foreign manufacturing division, in terms of both the total levels of output and employment supported by external final market sales and the total suppression of each foreign-owned manufacturing division.

5.3.7 - Chapter Conclusion.

In this chapter, I have provided an analysis of the economic impact of foreign-owned manufacturing in Scotland using an input-output model that is disaggregated by ownership. The ownership-disaggregated I-O table is based on the full survey-based Scottish I-O table for 1989. The strength of the ownership-disaggregated I-O Table is that it brings together different Scottish data sources, which are reconciled within a coherent framework. Many of the results presented in this section are impossible to obtain elsewhere and are specific to an I-O (or other accounting) type framework. These are particularly important for considering many regional policy issues, such as how 'embedded' or integrated individual foreign-owned manufacturing divisions are within the region.

The model results indicate that there are substantial structural differences between the foreign and UK-owned manufacturing sectors in Scotland. In general, foreign-owned manufacturing is more capital, intermediate and export intensive. However, the UK-owned manufacturing divisions contribute significantly more to the overall manufacturing balance of trade within the region. The sectoral I-O output and employment multipliers also capture the structural characteristics of both UK and foreign-owned production. Type I & II output multipliers are typically larger for the UK-owned manufacturing divisions, reflecting both the more in-depth linkage structure and labour intensity of production in these divisions. In contrast, the total employment multipliers are typically larger in the foreign-owned manufacturing divisions, which again reflects the high intermediate and capital intensity levels employed by these divisions.

In considering how embedded foreign-owned manufacturing is within Scotland, the results indicate, in general, that the foreign-owned manufacturing divisions are less embedded within the region. However, the actual differences in sourcing patterns (intermediate linkages) are relatively small. The different production methods (intermediate and capital intensity levels) employed by the foreign-owned divisions, rather than the differences in intermediate linkages, would appear to have a more significant impact in determining the overall contribution of these divisions to the region.

Using the 'hypothetical extraction' method provides an illustrative measure of the total linkage and employment supported by the foreign-owned manufacturing sector in Scotland. The results reveal that this sector supports total Scottish output of over £15 billion and some 196 thousand jobs in 1989. Of the components of this sector, the E&IE division is the most important with supported output and employment of over £6 billion and 62 thousand jobs, respectively, in 1989. These results, however, provide an extreme measure of the total impact of removing each foreign-owned manufacturing division.

In contrast, allocating total supported output and employment to final market sales, for each foreign-owned manufacturing division, reveals that foreign-owned manufacturing accounted for 13 and 8 per cent respectively of total Scottish output and employment in 1989. The estimates of total foreign-owned Scottish output and employment supported by final market sales are around 20 per cent lower than those reported for the total 'suppression' of each foreign-owned manufacturing division. However, the allocation of total supported final market output and employment is consistent with the overall values for total Scottish output and employment.

Finally, the I-O model cannot capture the full range of potential FDI impacts given the restrictive assumptions underlying the model. However, the ownership-disaggregated I-O Table provides a comprehensive set of regional accounts that can be used to identify many of the important characteristics of both indigenous and foreign-owned manufacturing. Accordingly, for a system-wide evaluation of FDI an ownership-disaggregated input-output table for Scotland provides an important starting point.

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5.4. - Chapter Appendix.

Table 5.10 reports type I & II output, income and employment multipliers for all sectors based on the ownership-disaggregated Scottish I-O model.

Table 5.10 - Type I and II Sectoral Output, Income and Employment multipliers, for all sectors in the ownership-disaggregated Scottish I-O table (1989).

	Output Multipliers		Income Multipliers		Employment Multipliers	
	Type I	Type II	Type I	Type II	Type I	Type II
Chem (UK)	1.42	2.12	1.65	2.28	1.74	2.52
Chem (For)	1.38	2.01	1.67	2.31	1.79	2.61
FD&T (UK)	1.82	2.72	2.80	3.86	2.63	3.59
FD&T (For)	1.43	2.00	2.05	2.82	2.16	3.01
T&CL (UK)	1.45	2.46	1.54	2.12	1.49	2.03
T&CL (For)	1.45	2.22	1.83	2.52	1.85	2.56
Meng (UK)	1.43	2.59	1.45	2.00	1.38	1.84
Meng (For)	1.34	2.32	1.40	1.93	1.38	1.86
E&IE (UK)	1.20	2.16	1.20	1.65	1.19	1.66
E&IE (For)	1.17	1.54	1.52	2.09	1.59	2.24
PPP (UK)	1.30	2.32	1.34	1.85	1.43	2.09
PPP (For)	1.31	2.27	1.37	1.89	1.61	2.46
O Man (UK)	1.45	2.43	1.56	2.15	1.53	2.08
O Man (For)	1.33	2.09	1.54	2.13	1.54	2.11
Agriculture	1.57	2.47	1.97	2.72	1.92	2.63
Energy + Water	1.43	2.09	1.98	2.73	2.00	2.75
Construction	1.54	2.57	1.66	2.29	1.43	1.78
Services	1.17	2.61	1.13	1.55	1.13	1.55

CHAPTER 6 – Construction of the Ownership-Disaggregated CGE Model Framework: AMOSFDI.

6.1 – Introduction

Chapter 3 provided an analysis and overview of the potential impact of inward investment on the Scottish economy, using the AMOS CGE model. However, the case for further disaggregation, to allow separate identification of foreign- and UK-owned components of the manufacturing sector, was compelling. The distinctive "structure" of foreign-owned manufacturing firms, in terms of higher capital intensities, greater import propensities and higher wages, for example, has been documented in chapters 1 and 5 and through out the general FDI literature. These differences can only be captured by a model that separates out the foreign-owned sub-sector of manufacturing. Moreover, a number of theories of FDI imply that foreign-owned firms may behave differently from indigenous firms and this can only be captured within a framework where foreign and UK-owned manufacturing firms are separately identified.

Chapter 5 provided a detailed analysis of the results from the ownership-disaggregated Scottish Input-Output database. This analysis included results from viewing the ownership-disaggregated I-O Table as an accounting framework, as well as, using these data to form the basis of an I-O model. However, the main purpose for constructing the ownership-disaggregated I-O Table is to provide the database for an ownership-disaggregated CGE model, which is one of the primary objectives of this thesis.

In this chapter, I discuss the importance of 'structure' and 'behaviour' in regional CGE's and outline a simulation framework in which I capture both the impact of distinct 'structure' and one particular specification of alternative behaviour for the foreign-owned manufacturing sub-sector. The chapter proceeds as follows. In section 6.2 I discuss the general literature relating to the importance of "structure" and "behaviour" in regional CGE's. In section 6.3, I provide an overview of the

AMOSFDI[1] simulation framework and models. Section 6.4 details the specification and calibration of these models. Section 6.5 discusses the SAM's used for each simulation model. Section 6.6 illustrates how these data are used to calibrate the model and section 6.7 provides a summary of model characteristics. Section 6.8 provides a short conclusion.

6.2 The importance of "structure" and "behaviour" in regional CGEs

As noted previously, foreign-owned manufacturing plants exhibit structural and behavioural characteristics that are typically different from indigenous manufacturing plants. In order to evaluate the impact of these plants (or sub-sector) one must incorporate these differences within the modelling framework i.e. the econometric, I-O, or as in this case, the CGE model. However, the consideration of the importance of both 'structural' and 'behavioural' equations within regional CGE's is not novel, although this particular application to FDI is.

For instance, Haddad *et al* (1998), drawing on related ideas in Israilevich *et al* (1996) and Gazel *et al* (1996)[2], explore the comparative importance of what they term "structural coefficients" and "behavioural parameters" in computable general equilibrium models (CGEs).[3] The former essentially reflect the base year social accounting matrix (SAM), and the latter refer to the functional forms and key parameters of the CGE. The labelling is, therefore, indicative and not intended to be interpreted literally. In this chapter I aim to explore this distinction further. I begin by considering *a priori* what factors are likely to govern the contribution of "structure" and "behaviour", in the sense these terms are used by Haddad *et al* (1998), to the regional impact of a demand shock, such as FDI. The approach is therefore quite pragmatic and not rooted in any appeal to the fundamental of for example, a neoclassical ideal-type model in which structure can be characterised in terms of utility and production functions.

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[1] AMOSFDI is an ownership-disaggregated variant of the AMOS model.
[2] These in turn build on earlier work by Hewings (1977,1984).
[3] The analysis of Haddad *et al* (1998) explores these ideas in Marshallian CGEs (e.g. Israilevich *et al*, 1997), as well as the better known Walrasian CGEs, such as that employed here.

Haddad, *et al* 1998 adopt a clear distinction between what they term 'structural' and 'behavioural' coefficients within CGE's. The 'structural' coefficients are captured by the main database of the model. In contrast, the 'behavioural' coefficients relate to the functional forms or specification chosen for the sector. In terms of FDI it is well documented that multi-national corporations (MNC's) operate in a particular manner, which in part dictates their sourcing patterns and production options for plants within the company. For instance, multi-national companies are more likely to source intermediate inputs from global suppliers or through inter-company transactions. These linkage and production characteristics are essentially captured in the base year data of the model, which in part reflect past or existing behaviour. This implies that such a clear distinction between what are termed 'structural' and 'behavioural' coefficients is perhaps flawed. However, I adopt this approach to highlight both the importance of accurately capturing the structural characteristics of foreign-owned plants in the base year model and to illustrate the potential role of 'behaviour' in influencing the impact of inward investment. The labelling is, therefore, indicative and not intended to be interpreted literally.

The "short-run" of many regional CGEs, including the model I employ in this chapter (AMOSFDI) and in chapter 3 (AMOS), is typically characterised by sectorally fixed capital stocks and geographically immobile labour. In this context any final demand stimulus will cause the price of both labour and capital to rise, and this in turn will generate various relative price changes and induce supply-side responses. In such a context sectoral responses are extremely unlikely to be uniform because sectors will be affected to different extents because of factor intensities and may be subject, for example, to different price-elasticities of demand.

In these circumstances "behaviour" differs among sectors, and "structure" is insufficient to pre-determine the systems' responses to demand disturbances. Indeed, because of this the economic "structure" is itself endogenous, evolving in response to the various incentives provided by relative price changes. Thus demand stimuli in the presence of any regional-specific factor would typically imply a different I-O table and SAM after the disturbance from that used to calibrate the model initially. This, of course, does not imply that initial structure "does not matter" in these circumstances.

Rather the implication is that not only structure matters: behaviour influences the system's response to disturbances as well as the factors that underlie differences in initial structure.

However, the long-run effects of a demand stimulus in the context of a small open region may be quite different (McGregor *et al*, 1996).[4] In the short-run different assumptions about the behaviour of sectors can generate radically different responses to demand disturbances, but in the long run these differences tend to disappear, as the solutions for a wide range of models all converge on the I-O solution. In the long run it is "as if" factors are in infinitely elastic supply: demand disturbances therefore do not have any impact on relative prices, so that there is no incentive for substitution in consumption or production. The fact that "behaviour" may differ radically among sectors in the face of relative price changes becomes irrelevant when conditions ensure the absence of such changes. Here "behaviour", as captured by the key parameters and behavioural relations of the CGE, may matter a great deal in the short-run (in addition to structure), but does not matter at all in the long run. In the long-run only "structure" matters and the model results are pre-determined by the nature of the initial I-O table and model.

In terms of FDI, ensuring that the initial base year model reflects the 'true' characteristics of the sector is important. However, depending on the type of exogenous shock and the characteristics of the region, 'behaviour' as defined will determine how the sector responds to this shock. This, in many cases, will imply a change in the initial structure of the region.

In this chapter, I discuss the motivation and construction of my simulation strategy and Models in order to develop a framework that can explore the contributions of "structure" and "behaviour" in influencing the overall impact of a inward investment (FDI), on the host region. This application is of particular interest given the emphasis placed on the distinctiveness of the "structure" of the foreign-

[4]Recall that McGregor *et al* (1996) demonstrate that, while local wage bargaining and capacity constraints may characterise the short-run behaviour of a small, open region, in the long-run capital accumulation/ decumulation and net migration flows may ultimately ensure the absence of any regional-specific factor.

owned sub-sector. Naturally, the higher capital intensity, lower linkages with the domestic sector, and higher wages are, for example, all captured in the base year, ownership-disaggregated SAM. Moreover, I outline a simulation framework that allows me to measure the extent to which this distinctiveness in structure governs the regional impact of FDI, and to what extent differences in "behaviour" prove important in this context. This is achieved by comparing the simulation properties of a hypothetical model, which is predicated upon an assumption of identical structure and behaviour of foreign- and UK-owned sub-sectors of manufacturing, with models that incorporate actual differences in "structure" and in "behaviour". I explain precisely how I proceed in the following sections with discussion of the model construction and the general simulation framework.

6.3. The AMOSFDI simulation framework and models

I begin by presenting an overview of the general AMOSFDI CGE framework. I then outline the simulation strategy, which involves comparative simulations of three specific model configurations of AMOSFDI. Finally, I outline the precise specification and calibration of these three models. This includes a discussion of differences: in "behaviour" among the three models that I employ in simulation, as reflected in different functional forms and key parameters; differences in "structure", as reflected in the social accounting matrix's (SAM's) to which the models are calibrated.

6.3.1 AMOSFDI general simulation framework

The general AMOS modelling framework was outlined in chapter 3. The AMOSFDI model is an ownership-disaggregated variant of the model, developed specifically to accommodate the apparent differences (structural and behavioural) that exist between UK- and foreign-owned manufacturing. The key difference between both models is that the AMOSFDI framework incorporates, separately, the foreign-owned sub-sector of manufacturing. The differences between the AMOS and AMOSFDI model relate primarily to the calibration and specification of the additional foreign manufacturing sector. In this section, I discuss these key differences, with the remaining AMOSFDI framework as discussed in chapter 3 for the AMOS model.

AMOSFDI has five transactor groups, namely households, the non-household personal sector, foreign-owned and UK-owned corporations, and government; four commodities and activities, viz. foreign-owned and UK manufactures, non-manufacturing traded and sheltered, and two exogenous external transactors (RUK and ROW). As discussed in the earlier Chapter for the AMOS model, commodity markets are taken to be competitive and I do not explicitly model financial flows. The assumption being that Scotland is a price-taker in competitive UK financial markets.

The AMOSFDI framework is identical to the original AMOS model in allowing a high degree of flexibility in the choice of key parameter values, model closures and even aggregative structure. For instance, no matter how the AMOSFDI model is configured, I can impose cost minimisation in production with multi-level production functions, generally of a CES form but with Leontief and Cobb-Douglas being available as special cases (used here in Model 3 below). The major sources of final demand are as before: consumption, investment, government expenditure and exports. Of these, consumption, real government expenditure and investment are identical to the earlier model specification. Recall that the initial inward investment is treated as exogenous with each period's capital stock updated between periods using a simple capital adjustment procedure. Exports (and imports) are generally determined via an Armington link (Armington, 1969) and are therefore relative-price sensitive (though here the exports of the foreign-owned manufacturing sector in Model 3 is exceptional in assuming a Leontief functional form).

The AMOSFDI framework also offers a variety of alternative hypotheses about the determination of regional wages, as discussed in chapter 3. In the AMOSFDI simulations, which are reported in chapter 7, I use both the national and regional bargaining (LNJ, 1991) labour market closures, with and without migration. Moreover, as in chapter 3, unless otherwise specified (see below for the foreign and UK-owned manufacturing sub-sectors in Model 3) all sectors use a CES technology with "best guess" elasticities of substitution of 0.3 (Harris, 1989) and Armington trade substitution elasticities of 2.0 (Gibson, 1990). The capital stock adjustment parameter (λ) is taken to be 0.5 in each sector. In summary, the AMOSFDI CGE model is an ownership-disaggregated variant of the AMOS CGE model. The key differences in structure and behaviour relates to the manufacturing sub-sectors: foreign and UK-owned.

6.3.2 Simulation strategy: Measuring the importance of the "structure" and "behaviour" of the foreign-owned sector

Hypothetical extraction methods have traditionally attempted to measure the importance of various sectors (or sub-sectors) for the relevant economy through simulating the consequences of suppressing some input-output linkages i.e. intermediate or final demands. (Recall that chapter 2 provided a review of this technique in an I-O context and chapter 5 illustrated an application to the ownership-disaggregated Scottish I-O Model.) My concern here is of a different kind, however. Starting from a model in which there is no distinction between the UK- and foreign-owned manufacturing sectors, I wish to disaggregate by ownership in a way that allows us to identify the separate contributions of differences in initial structure and in behaviour.

I begin by generating a model that, in effect, allows me to assume that the foreign-owned manufacturing sectors exhibits no distinctive structure or behavioural differences from the indigenous manufacturing sector. Model 1 assumes that the foreign-owned sector is identical to the domestically owned sector, in every respect except scale. The actual scale reflects the 'true' scale of the sector. The underlying I-O table and SAM for this model are, of course, hypothetical, derived on the assumption that all that I know about the foreign-owned sector is its share in total output. This captures a naïve "neoclassical" perspective that maintains that location and ownership are irrelevant. Such a model would also represent my "best guess" about FDI impacts in the absence of an appropriate ownership-disaggregated data base. This is an assumption that, in fact, characterises a number of applied studies of the impact of FDI in Scotland (e.g. Alexander and Whyte, 1995), because published Scottish input-output tables do not separately identify the foreign-owned manufacturing sector.

The purpose of Model 1 is, of course, to provide a useful benchmark that assists in the identification of the structural and behavioural influences of inward investment on the host region. In fact, in such a case where the conditions assumed by Model 1 actually prevail it would be difficult to find motivation for FDI since there would, by assumption, be no ownership or location advantages to be gained from it. Model 2, in contrast, acknowledges the true differences in the structures of the domestic and foreign-owned sectors, but maintains the hypothesis of identical behaviour. Here the behavioural equations of each sector are identical in terms of specification and the values of key parameters, outlined in chapter 3. However, the differences in structure are embodied in the ownership-disaggregated input-output table, and wider SAM, which constitutes the database of Model 2. This is based primarily on the ownership-disaggregated data, which was discussed in Chapter 4 and 5. Comparative simulation of Models 1 and 2 thus allows me to determine the impact that differences in structure have on the impact of the FDI shock to the system.

Model 3 allows for the possibility that the behaviour of the foreign-owned sector is distinctive, as well as accommodating the structural differences embodied in the SAM used to calibrate Model 2. Model 3 accommodates one theory of the behaviour of the foreign-owned sector, namely that it is very much less sensitive to local price changes than is the indigenous sector. This specification, as such, provides only one limiting case. Other theoretical models of FDI, particularly for developing countries, assume FDI is driven by quite different factors with the impact on the host economy dependent on a number of issues (Buffie, 1993; Malley & Moutos, 1994).

However, the behavioural specification chosen for the foreign-owned manufacturing sector, in Model 3, provides only one measure of the impact of incorporating 'distinct' behaviour in the foreign-owned sector. This, unlike incorporating 'true' structure in the model, provides only a relative measure of the importance of 'behaviour' as there are a number of plausible spectrums of behaviour one could assume for the foreign-owned manufacturing sector. For instance, Bradley and FitzGerald (1988) suggest that the Irish manufacturing sector, which is almost wholly foreign-owned, approximates Leontief or fixed coefficient production technology. However, the motivation for this specification is a law of one price (LOOP). With this model closure, changes in relative (world) prices lead to a shift of production capacity to other countries, rather than the substitution of production inputs i.e. labour for capital within the region. This implies that the MNC shifts or allocates production across different regions in response to changes in world prices (Minford *et al*, 1994; Bradley *et al*, 1993; 1995).

In contrast, the motivation for the behavioural specification for the foreign-owned sector in Model 3 is in terms of FDI for "domestic" production. In this case the multi-national company allocates production to a particular plant in order to serve that particular market, which is consistent with Markusen's (1995) stylised facts for FDI as a whole.[5] For instance, the representative firm here is a foreign-owned multi-plant/ multi-regional firm, which allocates production across space. The regional plant's output is determined by the parent's decision and so becomes exogenous to the region. The production structure is also inflexible, reflecting, for example, the adoption of an internationally adopted standard of production. Accordingly, I characterise Model 3 in terms of quite widespread Leontief functional forms, for commodity demands as well as production systems, which are next discussed.

6.4 The specification and calibration of the simulation models

I begin by discussing differences in the "behavioural" parameters among the three models and then consider "structural" differences. Together these determine the calibrated form of each of the simulation models.

6.4.1 Differences in "behaviour": functional forms and key parameter values for each of the AMOSFDI models

Models 1 and 2 assume that foreign- and UK-owned manufacturing sectors exhibit identical behaviour, and so possess identical functional forms and key parameter values, specifically those of the general default specification presented in chapter 3. Accordingly, many of the behavioural equations and key parameters used in Models 1 and 2 remain unchanged in Model 3, namely all equations other than those

[5] Recall that PACEC (1995) report that the main reasons for inward investors locating in the UK are market led. They identify that of those inward investors (some 70%) seeking to establish new markets, 70% were targeting the UK. The average share of total sales in the UK, by inward investors, averaged 49%.

for the two manufacturing sectors. Table 1 summarises the major alterations to specification and to key parameter values. Note that the specification of the non-manufacturing traded and sheltered sectors is exactly as in the general framework. For Models 1 and 2 the entries in the first two columns of Table 6.1 would, of course, be identical to those in the last two columns.

Table 6.1 - Functional Forms and Key Parameter Values for Model 3.

Functional Forms	UK-owned Manuf.	For.-owned Manuf.	Non-Manuf. Traded	Sheltered Sector
Technology:				
Gross Output	CES (0.45)	Leontief	CES (0.3)	CES (0.3)
Intermediate Inputs	CES (0.45)	Leontief	CES (0.3)	CES (0.3)
Value Added	CES (0.45)	Leontief	CES (0.3)	CES (0.3)
Trade:				
Exports RUK/ROW	CES (2.97)	Leontief	CES (2.0)	CES (2.0)
Intermediate Demands	CES (2.97)	Leontief	CES (2.0)	CES (2.0)
	CES (2.97)	Leontief	CES (2.0)	CES (2.0)
Consumption	CES (2.97)	Leontief	CES (2.0)	CES (2.0)
Investment	CES (2.97)	Leontief	CES (2.0)	CES (2.0)
Government Investment	CES (2.97)	Leontief	CES (2.0)	CES (2.0)

Note that the key parameter values for the UK-owned manufacturing sector have also been altered. This is to maintain the overall sensitivity of the manufacturing sector to price changes. (Adjustments were made using the foreign sector's output share.) The basic idea here is that the performance of manufacturing as a whole may be accurately captured in an aggregate model and this is retained in the disaggregated version. Thus, the overall sensitivity of total manufacturing output remains unchanged. In terms of the compact form of the general model, summarised in section 3.2.4 of chapter 3, these changes impact on the manufacturing sectors' equations for: price determination (equation 1); labour and capital demands (equations 7 and 8) and export demands (equation 16), as is illustrated in Table 6.2. (These sectors' intermediate demands, while not identified in the compact form are, of course, also altered.)

Table 6.2 – A summary of the key equations altered by the specification of the foreign-owned manufacturing sector in the AMOSFDI model.[6]

Equations	Short-run
(1) Price Determination	$p_i = p_i(W_n, W_k)$
(7) Labour demand	$N_i^d = N_i^d(Q_i, W_n, W_k)$
(8) Capital demand	$K_i^d = K_i^d(Q_i, W_n, W_k)$
(16) Export Demand	$X_i = X_i(p_i, \bar{p}_i^{RUK}, \bar{p}_i^{ROW}, \bar{D}^{RUK}, D^{ROW})$

NOTATION

Activity-Commodities

i, j are activity/commodity subscripts

Transactors

RUK = Rest of the UK, ROW = Rest of World

Functions

p (.)	CES cost function
K^d(.), N^d(.)	CES factor demand functions
C(.), I(.), X(.)	Armington consumption, investment and export demand functions, homogenous of degree zero in prices and one in quantities

Variables

D	exogenous export demand
K^d, K^S, K	capital demand, capital supply and capital employment
N^d, N^S, N	labour demand, labour supply and labour employment
P	price of commodity/activity output
Q	commodity/activity output

[6] The equation numbering in Table 6.2 relates to that presented in the compact form of the AMOS model in Table 3.1 of Chapter 3.

W_n, W_k price of labour to the firm, capital rental

X exports

Naturally, the impact of the behavioural specification of the foreign sub-sector of manufacturing in model 3 is to make the foreign-owned sector much less price-sensitive in all respects, while making the UK-owned sector rather more price-sensitive. The major distinguishing feature of Model 3 is its assumption of universal Leontief functional forms for production and trade relationships for the foreign-owned manufacturing sector. Recall the nest structure that is embodied in the constant elasticity of substitution (CES) production functions outlined in chapter 3. In each stage of production process is determined by cost minimisation. In contrast relative prices, nor substitution of factor inputs, are incorporated in the Leontief functional form, which essentially removes relative price sensitivity. Table 6.3 summarises the behavioural specification of the key equations for the UK and foreign-owned manufacturing sectors.

Table 6.3 – Comparison of Leontief and CES Demand Functions for selected variables for the foreign and UK manufacturing sector in Model 3.		
	Foreign Manufacturing	UK Manufacturing
Functional Form	Leontief Demand Functions	CES Demand Functions
Labour Demand (NDEM)	*(1)* $= DVL_{I\,1\text{-}4} * VA_I$	$= \left[\delta L_I * \dfrac{PVA_I}{PL_I}\right]^{\sigma} * VA_I$
Value Added (VA)	*(2)* $= DDV_{I\,1\text{-}4} * XDI_I$	$= \left[\beta VA_I * \dfrac{PXD_I}{PVA_I}\right]^{\sigma} * XD_I$
Intermediate Output (IOUK)	*(3)* $= DIU_{I1\text{-}4} * IO_I$	$= \left[\tau IO_I * \dfrac{PIO_I}{PIOUK}\right]^{\sigma} * IO_I$
Exports RUK (EXPRUK)	*(4)* $= TAUUK_I * UKDI$	$= \left[\mu Ex_{UKI} * \dfrac{PUK_I}{PEXUK_I}\right]^{\sigma} * UKD_I$
Leontief Output Prices	$PXD_I = [DDV_I * PVA_I] + [DDI_I * PIO_I]$ *(5)*	
CES Output Prices	PXA= $\left[DDV_i^{\alpha_i} * PVA^{1-\alpha_i} + DDI^{\alpha_i} * PIO^{1-\alpha_i}\right]^{\frac{1}{\alpha_i}}$	

Where

L_I	labour in sector i,
PVA_I	price of value added in sector i,
PL_I	price of labour in sector i,
VA_I	total value added in sector i,
PXD_I	price of output in sector i,
XD_I	sectoral output in sector i,
PIO_I	price of intermediate output in sector i,
$PIOUK_I$	price of intermediate output in sector i from RUK,
IO_I	total intermediate output for sector i,
$EXPUK_I$	RUK exports in sector i,
PUK_I	price of UK goods in sector i,
$PEXUK_I$	price of exports to RUK in sector i,

UKD_I	total UK demand for the output of sector i,
PXD_I	price of total output in sector i.
DDV_I	weighted share price of value added across the four sectors
PVA_I	price of value added in sector i
DDI_I	weighted share of price of intermediate output across the four sectors
PIO_I	price of intermediate output in sector I
Sigma (σ)	elasticity of substitution,
$\delta, \beta, \iota, \eta$	Constant Elasticity of Substitution (CES) share parameters.

Equation (1), in the second column of Table 6.3, is a Leontief demand function for labour demand. Note that there are no relative price components in any of the Leontief equations, which implies that expenditure decisions in the foreign manufacturing sector are taken independently of relative prices. (Thus, the output of this sub-sector is allocated across space by the parent company and is thus exogenously determined). Equations 2 and 3 are analogous to equation 1 and describe how the demand for intermediate inputs and value added are determined in the foreign manufacturing sub-sector. Note that the first part of each equation relates to an initial share parameter value and the second term is the total value for output in that sector (equation 2), and the total value for intermediate output (equation 3). (Essentially output is allocated to the plant, by the parent, based on the existing structure of production which is inflexible). Equation (4) describes the demand for exports to the rest of the UK (RUK) in the foreign-owned manufacturing sector. Note that TAUUK is the share parameter value for exports, $EXPUK_I$ is the value of export sales to the UK by sector i and $UKDI_I$ is the UK export Demand Index that takes an initial base value of 1, for sector i (and all sectors in the Model).

The equation to determine prices using the Leontief functional form (equation 5) again does not include relative costs or substitution of technologies. Instead, Leontief output prices are determined simply by the composite price of each intermediate input times the share parameter value (quantity) for that variable. (Recall that in a CGE all prices are initially unity. No actual price data are included in the model and instead the model calculates relative prices.)[7] The Leontief prices are based on the initial value of the output. Note that these share parameters are determined by the initial model calibration, which is based on the initial data-set. In contrast, the behavioural equations for the UK-owned manufacturing sector incorporate relative prices and allow substitution of factor inputs. In summary, the specification of the foreign-owned sub-sector of manufacturing provides one limiting case where the output of the foreign-owned sub-sector of manufacturing is exogenously determined by the parent company.

6.5 Differences in "structure": the Social Accounting Matrix (SAM's).

6.5.1 The SAM's for Models 1 to 3.

Model 1 assumes that the structure of the UK and foreign-owned manufacturing sectors is identical. The SAM for this model (SAM 1 in the Appendix of this chapter) is constructed on the assumption that I have no prior information about either manufacturing sector apart from the scale of each sector in terms of gross output. These output shares are used to disaggregate the manufacturing column and row of the 1989 Scottish SAM into their UK- and foreign-owned components. The other two models embody the actual differences in structure as captured between the UK- and foreign-owned manufacturing sectors, in the ownership-disaggregated SAM, discussed in the following section and reported as SAM 2 in the chapter Appendix of the chapter. Some indication of the significance of the differences in structure can be seen by inspection of Table 6.5 which presents the type I and II output multipliers implied by the I-O components of both the hypothetical (identical structure) and actual SAM's.

[7] This stems from microeconomic theory, which yields price equations (unit cost functions) which are

Table 6.4. Type I and II output multipliers associated with the hypothetical (identical structure) and ownership-disaggregated SAM.				
	Type I Output Multiplier:		Type II Output Multiplier:	
	Identical Structure	Actual Structure	Identical Structure	Actual Structure
UK-Owned Manufacturing	1.45	1.54	1.77	1.90
Foreign-owned Manufacturing	1.45	1.29	1.77	1.50
Non-Manufacturing Traded	1.35	1.35	1.76	1.76
Sheltered Sector	1.14	1.14	1.73	1.73

By construction the multipliers for the UK- and foreign-owned manufacturing sectors reported in Table 6.5 are the same for the hypothetical SAM which imposes identical structure. The actual structure implies quite different multiplier values, with significantly larger (smaller) values for the output multipliers of the UK-owned (foreign-owned) manufacturing sector. This reflects the fact that the UK manufacturing sector has stronger intermediate linkages with the other sectors in the model. Note that the multipliers for the non-manufacturing traded and sheltered sectors are the same for both models, a feature ensured by the way the I-O table was disaggregated.

6.5.2 Construction of ownership-disaggregated SAM for AMOSFDI Model.

Recall from chapter 3 that the existing AMOS CGE model has three sectors: manufacturing, non-manufacturing traded and sheltered. My objective is to extend the existing three sector SAM by incorporating separate UK and foreign-owned manufacturing. The ownership-disaggregated SAM is derived from the original AMOS SAM, which is based on data for 1989 (Yin, 1992). My first step is to extend the SAM framework to include four sectors:

1. UK manufacturing

'dual' to the production or demand functions which are expressed in terms of quantities only.

2. Foreign-owned manufacturing
3. Non-manufacturing traded
4. Sheltered Sector.

The main difference between the SAM in the AMOSFDI model, and that used in the original AMOS89 model, is that UK and foreign-owned manufacturing are captured separately within the SAM. The production data for the AMOSFDI SAM are taken from the ownership-disaggregated Input-Output Table, which was discussed in Chapters 4 and 5. However, although the I-O data are an integral part of the SAM, there are also interactions between the foreign-owned sub-sector and other institutional accounts (households, government, corporations etc.). In most cases, the existing SAM data relating to those institutional accounts are used, however, where possible the foreign-owned share is estimated using supplementary data.[8]

For the SAM for Models 2 and 3, I aggregate the seven UK and foreign-owned manufacturing sectors, from the ownership-disaggregated I-O Table, into two manufacturing sectors: UK and Foreign-owned. The four non-manufacturing sectors also have to be re-aggregated to conform to the existing sectoral classification used for the non-manufacturing and sheltered sectors in the existing AMOS SAM. Therefore, the sub-sectors that make up agriculture, energy and water, construction and services in the ownership-disaggregated Scottish I-O Table are re-aggregated into two sectors. Table 6.6 outlines the sectoral classification of the four-sector SAM for the AMOSFDI model.

[8] It was extremely difficult to obtain ownership-disaggregated data, for 1989, for many of the institutional accounts. Moreover, data relating to the flows or retention of profits from MNC's in Scotland was impossible to obtain. In the SAM, corporate flows are not distinguished by ownership.

Table 6.4 – Sectoral Classification of the four sectors in the AMOSFDI SAM.			
	Industrial Sectors in Ownership-disaggregated SAM (1989)	Original I-O Groupings (1989)	Standard Industrial Classification 1980. (2 digit level)
1	UK-Manufacturing	12-89	21-49
2	Foreign-Manufacturing	12-89	21-49
3	Non-manufacturing Traded	1-10, 91-97, 99-102 & 109-111	01-16, 61-76, 79, 83 & 102
4	Sheltered Sector.	11, 90 & 98, 103-108 & 112-114.	17, 50, 79 83-99

The manufacturing sector consists of sectors 12 to 89 of the 1989 I-O Table, which relates to categories 21 to 49 (at the two digit level) of the 1980 standard industrial classifications (SIC's). Non-manufacturing trade consists of agriculture, energy, distribution, transport, telecommunications, advertising and computer services. The Sheltered sector consists of water, construction, postal services and public administration. Table 6.7 reports the ownership-disaggregated I-O Table re-aggregated to this format and the Appendix of this Chapter reports the actual SAM for Models 1 and 2. (Recall that Models 2 and 3 have the same SAM).

Table 6.5 – Ownership-disaggregated I-O Table re-aggregated to four sectors.

AMOS I-O	UK Manu	For Manu	NMT	Sheltered	TID	Cons Exp	OFD	Exports	OUTPUT
UK Manu	2213.7	590.1	893.3	477.7	4174.9	1378.8	619.0	10914.8	17087.5
For Manu	670.3	312.5	271.8	113.9	1368.5	369.6	279.1	6265.9	8283.2
NMT	3345.4	682.4	3295.7	426.2	7749.6	7015.9	2348.4	5003.4	22117.4
Sheltered	356.7	118.2	1345.9	913.4	2734.3	2983.0	10284.7	1202.2	17204.1
TID	6586.2	1703.3	5806.7	1931.2	16027.3	11747.4	13531.3	23386.2	64692.2
Imports	4963.0	4640.5	4073.3	1235.1	14911.8	9556.2	9421.9	0.0	33890.0
W+S	4450.9	1423.1	7997.6	11126.9	24998.5	0.0	0.0	0.0	24998.5
OVA	1087.4	516.4	4239.8	2910.9	8754.5	3371.4	-522.8	867.0	12470.1
Total Inputs	17087.5	8283.2	22117.4	17204.1	64692.2	24675.0	21927.6	25120.2	136050.8

6.6 Model Calibration of AMOSFDI.

The ownership-disaggregated CGE Model is calibrated using the AMOSFDI SAM data. This provides an essential component of the model. Table 6.8 provides a complete list of the SAM data which is used to calibrate Models 2 and 3. (Recall, that Table 6.1 provided a comparison of the behavioural parameters for Model 3.) These data are taken directly from the SAM. However, recall that there are two types of parameters in CGE's: those which are extraneous to the system and those which are determined endogenously in order to calibrate the model. The latter include capital rental rates, capital stocks, sectoral wage rates etc. The SAM data provides the basis for calibrating the model. The ownership-disaggregated SAM data used in the AMOSFDI model are outlined as follows.

Table 6.6 Data and Parameters used in the calibration of the AMOSFDI CGE Model 3.

Variable		Description
C	21303.60	Total Household Consumption
CL	11747.36	H/hld consumption of local goods
CLL_1	1378.85	H/hld consumption of sector 1's local goods
CLL_2	369.64	H/hld consumption of sector 2's local goods
CLL_3	7015.88	H/hld consumption of sector 3's local goods
CLL_4	2982.99	H/hld consumption of sector 4's local goods
CR	5513.14	Total intermediate consumption imports (RUK)
CTAX_1	269.83	Taxes on intermediate consumption – sector 1.
CTAX_2	89.78	Taxes on intermediate consumption – sector 2.
CTAX_3	968.63	Taxes on intermediate consumption – sector 3.
CTAX_4	130.75	Taxes on intermediate consumption – sector 4.
CTAXH	3853.00	Taxes on consumer expenditure
CTAXF	0.00	Taxes on firm's expenditure
CTAXG	190.00	Taxes on government expenditure
CTAXK	160.00	Taxes on investment
CTAXT	80.00	Taxes on tourist's expenditure
CTAXUK	248.00	Taxes on RUK goods
CTAXW	462.00	Taxes on ROW goods
CUK	17260.50	H/hld's consump. Of UK composite goods
CW	4043.10	H/hld's consump. Of ROW imported goods
EX	1.00	Exchange Rate
EXPUK_1	6504.45	RUK Exports - Sector 1
EXPUK_2	2440.31	RUK Exports - Sector 2
EXPUK_3	3896.71	RUK Exports - Sector 3

EXPUK_4	1030.64	RUK Exports - Sector 4
EXPW_1	4410.33	ROW Exports - Sector 1
EXPW_2	3825.56	ROW Exports - Sector 2
EXPW_3	1106.71	ROW Exports - Sector 3
EXPW_4	171.53	ROW Exports - Sector 4
FSALE_1	71.02	Sales by final demand – sector 1
FSALE_2	24.79	Sales by final demand – sector 2
FSALE_3	99.53	Sales by final demand – sector 3
FSALE_4	67.10	Sales by final demand – sector 4
FSALEH	523.40	Sales by final demand – Households
FSALEF	0.00	Sales by final demand – Firms
FSALEG	-563.00	Sales by final demand – Government
FSALEK	-432.80	Sales by final demand – Capital
FSALET	53.00	Sales by final demand – Tourists
FSALEUK	22.00	Sales by final demand – UK
FSALEW	135.00	Sales by final demand – ROW
G	12816.37	Total General Government Final Consumption
GL	8941.67	GGFC for intermediate sectors.
GLL_1	229.27	GGFC for sector 1.
GLL_2	106.18	GGFC for sector 2.
GLL_3	670.30	GGFC for sector 3.
GLL_4	7935.91	GGFC for sector 4.
GR	2551.70	GGFC RUK imports.
GUK	11493.37	Total purchases GGFC for RUK goods
GW	1323.00	GGFC ROW imports.
IO_1	11549.21	Total indigenous intermediate linkages
IO_2	6343.72	Total foreign intermediate linkages
IO_3	9879.99	Total NMT intermediate linkages
IO_4	3166.21	Total sheltered intermediate linkages
IOL_1	6586.20	Total intermediate linkages – Sector 1
IOL_2	1703.26	Total intermediate linkages – Sector 2
IOL_3	5806.71	Total intermediate linkages – Sector 3
IOL_4	1931.15	Total intermediate linkages – Sector 4
IOLL_1_1	2213.73	Intermediate flows
IOLL_1_2	670.32	Intermediate flows
IOLL_1_3	3345.41	Intermediate flows
IOLL_1_4	356.74	Intermediate flows
IOLL_2_1	590.13	Intermediate flows
IOLL_2_2	312.55	Intermediate flows
IOLL_2_3	682.35	Intermediate flows
IOLL_2_4	118.23	Intermediate flows
IOLL_3_1	893.32	Intermediate flows
IOLL_3_2	271.81	Intermediate flows
IOLL_3_3	3295.69	Intermediate flows
IOLL_3_4	1345.89	Intermediate flows
IOLL_4_1	477.72	Intermediate flows
IOLL_4_2	113.86	Intermediate flows
IOLL_4_3	426.18	Intermediate flows
IOLL_4_4	913.40	Intermediate flows

IOR_1	2991.11	Intermediate imports from RUK-sector 1
IOR_2	2796.71	Intermediate imports from RUK-sector 2
IOR_3	2448.05	Intermediate imports from RUK-sector 3
IOR_4	964.86	Intermediate imports from RUK-sector 4
IOUK_1	9577.31	Total RUK Intermediate Inputs – Sector 1
IOUK_2	4499.97	Total RUK Intermediate Inputs – Sector 1
IOUK_3	8254.76	Total RUK Intermediate Inputs – Sector 1
IOUK_4	2896.02	Total RUK Intermediate Inputs – Sector 1
IOW_1	1971.90	Intermediate imports from ROW-Sector 1
IOW_2	1843.75	Intermediate imports from ROW-Sector 2
IOW_3	1625.23	Intermediate imports from ROW-Sector 3
IOW_4	270.20	Intermediate imports from ROW-Sector 4
IV	8446.35	Total Capital Stock
IVA_1	1404.86	Capital Stock – Sector 1
IVA_2	908.60	Capital Stock – Sector 2
IVA_3	2696.07	Capital Stock – Sector 3
IVA_4	3436.82	Capital Stock – Sector 4
IVL	3380.35	Total capital formation + stock changes
IVLL_1	220.03	Total capital formation + stock changes – Sect 1
IVLL_2	126.03	Total capital formation + stock changes – Sect 2
IVLL_3	713.99	Total capital formation + stock changes – Sect 3
IVLL_4	2320.30	Total capital formation + stock changes – Sect 4
IVR	3186.85	Total Imported Capital Goods
IVUK	6567.20	Imported Capital Goods from RUK
IVW	1879.15	Imported Capital Goods from ROW
KAV_1	9365.73	Capital Stock + depreciation
KAV_2	6057.30	Capital Stock + depreciation
KAV_3	17973.83	Capital Stock + depreciation
KAV_4	22912.12	Capital Stock + depreciation
NS_1	69.90	Skilled employees – Sector 1
NS_2	19.10	Skilled employees – Sector 2
NS_3	503.00	Skilled employees – Sector 3
NS_4	415.00	Skilled employees – Sector 4
NU_1	344.03	Un-Skilled employees – Sector 1
NU_2	93.97	Un-Skilled employees – Sector 2
NU_3	342.00	Un-Skilled employees – Sector 3
NU_4	465.00	Un-Skilled employees – Sector 4
NDEM	2252.00	Total Labour Demand
NDEMS	1007.00	Total Labour Demand – Skilled Employees
NDEMU	1245.00	Total Labour Demand – Un-Skilled Employees
NSUP	2252.00	Total effective Labour Force
LFORCE	2480.00	Total Labour Force
LFORCES	1049.00	Total Skilled Labour Force
LFORCEU	1431.00	Total un-skilled labour force
POP	5090.70	Population
WPOP	3167.80	Working age Population
NP	687.80	Non participants
PFS_1	1.00	Base Prices for Model.
PFS_2	1.00	Base Prices for Model.

PFS_3	1.00	Base Prices for Model.
PFS_4	1.00	Base Prices for Model.
PK_1	0.12	Capital Rental Rates (OVA/Capital Stock)
PK_2	0.09	Capital Rental Rates (OVA/Capital Stock)
PK_3	0.19	Capital Rental Rates (OVA/Capital Stock)
PK_4	0.12	Capital Rental Rates (OVA/Capital Stock)
PLS_1	19.86	Producers prices of Skilled Labour
PLS_2	23.25	Producers prices of Skilled Labour
PLS_3	12.04	Producers prices of Skilled Labour
PLS_4	15.54	Producers prices of Skilled Labour
PLU_1	8.90	Producers prices of Un-Skilled Labour
PLU_2	10.42	Producers prices of Un-Skilled Labour
PLU_3	5.68	Producers prices of Un-Skilled Labour
PLU_4	10.06	Producers prices of Un-Skilled Labour
PVA_1	1.00	Prices - Value Added - Sector 1
PVA_2	1.00	Prices - Value Added - Sector 2
PVA_3	1.00	Prices - Value Added - Sector 3
PVA_4	1.00	Prices - Value Added - Sector 4
PXA_1	1.00	Prices – Activities – Sector 1
PXA_2	1.00	Prices – Activities – Sector 2
PXA_3	1.00	Prices – Activities – Sector 3
PXA_4	1.00	Prices – Activities – Sector 4
PXC_1	1.00	Prices - Consumption – Sector 1
PXC_2	1.00	Prices - Consumption – Sector 2
PXC_3	1.00	Prices - Consumption – Sector 3
PXC_4	1.00	Prices - Consumption – Sector 4
PXD_1	1.00	Prices – Domestic Output – Sector 1
PXD_2	1.00	Prices – Domestic Output – Sector 2
PXD_3	1.00	Prices – Domestic Output – Sector 3
PXD_4	1.00	Prices – Domestic Output – Sector 4
PXUK	1.00	Aggregate RUK Price
PXWX	1.00	Aggregate World Price
PUK_1	1.00	RUK_Price
PUK_2	1.00	RUK_Price
PUK_3	1.00	RUK_Price
PUK_4	1.00	RUK_Price
PWX_1	1.00	External Price
PWX_2	1.00	External Price
PWX_3	1.00	External Price
PWX_4	1.00	External Price
FS	618.55	Corporations expenditure on Capital
GS	1041.77	Governments expenditure on Capital
HS	1921.01	Households expenditure on Capital
BOPUK	2499.60	Balance of Payments RUK
BOPW	2092.52	Balance of Payments ROW
SUBSIDY_1	-364.31	Subsidies – Sect 1
SUBSIDY_2	-164.39	Subsidies – Sect 2
SUBSIDY_3	-285.50	Subsidies – Sect 3
SUBSIDY_4	-10.87	Subsidies – Sect 4

SUBSIDYH	-1005.00	Household Subsidies
SUBSIDYF	0.00	Firms Subsidies
SUBSIDYG	0.00	Government Subsidies
SUBSIDYK	0.00	Capital Subsidies
SUBSIDYT	-10.00	Tourist Subsidies
SUBSIDYUK	0.00	Export Subsidies – RUK
SUBSIDYW	0.00	Export Subsidies – ROW
TC_1	169.74	Expenditure by foreign tourists – Sector 1
TC_2	46.91	Expenditure by foreign tourists – Sector 2
TC_3	964.14	Expenditure by foreign tourists – Sector 3
TC_4	28.45	Expenditure by foreign tourists – Sector 4
TCR	268.37	Imports purchases by Tourists – RUK
TCW	212.87	Imports purchases by Tourists – ROW
U	228.00	Unemployed
US	42.00	Skilled Unemployed
UU	186.00	Un-Skilled Unemployed
VA_1	5561.79	Total Value Added – Sector 1
VA_2	1989.28	Total Value Added – Sector 2
VA_3	11454.70	Total Value Added – Sector 3
VA_4	13850.90	Total Value Added – Sector 4
XA_1	17087.54	Total Activity Output – Sector 1
XA_2	8283.18	Total Activity Output – Sector 2
XA_3	22117.35	Total Activity Output – Sector 3
XA_4	17204.08	Total Activity Output – Sector 4
XD_1	17111.01	Domestic Production - Sector 1
XD_2	8333.00	Domestic Production - Sector 2
XD_3	21334.69	Domestic Production - Sector 3
XD_4	17017.11	Domestic Production - Sector 4
YHW	24998.53	Total Household Wages
YHK	1178.72	Total Household Capital (OVA)
YHC	4059.86	Household payments from Corporations
YHG	4059.86	Household payments from Government
YHUK	0.00	Household payments from RUK
YHWW	0.00	Household payments from ROW
YCK	6365.09	Payments to Corporations (interest etc.)
YCH	1924.99	Household payments to Corporations
YCG	1247.26	Government Payments to Corporations
YCUK	0.00	RUK payments to Corporations
YCW	34.00	ROW payments to Corporations
YGK	314.33	Payments (OVA) to Government
YGH	5110.70	Household payments to Corporations
YGC	2518.01	Corporations payment to Government
YGUK	5252.10	RUK payments to Government
YGW	319.97	ROW payments to Government
YINDTAX	4611.91	Indirect Tax
YINTAX	3290.00	Total Income Tax
YUKC	1173.00	Firms current transfers to RUK
YWC	1201.91	Firms current transfers to ROW

Table 6.8 provides a detailed description of the data used to calibrate Model 3. Recall that sectors 1 to 4 relate to UK-owned manufacturing, foreign-owned manufacturing, non-manufacturing traded and sheltered. Note that the ownership-disaggregated I-O data, reported in Table 6.7, account for the majority of the SAM data. For instance, the variables IO_1 to IO_4 capture the total intermediate linkages of each sector. Similarly, the variables I-OLL_1_1 to I-OLL_4_4 capture the intermediate flows between sectors. Total activity output and value added, for each sector, are captured by the variables XA_1 to 4 and VA_1 to 4, etc. These variables are coded in this manner for the model program, which specifies the functional forms and behavioural relationships within the model and sectors in general.

6.7- Summary of Model Characteristics.

The three different Models outlined in this chapter are designed to allow me to isolate and capture, through simulation, the different impacts of incorporating both structure and behaviour within a system-wide modelling framework. Table 6.7 summarises how some of the key stylized structural and behavioural characteristics of FDI are actually captured within the Model.

Table 6.7 – How the key structural and behavioural characteristics of FDI are captured in the AMOSFDI model.	
Patterns of Linkages	Base Year Model Data
Efficiency and Capital Intensity of Value added production	Base Year Model Data
Wage Differences	Base Year Model Data
Trade: exports, Balance of Payments	Base Year Model Data
Investment/Output ratios	Base Year Model Data
Capital rental rates.	Base Year Model Data
Investment Determination	Parameters Values/Model specification
Choice of Technology	Parameters Values/Model specification
Trade Elasticities	Parameters Values/Model specification
Production Elasticities	Parameters Values/Model specification
Sectoral Demands & Expenditure.	Parameters Values/Model specification

Note that the true base year Model data captures the main structural differences that exist between the foreign and UK-owned manufacturing sectors. These data provide the basis for identifying the importance of 'structure' in terms of the system-wide impact of FDI. The distinct 'behaviour' chosen for the foreign-owned manufacturing sector in Model 3 provides one possible specification. Namely that the foreign-owned manufacturing sub-sector is part of a wider production process with output allocated across plants, by the parent, in order to serve specific geographic markets, which is captured with Leontief functional form.

6.8 – Chapter 6 Conclusion.

AMOSFDI is a variant of the AMOS CGE model, which has been constructed specifically to capture the structural characteristics of foreign-owned manufacturing in Scotland. The framework also allows specification of distinct behaviour in the foreign-owned manufacturing sub-sector. The simulation framework outlined in this chapter (Models 1 to 3) provides a basis for considering the impact of the distinct 'structure' and 'behaviour' typically associated with foreign-owned manufacturing plants. The structural coefficients are captured, primarily, by the ownership-disaggregated I-O data, which was discussed in chapters 4 and 5. This essentially follows the analogy for 'structure' identified by Haddad *et al* 1998. The behavioural specification for the foreign-owned manufacturing sector is motivated in terms of FDI for "domestic" production, where the multi-national company allocates production to a particular plant in order to serve that particular market. This, however, provides only one limiting case for foreign-owned behaviour and should be considered accordingly. However, recall that the motivation for developing this framework (ownership-disaggregated CGE) is to provide a model which can explicitly capture the integral characteristics of the foreign-owned manufacturing sector. This framework provides such a starting point. Chapter 7 reports simulation results from all three models for the impact of a 100% export-oriented FDI plant.

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Chapter 6 - Appendix 1 - The Social Accounting Matrix for Model 1 (Identical Structure).

	UK Manuft.	For Manuft.	Non-manu.t	Sheltered	Households	Corporate	Government	Capital	Stocks	Expend	RUK	ROW	Labour	Labour	Value Added	Tax	Total
UK Manuft.	1718	833	785	398	1178	0	226	176	57	146	6024	5547	0	0	0	0	17088
For Manuft.	833	404	380	193	571	0	110	86	27	71	2920	2689	0	0	0	0	8283
Non-manu.t	2713	1315	3296	426	7016	0	670	608	106	964	3897	1107	0	0	0	0	22117
Sheltered	320	155	1346	913	2983	0	7936	2309	11	28	1031	172	0	0	0	0	17204
RUK	3898	1890	2448	965	5513	1173	2552	3135	52	268	0	0	0	0	0	0	21894
Goods and Services	3898	1890	2448	965	5513	0	2552	3135	52	268	0	0	0	0	0	0	20721
Transfers	0	0	0	0	0	1173	0	0	0	0	0	0	0	0	0	0	1173
ROW	2570	1246	1625	270	4043	1202	1323	1860	19	213	0	0	0	0	0	0	14371
Goods and Services	2570	1246	1625	270	4043	0	1323	1860	19	213	0	0	0	0	0	0	13169
Transfers	0	0	0	0	0	1202	0	0	0	0	0	0	0	0	0	0	1202
Taxes on Expenditure	242	117	969	131	3853	0	190	159	1	80	248	462	0	0	0	0	6452
Subsidies	-356	-173	-286	-11	-1005	0	0	0	0	-10	0	0	0	0	0	0	-1840
Skilled labour	1234	598	6054	6450	0	0	0	0	0	0	0	0	0	0	0	0	14337
Unskilled labour	2722	1319	1943	4677	0	0	0	0	0	0	0	0	0	0	0	0	10662
Other Value Added	1130	548	3457	2724	0	0	0	0	0	0	0	0	0	0	0	0	7858
Sales by final demand	65	31	100	67	523	0	-563	-397	-36	53	22	135	0	0	0	0	0
Households	0	0	0	0	0	4060	3395	0	0	0	0	0	14337	10662	1179	0	33632
UK Corporate	0	0	0	0	1925	0	1247	0	0	0	0	34	0	0	6365	0	9571
Government	0	0	0	0	5111	2518	0	0	0	0	5252	320	0	0	314	4612	18127
Capital	0	0	0	0	1921	619	1042	0	0	0	2500	2093	0	0	0	0	8173
Total	17088	8283	22117	17204	33632	9571	18127	7937	237	1813	21894	12558	14337	10662	7858	4612	207929

	UK Manuft.	For Manuft.	Non-manu.t	Sheltered	Households	Corporate	Government	Capital	Stocks	Tourist Expend	RUK	ROW	Skilled Labour	Unskilled Labour	Other Value Added	Net. Commd. Tax	Total
UK Manuft.	2214	590	893	478	1379	0	229	188	32	170	6504	4410	0	0	0	0	17088
For Manuft.	670	313	272	114	370	0	106	74	52	47	2440	3826	0	0	0	0	8283
Non-manu.t	3345	682	3296	426	7016	0	670	608	106	964	3897	1107	0	0	0	0	22117
Sheltered	357	118	1346	913	2983	0	7936	2309	11	28	1031	172	0	0	0	0	17204
RUK	2991	2797	2448	965	5513	1173	2552	3135	52	268	0	0	0	0	0	0	21894
Goods and Services	2991	2797	2448	965	5513	0	2552	3135	52	268	0	0	0	0	0	0	20721
Transfers	0	0	0	0	0	1173	0	0	0	0	0	0	0	0	0	0	1173
ROW	1972	1844	1625	270	4043	1202	1323	1860	19	213	0	0	0	0	0	0	14371
Goods and Services	1972	1844	1625	270	4043	0	1323	1860	19	213	0	0	0	0	0	0	13169
Transfers	0	0	0	0	0	1202	0	0	0	0	0	0	0	0	0	0	1202
Taxes on Expenditure	270	90	969	131	3853	0	190	159	1	80	248	462	0	0	0	0	6452
Subsidies	-364	-164	-286	-11	-1005	0	0	0	0	-10	0	0	0	0	0	0	-1840
Skilled labour	1389	444	6054	6450	0	0	0	0	0	0	0	0	0	0	0	0	14337
Unskilled labour	3062	979	1943	4677	0	0	0	0	0	0	0	0	0	0	0	0	10662
Other Value Added	1111	566	3457	2724	0	0	0	0	0	0	0	0	0	0	0	0	7858
Sales by final demand	71	25	100	67	523	0	-563	-397	-36	53	22	135	0	0	0	0	0
Households	0	0	0	0	0	4060	3395	0	0	0	0	0	14337	10662	1179	0	33632
UK Corporate	0	0	0	0	1925	0	1247	0	0	0	0	34	0	0	6365	0	9571
Government	0	0	0	0	5111	2518	0	0	0	0	5252	320	0	0	314	4612	18127
Capital	0	0	0	0	1921	619	1042	0	0	0	2500	2093	0	0	0	0	8173
Total	17088	8283	22117	17204	33632	9571	18127	7937	237	1813	21894	12558	14337	10662	7858	4612	207929

CHAPTER 7 – Simulation Results from the AMOSFDI CGE Models.

7.1 - Introduction.

In this chapter, I use the AMOSFDI CGE model framework (Models 1 to 3) to simulate the system-wide impact of FDI in Scotland under various assumptions. I conduct the same FDI export shock using three different simulation models in order to highlight the impact of incorporating both the 'structural' and 'behavioural' characteristics of foreign and indigenous manufacturing within a system-wide modelling framework. Chapter 6 discussed the general motivation for this approach and each of the simulation models, which I again summarise below.

Model 1. For this model I make both the structure and the behaviour of the foreign and UK-owned manufacturing sectors identical. This involves two steps: First I adjust the SAM data so that the export and import intensities, backward and forward linkages, composition of value added are identical – though the scale of sectors is 'true', as outlined in chapter 6. Secondly, I make the behavioural equations relating to each sector identical to those discussed in the exposition of the aggregate AMOS Model in chapter 3. This results in a 'hypothetical' model framework in which there are no structural or behavioural differences between the foreign and domestic manufacturing sectors within the model. This provides a benchmark case for contrasting the effects of incorporating the structural and behavioural influences of inward investment on the host region.

Model 2. In this model (model 2 in chapter 6), the 'true' structural characteristics of both the foreign and UK-owned sector are incorporated in the SAM i.e. model database. However, as in Model 1, I maintain the hypothesis of identical behaviour. Here the behavioural equations of each sector are identical in terms of specification and the values of key parameters as Model 1. However the different sourcing patterns, capital/labour intensities, wage rates, etc. that exist between the sectors are reflected in the base year data of this model.

Model 3. Model 3 incorporates distinctive behavioural functions for the foreign manufacturing sector, as well as accommodating the structural differences embodied in the SAM used to calibrate Model 2. In this case I assume that the output of the foreign-owned manufacturing sector is less sensitive to changes in relative factor conditions (local price changes) than the indigenous sector. Recall from chapter 6 that the motivation for this specification is in terms of FDI for "domestic" production, where the multi-national company allocates production (output) to a particular plant in order to serve that market. This specification, however, provides only one limiting case for the behaviour of the foreign-owned manufacturing sector. Table 7.1 summarises the key differences between Models 1, 2 and 3.

Table 7.1: AMOSFDI Simulation Models.

	Identical Behaviour	Different Behaviour
Indentical Structure	Model 1	----
Different Structure	Model 2	Model 3

In summary, Model 1 provides the case where ownership plays no role in determining behaviour or structure, almost like an ultra neo-classical case, where firms are price takers and their sourcing patterns and production processes are dictated by the market. Thus the results from using this model provide an aggregate analysis of the impact of incoming investment, which would be the same whether the investment is foreign or UK-owned. Model 2 incorporates the 'true' structural characteristics that exist between the UK and foreign-owned manufacturing, in Scotland, and Model 3 captures both the structural characteristics and one possible specification for the behaviour of the foreign-owned manufacturing sector.

However, note that Model 3 provides only one possible approximation for the behaviour of the foreign manufacturing sector, which typically would not apply to all foreign-owned plants within this sector in Scotland. Moreover, recall from chapter 5, that within the foreign-owned sector, the structural characteristics of the different industrial sectors varied. The behaviour of these sub-sectors would typically vary according to their subsidiary type. i.e. depending on the level of autonomy or range of activities the plant has authority over in Scotland. Accordingly, Model 3 should be viewed as a providing one possible specification for the foreign manufacturing sector, which does not necessarily encompass all possible spectrums of behaviour, but instead provides one limiting case.

7.2 – Simulation Strategy: 100% Export FDI Plant.

For all simulations in this chapter, I simulate the impact of a 100% export FDI shock. This consists of both an investment and export shock to the foreign manufacturing sector. The export FDI shock consists of a 20 per cent increase in foreign-owned manufacturing investment with the additional output, generated by the FDI shock, going directly to exports. I simulate this case by adjusting the export demand parameter for the foreign-owned sector such that the absolute increase in foreign-owned manufacturing exports at base prices just equals the increase in output associated with the 20% increase in foreign manufacturing investment. (This is consistent with the earlier simulations reported in Section 3.3.3 of chapter 3).

The initial investment shock to the foreign manufacturing sector, for all three models, increases foreign manufacturing capacity (capital stock), by 3 per cent. In period 1 when the investment shock is simulated, both investment and capital stocks are fixed. Recall from the discussion in chapter 3 that the period 1 FDI shock is treated as exogenous. The associated increase in foreign manufacturing capacity, generated by the exogenous investment shock, is determined in this period by both the percentage increase in investment and the depreciation rate of capital. For each model, I simulate the impact of a 20 per cent increase in foreign manufacturing investment, so that investment increases by 0.20%. The depreciation rate of capital in the base year model data is 0.15%, which means that capital stocks increase by 0.03 per cent in each case i.e. Models 1, 2 and 3. However, where the structure of the foreign manufacturing sector is different between Model 1 and Models 2 & 3 the actual scale of the export FDI shock, for the same percentage increase in investment and 100 per cent export intensity, is different. Recall that Models 2 and 3 incorporate the 'true' structure of the foreign-owned manufacturing sector but assume different behavioural characteristics.

For instance, the initial base year value for capital stock in the foreign manufacturing sector (£755m) in Model 1, is, of course, inaccurately lower than in Models 2 and 3. Where the actual structure of both sectors is incorporated in the base year model data, as in Models 2 and 3, the value for the foreign manufacturing capital stock is £908m reflecting the higher levels of capital intensity in the foreign manufacturing sector. This implies that the initial value of the investment shock is larger in Models 2 and 3 (£182m), compared with the value of the investment shock in Model 1 (£151m). Essentially, where the structural characteristics of the foreign and UK manufacturing sectors are different between Models, the actual value of the initial export FDI shock will also vary.

Moreover, in Model 1, the export intensity of both the UK and foreign-owned manufacturing sector is 68 per cent, which implies that the export-demand parameter must be adjusted by 4.43%, so that all of the additional foreign manufacturing output goes to exports. However, in Models 2 and 3, where the actual structure of both sectors is incorporated in the model, 76 and 64 per cent respectively of foreign and UK-owned manufacturing output goes to exports. For both these models, the foreign export demand parameter in the model is increased by only 3.97% in order to simulate the impact of a 100% export plant. Again, in both cases the scale of the shock in terms of the increase in foreign export demand is different although the actual value of foreign export sales (£248m) is the same in all three models.

In Model 1, the FDI and export shock (20% increase in foreign manufacturing investment plus 4.43% export demand shock) is equivalent to an incoming foreign-owned plant generating 5,162 direct jobs. In Models 2 and 3, the 20 per cent increase in foreign manufacturing investment, with 100 per cent export intensity, generates 3,392 direct jobs. The difference in the scale of the exogenous employment shock, as a result of the FDI, stems from the latter cases incorporating the actual structure of both sectors within the model. Recall from chapter 6 that in Model 1 the manufacturing employment data was partitioned between both sectors using an output share. Accordingly, foreign-owned employment is of course (inaccurately) larger in

Model 1, so that the increase in foreign capacity (3.0%) generated by the FDI shock, generates a larger direct employment shock using this model data. Table 7.2 contrasts the scale of the export FDI shock (20% increase in foreign manufacturing investment with 100% export intensity), in terms of the associated stimulus to 'foreign' capital stock, exports, output and employment, across the three models.

Tables 7.2 – The impact of the Export FDI shock in terms of capital stock, exports, output and direct employment across Models 1, 2 and 3.

	Model 1		Model 2		Model 3	
	%	Value	%	Value	%	Value
Capital Stock	3.0	£151m	3.0	£182m	3.0	£182m
Exports	4.43	£248m	3.97	£248m	3.97	£248m
Output	3.0	£248m	3.0	£248m	3.0	£248m
Employment	3.0	5,162	3.0	3,392	3.0	3,392

The differences in capital stock, exports and employment reported in Table 7.2 stem from incorporating the distinct structural characteristics of the foreign and UK manufacturing sectors within Models 2 and 3. To simulate the same direct employment shock, for each Model, I would have to simulate different period 1 investment shocks for Models 1 and 2 (recall Models 2 and 3 have the same structure). Similarly, to simulate the same actual investment shock (in terms of the actual value) in Models 1 and 2, I would have to use different investment shocks and even then, the associated direct employment in both models would be different. The point is that these differences in capital stock, exports and employment, for the same 20 per cent increase in foreign manufacturing investment with 100 per cent export intensity, reflect the differences in structure between these sectors in Models 1 and 2.

Recall from chapter 6 that I hold the actual value of output in the foreign manufacturing sector constant across the three Models. This means that the actual value of output generated by the investment shock is the same across the three Models (£248m). Note from Table 7.3 that this is the case, which implies that the export FDI shock generates the same demand-side shock in each Model. Moreover, with foreign manufacturing capacity (capital stocks) increasing by 3 per cent, in each Model, then each sector also receives the same proportionate supply-side shock. Therefore, as the three Models are standardised on output, I simulate a 20 per cent increase in manufacturing investment with 100 per cent export intensity.

For all three cases, I report the results for period by period simulations up to 50 periods. This captures the impact period and the subsequent adjustment to medium and long-run equilibrium. In each case I use four different labour market closures to highlight the impact of both a passive and non-passive labour market with and without migration:

1. National bargaining with no migration
2. National bargaining combined with the Layard, Nickel and Jackman (LNJ) migration function
3. LNJ regional bargained wage closure with no migration
4. LNJ regional bargained wage closure combined with the LNJ migration function.

Recall from the earlier discussion relating to the impact of FDI within a region (chapter 2), and the simulation results presented in chapter 3, that FDI can have important labour market effects. Accordingly, I simulate the export FDI shock for each of the four labour market closures, outlined above, in order to capture these impacts.

Therefore for each case (model) there are four sets of results. The results generated for each labour market closure, across the three models, are qualitatively similar. For Model 1, I detail both the qualitative and quantitative impact of the FDI export shock. Following on, I highlight the differences between the results from incorporating the actual structure of the sectors with Model 2. Model 3 compares both the impacts of incorporating structure and behaviour with the results from the previous two models. The following sections report the results from each case in turn, starting with Model 1.

7.3 Model 1 – No structural or behavioural differences between sectors.

The motivation for constructing this model framework is to illustrate the results from modelling the impact of FDI using a model which does not capture or distinguish between the 'structural' or 'behavioural' characteristics of the foreign-owned manufacturing sub-sector. Recall that only the actual scale of the sector, in terms of output, is correct. (This is similar to the analysis of FDI discussed in chapter 3 where the Model incorporated no structural or behavioural differences, for plants, within the manufacturing sector.) The results from Model 1 simulations should be viewed as stylised given that the purpose of constructing this 'hypothetical' model is to provide a benchmark case from which I can separately estimate the impact of incorporating the structural and behavioural characteristics that are typically associated with FDI. However, other research and FDI impact studies have implicitly used models with similar assumptions to Model 1 (Alexander & Whyte, 1995).

7.3.1. 100% Export FDI with National Bargaining labour market closure, no migration.

I report the impact of a 20% increase in foreign-owned manufacturing investment with 100% export intensity. This implies that none of the additional foreign-owned output generated by the FDI shock is sold in the Scottish market.[1] As a result, there is no direct product market displacement of either foreign or UK-owned manufacturing activity. By adopting the national bargaining wage closure (fixed nominal wage), the regional nominal wage is assumed to be unresponsive to changes in the regional economy. Essentially, wage rates are set within a national bargaining framework with the region acting as a nominal-wage taker. The results for key economic variables are reported in Table 7.3. For all simulations in this section, the first period results are qualitatively the same across all labour market closures, since period 1 is the construction period, and the improved export performance does not apply until the plant comes on-stream (period 2).

[1] I assume that the increase in foreign manufacturing exports does not displace existing Scottish manufacturing exports.

Table 7.3 - Model 1 with National Bargaining and No Migration					
	Period 1	Period 2	Period 10	Period 25	Period 50
GDP (income measure)	0.11	0.37	0.51	0.55	0.56
Consumption	0.13	0.36	0.45	0.48	0.48
Investment	1.79	0.62	0.60	0.60	0.60
Nominal before-tax wage	0.00	0.00	0.00	0.00	0.00
Real B-Tx consumption wage	-0.04	-0.08	-0.02	0.00	0.00
Total employment (000's):	0.13	0.42	0.53	0.56	0.57
UK Manufacturing:	0.03	0.15	0.23	0.25	0.26
For. Manufacturing:	0.03	3.17	3.26	3.29	3.29
Non-Manu traded:	0.08	0.24	0.41	0.47	0.48
Sheltered:	0.25	0.17	0.23	0.25	0.25
Total unemployment (000's)	-0.97	-3.12	-3.91	-4.18	-4.20
Labour participation rate (%)	0.03	0.10	0.12	0.13	0.13
Total population (000's)	0.0	0.00	0.00	0.00	0.00
Price of value added:					
UK Manufacturing	0.02	0.11	0.03	0.00	0.00
For. Manufacturing	0.02	0.12	0.03	0.00	0.00
Non-Manu traded	0.08	0.24	0.07	0.01	0.00
Sheltered	0.16	0.11	0.02	0.00	0.00
Capital rental rates:					
UK Manufacturing	0.09	0.48	0.12	0.01	0.00
For. Manufacturing	0.09	0.55	0.13	0.01	0.00
Non-Manu traded	0.26	0.81	0.23	0.02	0.00
Sheltered	0.82	0.56	0.10	0.01	0.00
Consumer price index	0.04	0.08	0.02	0.00	0.00
Value-added:					
UK Manufacturing	0.02	0.11	0.22	0.25	0.26
For. Manufacturing	0.02	3.13	3.25	3.29	3.29
Non-Manu Traded	0.05	0.17	0.39	0.47	0.48
Sheltered	0.20	0.14	0.22	0.25	0.25
Sectoral Output:					
UK Manufacturing	0.03	0.13	0.22	0.25	0.26
For. Manufacturing	0.03	3.15	3.26	3.29	3.29
Non-Manu Traded	0.06	0.19	0.39	0.47	0.48
Sheltered	0.20	0.14	0.22	0.25	0.25
Capital stocks:					
UK Manufacturing	0.00	0.00	0.19	0.25	0.26
For. Manufacturing	0.00	3.00	3.22	3.29	3.29
Non-Manu Traded	0.00	0.00	0.34	0.46	0.48
Sheltered	0.00	0.00	0.20	0.25	0.25
Exports					
UK Manufacturing	-0.02	-0.10	-0.02	0.00	0.00
For. Manufacturing	-0.02	4.32	4.40	4.43	4.43
Non-Manu Traded	-0.11	-0.35	-0.10	-0.01	0.00
Sheltered	-0.29	-0.20	-0.04	0.00	0.00
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.17	0.44	0.47	0.48	0.48
Firms disposable	0.34	0.75	0.61	0.57	0.57

Period 1 represents the impact of the 20% increase in foreign manufacturing investment only. This increased investment generates an expansion in foreign manufacturing capacity of 3 per cent. The period 1 impact of the manufacturing investment shock is predominately located in the sheltered sector due to the construction of the FDI plant. GDP and total employment increase by 0.11 and 0.13 per cent respectively in this period. However, with fixed capacity in period 1, the exogenous demand shock leads to an increase in value-added prices and a fall in regional competitiveness, with exports falling across all sectors. The period 2 figures show a substantial rise in GDP and total employment of 0.37 and 0.42 per cent, as the FDI manufacturing capacity comes on stream. For instance, foreign-owned manufacturing employment increases by 3.13 per cent with employment in the UK manufacturing and both the non-manufacturing traded and the sheltered sector increasing by 0.15, 0.24 and 0.17 per cent, respectively.

The combined impact of the increased capacity and export demand in foreign manufacturing implies that both demand and supply schedules in the foreign-owned sector shift outwards. This produces an increase in output in this division of 3.15%, which is accompanied by a rise in value-added prices and capital rental rates of 0.12 and 0.55 per cent, respectively. The expansion in activity in the UK manufacturing and the non-manufacturing sectors, generated directly by the 100% FDI export plant, increases their capital rental rates so that period 2 investment in these divisions stays above base levels.

For all measures of activity in all sectors, the long-run equilibrium solutions lie above the corresponding base values, but commodity and factor prices return to their base levels. Thus, employment, output, value added and capital stocks all increase by the same proportionate amount as the model generates long-run results that replicate I-O. (This is similar to the results obtained in chapter 3 and reported by McGregor *et al*, 1996). Accordingly, the rise in manufacturing exports is ultimately the full 4.43%, with no change in non-manufacturing exports. This generates an increase in activity in foreign manufacturing, UK manufacturing, non-manufacturing traded and sheltered sectors of 3.29, 0.26, 0.48 and 0.25 per cent, respectively.

However, it is interesting to consider the build up of employment from the impact period to long-run equilibrium. Figure 1 highlights the change in total and sectorally disaggregated employment from the initial base-year values. Employment in all sectors is stimulated by the export performance of the incoming foreign-owned plant. In the short run, 73 per cent of the period 1 employment impact is located in the sheltered sector where employment increases by 2,156 (period 1) which substantially overshoots its long-run value due to the scale of the one period shock. Manufacturing employment accounts for only 5 per cent of the period 1 impact with both UK and foreign manufacturing employment increasing by 0.03 per cent in this period.

In period 2, foreign-owned manufacturing employment increases by more than the direct employment at the plant (5,456), due to the increased intermediate demand and consumption effects similar to those operating in the other sectors of the model. Fixed capacity in these other sectors increases value-added prices and capital rental rates further so that their export sales continue to deteriorate. After period 2, the impact of the higher intermediate demand and consumption effects stimulates investment in the manufacturing, non-manufacturing traded and sheltered sector, which eases capacity constraints. As a result, value-added prices and capital rental rates begin to fall across all sectors, which increases regional competitiveness and offsets the previous fall in export sales for these sectors. Foreign-owned capacity and employment continue to rise, with the other sectors in the model benefiting from the indirect effects that are generated, within the regional economy, as a result of the FDI shock.

The total employment generated by the 100% export FDI plant where there are no structural or behavioural differences incorporated in the model is 12,791. With the direct employment shock equal to 5,162, this is equivalent to a foreign-owned employment multiplier of 2.48. Table 7.4 reports the long-run increase in GDP, Household Disposable Income and Total Employment (including multiplier values) for the export FDI shock.

Table 7.4 – The long-run increase in GDP, Household Disposable Income and Total Employment (including multiplier values) for an incoming 100% export FDI plant generating 5,162 direct jobs with the national bargaining wage closure.		
Model 1:	**LONG RUN IMPACT:**	
Gross Domestic Product (GDP)	£183m	
Household Disposable Income (HHDY)	£138m	
		Employment Multiplier
Total Employment	12,791	2.48
UK-Owned Manufacturing	905	0.18
Foreign-owned Manufacturing	5,666	1.10
Non-Manufacturing Traded	4,022	0.78
Sheltered Sector	2,191	0.42

Note that the export FDI shock leads to an increase in regional GDP and household disposable income (HHDY) of £183 and £138 million, respectively. However, the intermediate demand and consumption effects are relatively small in both manufacturing divisions. Recall that in these simulations, both the UK and foreign-owned manufacturing sectors have identical structure and behavioural characteristics. The largest indirect employment impacts are in the non-manufacturing traded and sheltered sectors with employment in these sectors increasing by 4,022 and 2,191 jobs, respectively. It is instructive to compare these multiplier estimates with those generated using the four-sector I-O model, with identical structure, reported in Chapter 6.

The type II employment multiplier for the foreign-owned manufacturing sector, using the four sector AMOSFDI I-O model were the structure of both sectors is identical, was 2.34. The long-run (I-O) employment multiplier generated by the AMOSFDI CGE Model 1, where there are no structural or behavioural differences between sectors, is larger because the CGE model includes the additional effects of endogenous investment and government transfers. For instance after the initial FDI shock, investment is endogenously determined within the model as part of the period

Figure 7.1 - Change in total employment and employment by sector for an Export FDI shock with national bargaining, based on Model 1.

by period updating of capital stocks. Central government flows (transfer payments) are also endogenously determined within the model. With increased or decreased population through migration flows, the associated government transfers and general expenditure will vary within the region. Therefore, the AMOSFDI model replicates an endogenous investment I-O model. The sectoral impacts of the export shock are similar between both models. This is essentially what we expect given that these I-O data form the main part of the SAM and thus the database for the CGE model. However, in the basic I-O model, the employment multipliers are typically interpreted as applying to the short run (Richardson, 1985). Within the CGE model these results represent the long-run impact (by period 50). It is interesting to note the speed of adjustment towards long-run equilibrium, using the period by period simulations.

Figure 7.1 shows the change in employment by sector. Note that in period 2 and 10, the total employment impact is 74 and 93 per cent respectively of its long-run total. The period 2 total employment impact essentially represents the direct employment associated with the export FDI shock, as 96 per cent of the total foreign-owned employment impact is achieved within this period i.e. the FDI capacity and employment come on stream in this period. In the other sectors of the model the adjustment towards long-run equilibrium is more protracted, due to the effects of capacity constraints in these sectors. Period 2 employment in UK manufacturing, non-manufacturing and the sheltered sector is 57, 58 and 73 per cent respectively of their respective long-run employment impacts. After period 2, the initial capacity constraints begin to ease across these sectors, which stimulates output and employment further, as commodity and factor prices return to their initial base year values.

7.3.2 Model 1 with National Bargaining and LNJ Migration.

In this section I again report the results for a 100% export FDI shock (the same shock as the previous section) with national bargaining and LNJ migration function. Table 7.5 reports the results for key economic variables and Figure 7.2 plots the change in employment by sector for the period by period simulations. Note that the results are quantitatively and qualitatively very similar to the case with national bargaining (7.3.1). The main difference is that migration augments the impact of the

Table 7.5 - Model 1 with National Bargaining and Migration.					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.11	0.37	0.52	0.58	0.59
Consumption	0.13	0.37	0.53	0.58	0.59
Investment	1.79	0.62	0.62	0.62	0.62
Nominal before-tax wage	0.00	0.00	0.00	0.00	0.00
Real B-Tx consumption wage	-0.04	-0.08	-0.02	0.00	0.00
Total employment (000's):	0.13	0.42	0.55	0.59	0.60
UK Manufacturing:	0.03	0.15	0.23	0.26	0.27
For. Manufacturing:	0.03	3.17	3.27	3.30	3.31
Non-Manu traded:	0.08	0.24	0.44	0.51	0.52
Sheltered:	0.25	0.17	0.25	0.27	0.28
Total unemployment (000's)	-0.97	-2.81	0.02	0.55	0.60
Labour participation rate (%)	0.03	0.09	0.01	0.00	0.00
Total population (000's)	0.00	0.04	0.48	0.59	0.60
Price of value added:					
UK Manufacturing	0.02	0.11	0.03	0.00	0.00
For. Manufacturing	0.02	0.12	0.03	0.00	0.00
Non-Manu traded	0.08	0.24	0.08	0.01	0.00
Sheltered	0.16	0.11	0.03	0.00	0.00
Capital rental rates:					
UK Manufacturing	0.09	0.48	0.13	0.01	0.00
For. Manufacturing	0.09	0.55	0.14	0.01	0.00
Non-Manu traded	0.26	0.81	0.26	0.03	0.00
Sheltered	0.82	0.56	0.13	0.01	0.00
Consumer price index	0.04	0.08	0.02	0.00	0.00
Value-added:					
UK Manufacturing	0.02	0.11	0.22	0.26	0.27
For. Manufacturing	0.02	3.13	3.26	3.30	3.31
Non-Manu Traded	0.05	0.17	0.41	0.51	0.52
Sheltered	0.20	0.14	0.24	0.27	0.28
Sectoral Output:					
UK Manufacturing	0.03	0.13	0.23	0.26	0.27
For. Manufacturing	0.03	3.16	3.27	3.30	3.30
Non-Manu Traded	0.06	0.19	0.42	0.51	0.52
Sheltered	0.20	0.14	0.24	0.27	0.28
Capital stocks:					
UK Manufacturing	0.00	0.00	0.19	0.26	0.27
For. Manufacturing	0.00	3.00	3.23	3.30	3.30
Non-Manu Traded	0.00	0.00	0.36	0.50	0.52
Sheltered	0.00	0.00	0.21	0.27	0.28
Exports:					
UK Manufacturing	-0.02	-0.10	-0.03	0.00	0.00
For. Manufacturing	-0.02	4.32	4.40	4.43	4.43
Non-Manu Traded	-0.11	-0.35	-0.11	-0.01	0.00
Sheltered	-0.29	-0.20	-0.05	0.00	0.00
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.17	0.45	0.55	0.58	0.59
Firms disposable	0.34	0.75	0.64	0.60	0.60

Figure 7.2 - Change in total employment and employment by sector for an Export FDI shock with national bargaining and LNJ migration - Model 1.

FDI by attracting migrants into the region, which reinstates the initial unemployment rate and increases government transfers and therefore consumption within the region. Note that the increase in population impacts only on the demand side of the economy (regional income and consumption) via increased unemployment transfers from government. (Recall that with the LNJ migration function regional net in-migration is positively related to the regional relative real wage and negatively related to the relative unemployment rate.) The impact of the migration is however relatively small in this case. With national bargaining, although the unemployment rate initially falls, the real wage also falls in the short run, which limits the flow of in-migrants.

In summary, regional GDP and total employment increase by 0.59 and 0.60 per cent respectively which is slightly higher than in the case with national bargaining only. The model generates long run results which are again identical to an I-O model with equi-proportionate increases in employment, output, value added and capital stock of 0.27, 3.31, 0.52 and 0.28 per cent respectively for the UK manufacturing, foreign manufacturing, non-manufacturing traded and sheltered sectors. Table 7.6 reports the long-run increase in GDP, Household Disposable Income and total Employment (including multiplier values) for the export FDI shock.

Table 7.6 – The long-run increase in GDP, Household Disposable Income and Total Employment (including multiplier values) for an incoming 100% export FDI plant generating 5,162 direct jobs with the national bargaining and migration.

Model 1:	**LONG RUN IMPACT:**	
Gross Domestic Product (GDP)	£192m	
Household Disposable Income (HHDY)	£167m	
		Employment Multiplier
Total Employment	13,422	2.60
UK-Owned Manufacturing	948	0.18
Foreign-owned Manufacturing	5,686	1.10
Non-Manufacturing Traded	4,369	0.85
Sheltered Sector	2,420	0.47

Note that the additional impact of migration leads to an increase in both regional GDP and HHDY of £9 and £29 million, respectively, from the previous case. Thus, with increased population the total regional income for households, including government transfers, increases. The total system-wide employment impact generated by the export FDI shock with national bargaining and migration is 13,422, which is equivalent to an employment multiplier of 2.60. Note that the employment multiplier impacts in the UK and foreign manufacturing sectors (0.18 and 1.10) are similar to the previous simulation with national bargaining only. However, the adjustment towards long-run equilibrium is more protracted. By periods 2 and 10, total employment is 71 and 92 per cent respectively, of its long-run total here, compared with 74 and 93 per cent for the previous simulation with national bargaining only. Of the four sectors in the model, the adjustment to long-run equilibrium is most protracted in the non-manufacturing traded sector.

7.3.3 Model 1 with the LNJ regional bargaining labour market closure and no migration.

In this section, I replace the National Bargaining closure with the Layard, Nickell and Jackman (LNJ) (1991) regional bargained real wage (BRW) function in order to demonstrate the potential impact of a non-passive labour market, in which wages are sensitive to regional labour market conditions. In this relationship, the regional real-consumption wage is negatively related to the regional unemployment rate. This relationship implies that as regional unemployment increases, workers bargaining power falls, which puts downward pressure on the real consumption wage. Similarly, if the regional unemployment rate falls, workers bargaining power increases which, in turn, puts upward pressure on the real consumption wage. This real wage function is econometrically parameterised using UK data (LNJ, 1991).

The simulation results for this case are reported in Table 7.7 and again refer to a 100% export plant. That is to say, I use the same 20% manufacturing investment shock together with a 4.43% export stimulus. Figure 7.3 plots the total employment impact by sector for the period by period simulations. The results of the 100% export FDI shock with regional bargaining are markedly different from those obtained under

Table 7.7 - Model 1 with Regional Bargaining and no Migration.					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.05	0.21	0.24	0.25	0.25
Consumption	0.13	0.34	0.37	0.37	0.37
Investment	1.79	0.35	0.35	0.35	0.35
Nominal before-tax wage	0.11	0.31	0.32	0.32	0.32
Real B-Tx consumption wage	0.05	0.18	0.21	0.21	0.21
Total employment (000's):	0.06	0.21	0.24	0.24	0.25
UK Manufacturing:	-0.05	-0.08	-0.07	-0.07	-0.07
For. Manufacturing:	-0.05	2.95	2.95	2.96	2.96
Non-Manu traded:	0.00	0.02	0.07	0.09	0.09
Sheltered:	0.19	-0.03	-0.01	-0.01	-0.01
Total unemployment (000's)	-0.46	-1.57	-1.75	-1.81	-1.81
Labour participation rate (%)	0.01	0.05	0.05	0.06	0.06
Total population (000's)	0.0	0.00	0.00	0.00	0.00
Price of value added:					
UK Manufacturing	0.08	0.26	0.27	0.27	0.27
For. Manufacturing	0.08	0.27	0.27	0.27	0.27
Non-Manu traded	0.12	0.34	0.27	0.25	0.25
Sheltered	0.24	0.29	0.28	0.27	0.27
Capital rental rates:					
UK Manufacturing	-0.06	0.06	0.09	0.09	0.08
For. Manufacturing	-0.06	0.14	0.10	0.09	0.08
Non-Manu traded	0.12	0.39	0.16	0.09	0.09
Sheltered	0.73	0.22	0.11	0.08	0.08
Consumer price index	0.06	0.13	0.11	0.10	0.10
Value-added:					
UK Manufacturing	-0.04	-0.06	-0.06	-0.06	-0.06
For. Manufacturing	-0.04	2.96	2.97	2.97	2.97
Non-Manu Traded	0.00	0.02	0.09	0.11	0.11
Sheltered	0.15	-0.02	0.00	0.00	0.00
Sectoral Output:					
UK Manufacturing	-0.03	-0.02	-0.02	-0.01	-0.01
For. Manufacturing	-0.03	3.01	3.01	3.02	3.02
Non-Manu Traded	0.01	0.04	0.11	0.13	0.13
Sheltered	0.16	-0.01	0.01	0.01	0.01
Capital stocks:					
UK Manufacturing	0.00	0.00	-0.01	-0.01	0.00
For. Manufacturing	0.00	3.00	3.02	3.03	3.03
Non-Manu Traded	0.00	0.00	0.12	0.16	0.16
Sheltered	0.00	0.00	0.05	0.06	0.06
Exports:					
UK Manufacturing	-0.07	-0.23	-0.24	-0.24	-0.24
For. Manufacturing	-0.07	4.18	4.18	4.19	4.19
Non-Manu Traded	-0.17	-0.48	-0.39	-0.36	-0.36
Sheltered	-0.43	-0.53	-0.50	-0.50	-0.50
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.19	0.47	0.47	0.48	0.48
Firms disposable	0.26	0.49	0.45	0.44	0.44

Figure 7.3 - Change in total employment and employment by sector for an Export FDI shock with regional bargaining - Model 1.

the assumption of national bargaining. The major source of the difference stems from the rise in the bargained real wage, as a result of the increase in regional employment, generated by the export FDI shock. Thus, wages and prices rise across all sectors in the model, as does regional consumption. However, the increase in the regional wage and prices erodes competitiveness across all sectors and leads to labour market displacement in the UK manufacturing and Sheltered sector and net displacement in foreign manufacturing.

In period 1, the FDI shock leads to a rise in total employment and the real wage. As before, the period 1 employment impact is concentrated primarily in the sheltered sector (1,637 jobs), due to the construction of the FDI plant. Note, however, that even though period 1 total employment increased by 0.06 per cent (1,396 jobs), there is labour market displacement in both the UK and foreign-owned manufacturing sectors. Essentially, with the regional bargaining labour market closure the FDI investment shock leads to an immediate rise in employment, a corresponding reduction in the unemployment rate and an accompanying increase in the real wage.

This increase in the real wage erodes the competitiveness of the UK and foreign-owned manufacturing and non-manufacturing sectors. Value added prices rise by 0.08 per cent in both manufacturing sectors, and by 0.12 and 0.24 per cent, respectively, in the non-manufacturing traded and sheltered sectors. Overall, the period 1 impact is positive with regional GDP and employment increasing by 0.05 and 0.06 per cent, respectively. However, the rise in the real wage leads to exports and capital rental rates in the UK and foreign-owned manufacturing sector falling below their original base year values which, in turn, leads to a fall in employment in both manufacturing sectors of 177 and 86, respectively. Employment in the non-manufacturing traded sector stays above its base values due to stronger intermediate demand and consumption effects in this sector, which are generated by the expansion in employment in the sheltered sector.

In period 2, the FDI manufacturing capacity and associated direct employment comes on stream. Regional GDP increases by 0.21% and value added prices and capital rental rates move above base values for all sectors in the model. Foreign-owned manufacturing capacity increases by the full 3.0% and exports increase by

4.18%. Employment in the sheltered sector is a one period peak following the construction of the FDI plant and returns to just above its base value. However, the period 2 rise in total employment generated by the increase in foreign manufacturing capacity leads to a further substantial rise in the real wage. Essentially, as the unemployment rate within the region falls, workers bargaining power increases and the real consumption wage rises.

The impact of the higher real wage means that in period 2 there is direct labour market displacement in UK manufacturing and net labour market displacement in the foreign manufacturing sector. Recall that the 100% export FDI shock is equivalent to some 5,162 direct jobs. Period 2 total employment in the foreign-owned manufacturing sector is 5,069 indicating net labour market displacement of 93 jobs within this sector. Employment in UK manufacturing is more severely affected with employment still below its base year value in period 2, despite the impact of higher intermediate demand and consumption. Labour market crowding-out leads to a fall in UK manufacturing employment of 266 jobs in this period. Moreover, following the period 1 construction of the FDI plant in the sheltered sector, employment falls below base in this sector with some 238 jobs displaced. In total, period 2 employment increases to 4,747, with labour market displacement equal to 504.

After period 2, the effects of the higher intermediate demand and consumption generated by the export FDI shock continue to stimulate all sectors. However, in the long run the rise in the real wage remains above base, which leads to permanently higher prices across all sectors and a permanent deterioration in the region's competitiveness. For instance, exports by the foreign-owned sector increase by 4.19 per cent, which is less than the associated export shock (4.43%), indicating displacement of foreign manufacturing exports. Exports by the UK manufacturing, non-manufacturing traded and sheltered sector fall by 0.24, 0.36 and 0.50 per cent respectively, relative to their base year values. Moreover, there is long-run labour market displacement in both UK manufacturing and the sheltered sector.

In UK manufacturing, value-added output falls by 0.06 per cent in the long-run as a result of the permanent increase in value added prices and capital rental rates within this sector. Moreover, UK manufacturing capacity also remains unchanged despite the export FDI shock, although capital stocks increase by 0.16 and 0.06 per cent in the non-manufacturing traded and sheltered sectors due to the stronger intermediate demand effects operating in these sectors. With the regional bargaining closure the model does not generate I-O type results because there is a permanent increase in factor prices (labour) which leads to the substitution of factor inputs within these sectors.

Accordingly, much of the potential indirect impact of the incoming FDI plant, generated by stimulating intermediate linkage and consumption demand for these sectors, is mitigated by the loss in regional competitiveness, which is caused by the higher regional real wage. Even in the long run there remains positive labour market displacement in three of the four sectors in the model. In the UK manufacturing and sheltered sector the FDI export shock leads to long run labour market displacement of 256 and 79 jobs, respectively. In the foreign manufacturing sector, there is net displacement of 76 jobs. The level of labour market displacement in the foreign-owned sector is of particular interest, given that the FDI shock is 100 per cent exports, so that there is no direct product market displacement. Moreover, regional GDP and household disposable income are much reduced as is reported (with employment) in Table 7.8.

Table 7.8 – The long-run impact on GDP, Household Disposable Income and Total Employment (including multiplier values) for an incoming 100% export FDI plant generating 5,162 direct jobs with the regional bargaining labour market closure.		
Model 1:	**LONG RUN IMPACT:**	
Gross Domestic Product (GDP)	£83m	
Household Disposable Income (HHDY)	£136m	
		Employment Multiplier
Total Employment	5,517	1.07
UK-Owned Manufacturing	-256	-0.05
Foreign-owned Manufacturing	5,086	0.99
Non-Manufacturing Traded	761	0.15
Sheltered Sector	-79	-0.02

Recall that for the same export FDI shock with national bargaining, regional GDP and HHDY increased by £183 and £138 million, respectively. The change in HHDY is relatively small, from the national bargaining case, reflecting both the increases in the real wage and net employment within the region. However, GDP falls by around £100m, which reflects the lower total employment impact of the export FDI shock with regional bargaining. In total, the region-wide employment impact is some 7,274 less than the corresponding case with national bargaining.

Recall that the employment multiplier for the same shock with national bargaining was 2.48. The total employment multiplier in this case is 1.07, with permanent labour market displacement in the UK manufacturing and sheltered sectors. Note that the indigenous manufacturing sector is the most adversely affected with 256 jobs lost within this sector. Recall that with the National Bargaining closure, for the same export FDI shock, UK manufacturing employment increased by 905 jobs.

The labour market response to an aggregate shock, such as FDI, obviously has a major impact on regional employment. Moreover, where regional bargaining does prevail, an I-O model would substantially over estimate the region-wide employment impact of the incoming plant. Essentially, with the regional bargaining labour market closure the FDI stimulus creates both a large positive demand and negative supply-side shock. The scale of the demand side effect is determined by the structural characteristics of the foreign-owned sector. In contrast, the supply-side impact is determined primarily by how the regional wage rate is determined. In the model this relationship is parameterised by the econometric results reported by Layard, Nickel and Jackman (1991).

7.3.4 Model 1 Regional Bargaining and LNJ Migration.

In the previous section, the economic impacts of the FDI and export stimuli were considered in isolation of migration. However, we know from chapter 3 that migration can have important effects on the regional response to a demand disturbance in the presence of regional wage flexibility (McGregor *et al*, 1996). In this section, I simulate the case of a 100% export plant and, in Table 7.9, report the changes in key economic variables for the initial (period 1) impact effect and for subsequent periods 2, 10, 25 and 50.

The period 1 impact for employment and the real wage is unchanged from the standard LNJ bargaining wage closure reported in the previous section. In period 2, in-migration occurs in response to the period 1 rise in both the real wage and employment rates, which has both strong demand and supply-side effects within the regional economy. The increase in population, from period 2, augments the exogenous demand stimulus through higher government expenditure. Moreover, with a given level of employment, in-migration increases the supply of labour within the region which, in turn, increases the regional unemployment rate. This puts downward pressure on the real consumption wage, through the bargaining function, with migration continuing until the real wage falls to its initial base year level. The fall in the real wage further stimulates output and total employment with migration occurring until the zero net migration condition is restored. The model again generates long run results of an I-O nature with no long run changes in factor prices and exports increasing by the full amount of the shock (4.43%).

Table 7.9 - Model 1 with Regional Bargaining and Migration					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.05	0.22	0.40	0.53	0.58
Consumption	0.13	0.34	0.46	0.55	0.58
Investment	1.79	0.36	0.52	0.59	0.62
Nominal before-tax wage	0.11	0.30	0.12	0.03	0.00
Real B-Tx consumption wage	0.05	0.17	0.06	0.02	0.00
Total employment (000's):	0.06	0.22	0.41	0.54	0.59
UK Manufacturing:	-0.05	-0.07	0.10	0.22	0.26
For. Manufacturing:	-0.05	2.96	3.13	3.26	3.30
Non-Manu traded:	0.00	0.03	0.27	0.45	0.51
Sheltered:	0.19	-0.02	0.14	0.24	0.27
Total unemployment (000's)	-0.46	-1.46	-0.16	0.40	0.57
Labour participation rate (%)	0.01	0.05	0.02	0.00	0.00
Total population (000's)	0.00	0.02	0.34	0.53	0.59
Price of value added:					
UK Manufacturing	0.08	0.25	0.14	0.04	0.01
For. Manufacturing	0.08	0.27	0.14	0.04	0.01
Non-Manu traded	0.12	0.33	0.18	0.05	0.01
Sheltered	0.24	0.29	0.14	0.04	0.00
Capital rental rates:					
UK Manufacturing	-0.06	0.07	0.19	0.06	0.01
For. Manufacturing	-0.06	0.15	0.20	0.06	0.01
Non-Manu traded	0.12	0.41	0.30	0.09	0.01
Sheltered	0.73	0.24	0.19	0.05	0.00
Consumer price index	0.06	0.13	0.06	0.02	0.00
Value-added:					
UK Manufacturing	-0.04	-0.05	0.09	0.22	0.26
For. Manufacturing	-0.04	2.97	3.13	3.25	3.30
Non-Manu Traded	0.00	0.02	0.26	0.44	0.51
Sheltered	0.15	-0.02	0.14	0.24	0.27
Sectoral Output:					
UK Manufacturing	-0.03	-0.01	0.12	0.22	0.26
For. Manufacturing	-0.03	3.01	3.15	3.26	3.30
Non-Manu Traded	0.01	0.05	0.27	0.45	0.51
Sheltered	0.16	-0.01	0.14	0.24	0.27
Capital stocks:					
UK Manufacturing	0.00	0.00	0.08	0.21	0.26
For. Manufacturing	0.00	3.00	3.11	3.25	3.30
Non-Manu Traded	0.00	0.00	0.22	0.43	0.51
Sheltered	0.00	0.00	0.12	0.23	0.27
Exports:					
UK Manufacturing	-0.07	-0.22	-0.12	-0.04	0.00
For. Manufacturing	-0.07	4.18	4.30	4.39	4.43
Non-Manu Traded	-0.17	-0.48	-0.25	-0.07	-0.01
Sheltered	-0.43	-0.52	-0.25	-0.07	-0.01
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.19	0.47	0.52	0.57	0.58
Firms disposable	0.26	0.50	0.59	0.60	0.60

Figure 7.4 - Change in total employment, real wage and population following an Export FDI shock with regional bargaining and migration - Model 1.

Figure 7.5 - Change in total employment and employment by sector for an Export FDI Shock with regional bargaining and LNJ migration - Model 1.

Figure 7.4 plots the period by period percentage change in total employment, real wage and population as a result of the 100% export FDI shock with regional bargaining and migration. Note the impact of in-migration through the changes in total population: as population increases after period 2, the bargained real wage starts to fall, and total employment continues to rise until long run equilibrium is restored. However, unlike the previous labour market closures, long-run equilibrium is not achieved over a relatively short period of time. Figure 7.5 plots the actual change in employment by sector as a result of the export FDI shock. Note that there is net aggregate labour market displacement until period 3. Labour market crowding-out persists in the UK manufacturing sector until period 5 and the sheltered sector experiences a one period fall (period 2) in employment due to the effects of the higher regional wage. Moreover, GDP, HHDY and employment converge on the long run results generated for the national bargaining and migration closure, as is reported in Table 7.10.

Table 7.10 – The long-run impact on GDP, Household Disposable Income and Total Employment (including multiplier values) for an incoming 100% export FDI plant generating 5,162 direct jobs with the regional bargaining and migration.

Model 1:	**LONG RUN IMPACT:**	
Gross Domestic Product (GDP)	£192m	
Household Disposable Income (HHDY)	£167m	
		Employment Multiplier
Total Employment	13,422	2.60
UK-Owned Manufacturing	948	0.18
Foreign-owned Manufacturing	5,686	1.10
Non-Manufacturing Traded	4,369	0.85
Sheltered Sector	2,420	0.47

However, with the LNJ closure with migration the adjustment towards long-run equilibrium is more protracted. By periods 2 and 10, total employment is 37 and 70 per cent of its long-run total compared with 71 and 92 per cent, respectively, for the same export FDI shock with national bargaining and migration (reported in Section 7.3.2). Thus, with the regional bargaining and migration closure, the long run is not achieved until period 78. In terms of employment, even though both labour market closures generate identical long run results, the short to medium run employment impacts are quite different. Accordingly, the choice of labour market closure has significant impacts on both the total employment generated and the build up of employment, which is particularly important for regional policy evaluations (for a discussion of these issues applied to the evaluation of regional selective assistance in Scotland see Gillespie *et al*, 1998).

Finally, the key point from adopting this labour market closure is that in-migration augments the impact of the FDI shock under regional bargaining by putting downward pressure on the real consumption wage until it eventually returns to its initial level. The long run results generated using this closure are again of an I-O nature, though the speed of adjustment is very protracted.

7.3.5 Summary of model results where there are no structural or behavioural differences between the UK and foreign manufacturing sectors in the model.

Model 1 assumes the hypothesis of no structural or behavioural differences between the foreign and UK-owned manufacturing sectors. The export FDI shock simulated in Model 1 is equivalent to an increase in both foreign manufacturing investment and output of £151m and £248m, respectively. Where there are no wage effects the export FDI shock generates 5,162 direct jobs. The indirect (and wider) effects of the FDI shock are influenced by the nature of wage setting within the region. For instance, where wage impacts from the export FDI shock are zero (national bargaining or migration closures) the indirect employment effects are relatively large, particularly in the non-manufacturing traded sector. Moreover, with these labour market closures, the Model generates long run results that are identical to an I-O model. However, the time period of adjustment is important. With national bargaining, with and without migration, by period 10 over 90 per cent of the long run impact is achieved. In contrast, with regional bargaining and migration, the long run impact is more protracted and by the same period only 70 per cent of the long run impact is generated.

Where the regional bargaining labour market closure is employed with no migration, there is significant crowding out in the UK manufacturing and sheltered sectors, with net labour market displacement in the foreign manufacturing sector. With regional bargaining and the LNJ migration function, in-migration serves to reinstate the unemployment rate differential between the regions and eliminate the rise in the bargained real wage that would otherwise occur.

Finally, Model 1 provides a benchmark case from which I can highlight the importance of incorporating the different 'structural' and 'behavioural' characteristics of the UK and foreign manufacturing sectors. In the following section I begin by establishing the importance of the 'true' structural characteristics of both manufacturing sectors using Model 2, as outlined in chapter 6, and undertake the same four simulations.

7.4 Model 2: Incorporating the 'true' Structural Characteristics within the model.

Recall that chapter 3 provided a system-wide analysis of the impact of FDI using the AMOS model. One of the major limitations of the analysis is that the AMOS model could not distinguish or capture the structural differences that exist between the UK and foreign-owned manufacturing sectors. In these simulations the different production processes of sectors are incorporated in the base year data and both sectors are modelled separately within the AMOSFDI model. However, both the UK and foreign-owned manufacturing sectors are assumed to have identical behavioural characteristics. The results in this section are reported for the same four simulations as the previous section with the focus of the analysis centred on the impact of incorporating the actual structure of each sector within the model

Note that incorporating distinctive or 'true' structure within the model has an immediate impact on the scale of the export shock. Recall from Table 7.2 that the base year model data is different for Model 2, compared with Model 1, which has an impact on the actual value of the investment shock and the level of direct employment associated with the export FDI plant. This reflects the higher levels of capital and

Table 7.11 - Model 2 with National Bargaining and no Migration					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.13	0.29	0.39	0.42	0.42
Consumption	0.15	0.28	0.34	0.36	0.37
Investment	2.15	0.58	0.56	0.56	0.56
Nominal before-tax wage	0.00	0.00	0.00	0.00	0.00
Real B-Tx consumption wage	-0.05	-0.05	-0.01	0.00	0.00
Total employment (000's):	0.16	0.29	0.36	0.39	0.39
UK Manufacturing:	0.04	0.11	0.17	0.19	0.19
For. Manufacturing:	0.03	3.13	3.18	3.20	3.20
Non-Manu traded:	0.09	0.16	0.27	0.31	0.31
Sheltered:	0.30	0.14	0.19	0.20	0.20
Unemployment rate (%)	-1.21	-2.22	-2.78	-2.97	-2.99
Labour participation rate (%)	0.04	0.07	0.08	0.09	0.09
Total population (000's)	0.00	0.00	0.00	0.00	0.00
Price of value added:					
UK Manufacturing	0.02	0.07	0.02	0.00	0.00
For. Manufacturing	0.03	0.12	0.03	0.00	0.00
Non-Manu traded	0.09	0.16	0.05	0.00	0.00
Sheltered	0.19	0.09	0.02	0.00	0.00
Capital rental rates:					
UK Manufacturing	0.12	0.36	0.09	0.01	0.00
For. Manufacturing	0.11	0.41	0.09	0.00	0.00
Non-Manu traded	0.31	0.52	0.16	0.02	0.00
Sheltered	0.98	0.47	0.08	0.00	0.00
Consumer price index	0.05	0.05	0.01	0.00	0.00
Value-added:					
UK Manufacturing	0.03	0.09	0.17	0.19	0.19
For. Manufacturing	0.02	3.09	3.17	3.20	3.20
Non-Manu Traded	0.06	0.11	0.25	0.31	0.31
Sheltered	0.24	0.12	0.18	0.20	0.20
Sectoral Output:					
UK Manufacturing	0.03	0.10	0.17	0.19	0.19
For. Manufacturing	0.03	3.11	3.18	3.20	3.20
Non-Manu Traded	0.07	0.12	0.26	0.31	0.31
Sheltered	0.24	0.12	0.18	0.20	0.20
Capital stocks:					
UK Manufacturing	0.00	0.00	0.14	0.19	0.19
For. Manufacturing	0.00	3.00	3.16	3.20	3.20
Non-Manu Traded	0.00	0.00	0.22	0.30	0.31
Sheltered	0.00	0.00	0.16	0.20	0.20
Exports:					
UK Manufacturing	-0.03	-0.08	-0.02	0.00	0.00
For. Manufacturing	-0.02	3.90	3.95	3.97	3.97
Non-Manu Traded	-0.13	-0.23	-0.07	-0.01	0.00
Sheltered	-0.35	-0.17	-0.03	0.00	0.00
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.20	0.34	0.36	0.36	0.37
Firms disposable	0.41	0.59	0.48	0.45	0.45

intermediate intensity actually employed in the foreign manufacturing sector. The export FDI shock, in Model 2, is equivalent to an increase in foreign manufacturing investment and output of £182m and £248m, respectively. The associated FDI employment is, however, 3,392 reflecting the lower levels of employment per unit of gross output used in the foreign manufacturing sector.

7.4.1. Model 2 with National Bargaining and no migration.

The results for key economic variables are reported in Table 7.11. The first period results are qualitatively similar to the results for the national bargaining labour market closure in Model 1 (Section 7.3.1). The main difference between Models 1 and 2 is that although the aggregate manufacturing structure remains unchanged, as a whole, the division receiving the stimulus (export FDI shock) dominates the first round effects. Thus, the main period 1 differences from Model 1 are that manufacturing value added prices, capital rental rates, exports etc. in the UK and foreign manufacturing sector respond differently to the exogenous investment shock, although these differences are typically small.

For instance, value added prices increase by more in the foreign manufacturing sector because of the higher cost of labour (foreign wage rates), which are incorporated within the base year data for Model 2. As before, period 1 activity is concentrated primarily in the sheltered sector with the construction of the FDI plant. However, total employment increases by 0.16 per cent in this period, for the same 20% increase in foreign manufacturing investment, compared with only 0.13 per cent in Model 1. The associated period 1 increase in household disposable income (HHDY) is also larger in Model 2. The higher stimulus to employment and regional income in Model 2 stems from the actual value of the investment shock, which is larger in this case due to the actual level of capital intensity in the foreign manufacturing sector.

The period 2 figures show a rise in both GDP and total employment of 0.29 per cent. The period 2 increase in both these variables is lower than the corresponding closure with Model 1. Incorporating the actual structure of both manufacturing sectors in the model, results in foreign employment, output, value added and capital rental

Figure 7.6 - Change in total employment and employmen by sector for an Export FDI Shock with national bargaining - Model 2.

rates increasing by more in this period. However, the larger increases in GDP and total employment, reported for the same output shock and labour market closure in Model 1, stems from the structure of the foreign manufacturing sector in that model: i.e. the larger direct employment shock and higher levels of local sourcing and labour intensity. In the long run, as capacity constraints are eased across all sectors, commodity prices return to their initial base values and the model generates I-O type results, as in the previous case. Employment, output, value added and capital stocks increase by 0.19, 3.18, 0.31 and 0.20 per cent, respectively, in the UK manufacturing, foreign manufacturing, non-manufacturing traded and sheltered sector. The long run increases in activity are, however, lower than those reported using Model 1 (with identical structure between the manufacturing sectors).

Figure 7.6 highlights the change in total employment and employment by sector from the initial base-year values. Table 7.12 reports the long-run increase in GDP, Household Disposable Income and total Employment and employment by sector for the same case (export FDI shock with national bargaining) for Models 1 and 2.

Table 7.12 – Comparison of the long run impact on GDP, HHDY and total and sectorally disaggregated employment, by sector, for the national bargaining labour market closure using AMOSFDI Models 1 and 2.

	Model 1	**Model 2**
Gross Domestic Product (GDP)	£183m	£138m
Household Disposable Income	£138m	£104m
Direct Employment	**5,162**	**3,392**
Total Employment	12,791	8,760
UK-Owned Manufacturing	905	799
Foreign-owned Manufacturing	5,666	3,600
Non-Manufacturing Traded	4,022	2,628
Sheltered Sector	2,191	1,742

Clearly, in the model where the structure of both sectors is, of course inaccurately, taken to be identical (Model 1), the model overestimates the impact of the export FDI shock. Thus, GDP and HHDY are £45 and £34 million higher in

Model 1. The 'true' total employment impact is overestimated by around 46 per cent, compared with Model 2, which is equivalent to some 4,031 jobs. Obviously, incorporating the distinct structure of both manufacturing sectors within the model has a significant impact on the model results. Particularly, since in both Models 1 and 2 the overall aggregate manufacturing sector (UK plus foreign) is the same in both models. Table 7.13 reports both total employment multipliers and employment/output multipliers per unit of final demand, for the same export FDI shock with national bargaining using AMOSFDI Models 1 and 2.

Table 7.13 – Comparison of the employment multipliers and employment/output multipliers per unit of final demand for a 100% Export FDI shock with national bargaining, using Models 1 and 2.

	Employment Multiplier		Employment/Output Multipliers per unit of final demand (£1million)	
	Model 1	Model 2	Model 1	Model 2
Total Employment	**2.48**	**2.58**		
UK-Owned Manufacturing	0.18	0.24	21	24
Foreign-owned Manufacturing	1.10	1.06	21	14
Non-Manufacturing Traded	0.78	0.77	38	38
Sheltered Sector	0.42	0.51	51	51

Recall from chapter 5, the employment/output multiplier indicates the amount of employment generated per additional unit of final demand (per £1m of output in Table 7.13). Both the labour intensity and linkage structure of the individual manufacturing sectors determine these multipliers. In contrast, the total employment multiplier indicates the increase in region-wide employment as a result of a unit increase in employment in that sector. Note that the total employment multiplier for the export FDI shock in Model 2 (2.58) is larger than the corresponding employment multiplier (2.48), generated by Model 1. This may seem surprising given that that the total (direct) employment impact is substantially larger in Model 1. However, incorporating the actual structure of the manufacturing sectors in Model 2, compared with the structure of the sector in Model 1, has two countervailing effects on the total employment multipliers. The proportion of total intermediate inputs sourced locally by the foreign manufacturing sector is reduced, although the value of output generated per direct employee is increased. Therefore, even though the direct employment and local linkages are larger in Model 1, the greater value of output generated per employee, in Model 2, increases the indirect linkage effects, which increases the total employment multiplier for this sector in Model 2.

The different employment/output multipliers that are reported in Table 7.13 for the manufacturing sectors in Model 2 reinforce this point. Note that per £1m of additional output, 14 jobs are created in the foreign manufacturing division compared with 24 for UK manufacturing. Essentially, UK (indigenous) manufacturing is more labour intensive. However, a unit increase in foreign employment will generate a larger direct increase in output than the equivalent case in the UK manufacturing division. The differences in labour/output ratios (intensities) between sectors are larger than the differences in the proportions of inputs sourced locally, which generates larger total employment multipliers for the foreign manufacturing sectors. These points were discussed in detail in chapter 5 (see also Gillespie, 1998).

Moreover, the sectoral composition of the long-run employment multipliers, based on Models 1 and 2, is also slightly different. For instance, in Model 2, the indirect employment impacts generated by the exogenous FDI shock are smaller in the foreign manufacturing sector, but larger in the UK manufacturing and sheltered sector. However, overall the values of the total employment multipliers generated by each model are quite close, indicating that in terms of static impact analysis, using either multiplier value would generate long-run employment estimates that are relatively similar. However Model 1 substantially overestimates the total employment impact compared with Model 2 where the actual structural characteristics of both sectors are incorporated.[2]

In summary, with the national bargaining labour market closure, incorporating the 'true' structure of the foreign manufacturing sector within the model does have a

[2] Recall from chapter 6 (section 6.5.1), that I report type I and II output multipliers for the foreign manufacturing sector, generated by the four-sector AMOSFDI I-O model with the actual structure of both sectors incorporated in the model. The equivalent type II I-O employment multiplier for the foreign manufacturing sector is 2.37.

Table 7.14 - Model 2 with National Bargaining and Migration					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.13	0.29	0.40	0.44	0.44
Consumption	0.15	0.29	0.40	0.43	0.43
Investment	2.15	0.58	0.58	0.58	0.58
Nominal before-tax wage	0.00	0.00	0.00	0.00	0.00
Real B-Tx consumption wage	-0.05	-0.05	-0.02	0.00	0.00
Total employment (000's):	0.16	0.29	0.38	0.41	0.41
UK Manufacturing:	0.04	0.11	0.18	0.20	0.20
For. Manufacturing:	0.03	3.13	3.19	3.20	3.21
Non-Manu traded:	0.09	0.16	0.29	0.34	0.34
Sheltered:	0.30	0.14	0.20	0.22	0.22
Unemployment rate (%)	-1.21	-1.88	-0.32	-0.03	0.00
Labour participation rate (%)	0.04	0.06	0.01	0.00	0.00
Total population (000's)	0.0	0.05	0.34	0.40	0.41
Price of value added:					
UK Manufacturing	0.02	0.07	0.02	0.00	0.00
For. Manufacturing	0.03	0.12	0.03	0.00	0.00
Non-Manu traded	0.09	0.16	0.05	0.01	0.00
Sheltered	0.19	0.10	0.02	0.00	0.00
Capital rental rates:					
UK Manufacturing	0.12	0.36	0.10	0.01	0.00
For. Manufacturing	0.11	0.41	0.10	0.01	0.00
Non-Manu traded	0.31	0.53	0.18	0.02	0.00
Sheltered	0.98	0.48	0.09	0.01	0.00
Consumer price index	0.05	0.05	0.02	0.00	0.00
Value-added:					
UK Manufacturing	0.03	0.09	0.17	0.20	0.20
For. Manufacturing	0.02	3.09	3.18	3.20	3.21
Non-Manu Traded	0.06	0.11	0.27	0.33	0.34
Sheltered	0.24	0.12	0.19	0.22	0.22
Sectoral Output:					
UK Manufacturing	0.03	0.10	0.17	0.20	0.20
For. Manufacturing	0.03	3.11	3.18	3.20	3.21
Non-Manu Traded	0.07	0.12	0.27	0.33	0.34
Sheltered	0.24	0.12	0.19	0.22	0.22
Capital stocks:					
UK Manufacturing	0.00	0.00	0.15	0.20	0.20
For. Manufacturing	0.00	3.00	3.16	3.20	3.21
Non-Manu Traded	0.00	0.00	0.23	0.33	0.34
Sheltered	0.00	0.00	0.17	0.21	0.22
Exports:					
UK Manufacturing	-0.03	-0.08	-0.02	0.00	0.00
For. Manufacturing	-0.02	3.90	3.95	3.97	3.97
Non-Manu Traded	-0.13	-0.23	-0.08	-0.01	0.00
Sheltered	-0.35	-0.17	-0.03	0.00	0.00
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.20	0.34	0.41	0.43	0.43
Firms disposable	0.41	0.59	0.50	0.47	0.47

Figure 7.7 - Change in total employment and employment by sector for an Export FDI shock with national bargaining and migration - Model 2.

significant effect on the total employment generated, although actual differences in employment multipliers between the models are relatively small.

7.4-2. Model 2 National Bargaining and LNJ Migration.

Table 7.14 reports the results for key economic variables and Figure 7.7 plots the change in employment by sector for the period by period simulations, for this case. Note that the results are qualitatively similar to those with the corresponding closure in Model 1. As before, migration augments the impact of the FDI shock so that the long-run effects are larger than when population is fixed. Table 7.15 compares the sectoral disaggregation of the total employment impact and multiplier values, by sector, for this closure using Models 1 and 2.

Table 7.15 – Comparison of the direct employment and long run employment impact and multiplier values generated for a 100% Export FDI shock with national bargaining and migration, using AMOSFDI Models 1 and 2.

	Model 1	Model 2	Model 1 Employment Multiplier:	Model 2 Employment Multiplier:
Direct Employment	**5,162**	**3,392**		
Total Employment	13,422	9,256	**2.60**	**2.73**
UK-Owned Manufacturing	948	840	0.18	0.25
Foreign-owned Manufacturing	5,686	3,624	1.10	1.07
Non-Manufacturing Traded	4,369	2,881	0.85	0.85
Sheltered Sector	2,420	1,910	0.47	0.56

The total system-wide employment impact generated by the export FDI shock with national bargaining and migration is 9,256, which is equivalent to an employment multiplier of 2.72. The total employment generated by Model 1 is again substantially larger than the 'true' estimate. The long run changes in GDP and HHDY (£144 and £124 million) in Model 2 are also substantially lower than in Model 1. However, the actual employment multiplier is larger in Model 2 where the actual structure of both sectors is incorporated. Finally, these results are similar to the previous section with Model 1 overestimating the impact of the export FDI shock. In

Table 7.16 - Model 2 with Regional Bargaining and No Migration.					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.07	0.18	0.20	0.21	0.21
Consumption	0.15	0.27	0.28	0.29	0.29
Investment	2.15	0.40	0.39	0.39	0.39
Nominal before-tax wage	0.14	0.21	0.22	0.22	0.22
Real B-Tx consumption wage	0.06	0.13	0.14	0.15	0.15
Total employment (000's):	0.07	0.15	0.16	0.17	0.17
UK Manufacturing:	-0.07	-0.06	-0.06	-0.05	-0.05
For. Manufacturing:	-0.05	2.99	3.01	3.01	3.01
Non-Manu traded:	0.00	0.01	0.04	0.04	0.05
Sheltered:	0.22	0.01	0.02	0.02	0.02
Unemployment rate (%)	-0.56	-1.11	-1.23	-1.27	-1.27
Labour participation rate (%)	0.02	0.03	0.04	0.04	0.04
Total population (000's)	0.0	0.00	0.00	0.00	0.00
Price of value added:					
UK Manufacturing	0.09	0.18	0.19	0.19	0.19
For. Manufacturing	0.09	0.21	0.18	0.17	0.17
Non-Manu traded	0.14	0.22	0.18	0.17	0.17
Sheltered	0.28	0.22	0.19	0.19	0.19
Capital rental rates:					
UK Manufacturing	-0.09	0.03	0.06	0.06	0.06
For. Manufacturing	-0.02	0.19	0.09	0.06	0.06
Non-Manu traded	0.14	0.23	0.10	0.06	0.06
Sheltered	0.88	0.24	0.08	0.06	0.06
Consumer price index	0.07	0.09	0.08	0.07	0.07
Value-added:					
UK Manufacturing	-0.05	-0.04	-0.05	-0.05	-0.04
For. Manufacturing	-0.03	3.00	3.02	3.03	3.03
Non-Manu Traded	0.00	0.00	0.05	0.06	0.06
Sheltered	0.18	0.01	0.03	0.03	0.03
Sectoral Output:					
UK Manufacturing	-0.04	-0.02	-0.02	-0.02	-0.02
For. Manufacturing	-0.01	3.04	3.06	3.06	3.06
Non-Manu Traded	0.01	0.02	0.06	0.07	0.07
Sheltered	0.19	0.01	0.03	0.04	0.04
Capital stocks:					
UK Manufacturing	0.00	0.00	-0.01	-0.01	-0.01
For. Manufacturing	0.00	3.00	3.05	3.06	3.06
Non-Manu Traded	0.00	0.00	0.07	0.09	0.09
Sheltered	0.00	0.00	0.06	0.07	0.07
Exports:					
UK Manufacturing	-0.10	-0.19	-0.20	-0.20	-0.20
For. Manufacturing	-0.06	3.84	3.86	3.86	3.86
Non-Manu Traded	-0.20	-0.32	-0.26	-0.25	-0.25
Sheltered	-0.52	-0.40	-0.35	-0.34	-0.34
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.22	0.35	0.36	0.36	0.36
Firms disposable	0.31	0.41	0.37	0.36	0.36

the following sections I consider the same FDI shock to Model 2 except that I employ the LNJ regional bargaining function as the labour market closure.

7.4-3. Model 2 with the LNJ regional bargaining labour market closure and no migration.

The simulation results reported in Table 7.16 and presented here are again for a 100% export FDI plant. That is to say, I use the same 20% manufacturing investment shock together with a 3.97% export stimulus (100% export intensity). As before, the results from using this labour market closure are markedly different from the previous sections with national bargaining and migration and are qualitatively similar to those reported for the corresponding case in Model 1, which are outlined in section 7.3.3.

With regional bargaining, in period 1 the FDI shock leads to a rise in total employment and the real wage. As before, the period 1 employment impact is concentrated primarily in the sheltered sector (1,977 jobs), and there is labour market displacement in both the UK and foreign manufacturing sector. However, with the actual structural characteristics of each sector incorporated in Model 2, the period 1 impact of the investment shock has a more adverse affect on the UK manufacturing sector than was the case where the manufacturing sectors had identical structure (Model 1). This reflects the fact that foreign manufacturing is less labour intensive than the UK manufacturing sector. That is to say, labour accounts for a smaller proportion of value added production in this sector. Accordingly, the period 1 rise in the real wage has a more detrimental effect on the competitiveness of the UK manufacturing sector due to the greater labour intensity of production in this sector.

For instance in period 1 the real wage and both foreign and UK manufacturing value-added prices increase by 0.06 and 0.09 per cent, respectively. However, UK manufacturing employment, output, capital rental rates and exports all fall by more, than the foreign manufacturing sector, due to the greater labour intensity of this sector. In period 2, the foreign manufacturing capacity generated by the FDI export shock comes on stream. However, the period 2 rise in total employment generated by the increase in foreign manufacturing employment leads to a further substantial rise in

Figure 7.8 - Change in total employment and employment by sector for an Export FDI shock the regional bargaining labour closure - Model 2.

the real wage (0.13%). This is however less than the corresponding rise in the real wage (0.18%) for Model 1, which reflects the larger direct employment shock generated by the export FDI shock in that model.

Moreover, the rise in the real wage continues to erode competitiveness in all sectors of the economy and there is labour market displacement in both the UK and foreign-owned manufacturing sector. In the corresponding case with Model 1, there was also period 2 labour market displacement in the sheltered sector of some 238 jobs. Period 2 total employment in the foreign-owned manufacturing sector is 3,385 indicating labour market displacement of 7 jobs within this sector. Employment in UK manufacturing is more severely affected with 228 jobs displaced in this period.

In the long run, the rise in the real wage remains above base, which causes a permanent deterioration in the region's competitiveness. As a result, positive labour market displacement remains in the UK manufacturing sector although net labour market displacement in the foreign-owned manufacturing sector is eliminated by period 4. In the UK-owned sector the FDI export shock leads to long run labour market displacement of 224 jobs. Figure 7.8 plots the total employment impact by sector for the period by period simulations and Table 7.17 reports the log run impact on GDP, HHDY and employment by sector (and employment multipliers) for the same export FDI shock with regional bargaining using both Models 1 and 2.

Table 7.17 – Comparison of Total GDP, HHDY and employment by sector (and multiplier values) generated for a 100% Export FDI shock with regional bargaining using both AMOSFDI Models 1 and 2.				
	Model 1	Model 2	Model 1 Employment Multiplier:	Model 2 Employment Multiplier:
GDP	**£83**	**£69m**		
HHDY	**£136m**	**£102m**		
Direct Employment	**5,162**	**3,392**		
Total Employment	5,517	3,761	**1.07**	**1.11**
UK-Owned Manufacturing	-256	-224	-0.05	-0.07
Foreign-owned Manufacturing	5,086	3,407	0.99	1.00
Non-Manufacturing Traded	761	380	0.15	0.11
Sheltered Sector	-79	194	-0.02	0.06

Note that estimates for the impact on regional GDP and HHDY by Model 1 are around one third and one fifth larger than the comparable estimates from Model 2. Model 1 also over-estimates the long-run employment impact of the export FDI shock, with regional bargaining, by 1,779 jobs (48%), compared with Model 2. (These larger employment estimates stem primarily from the direct employment associated with Model 1.) Moreover, the distribution of the employment impacts differs between Models 1 and 2. For instance, the long-run employment multiplier value in Model 2 is 1.11 compared with 1.07 for Model 1. Although these are very close, the distribution of the indirect employment multiplier impacts between sectors varies across the two models.

For instance in Model 1, the employment multiplier impact in the sheltered sector is negative whilst in Model 2, with the actual structure of both sectors incorporated within the model, the indirect employment impact in the sheltered sector is positive. Moreover, the employment multiplier for the foreign manufacturing sector in Model 2 is just greater than unity (1.004), which indicates there is no net displacement of employment in this sector. Note also that Model 1 over-estimates the indirect employment impact in the non-manufacturing traded sector and the UK manufacturing sector.

Table 7.18 – Model 2 with Regional Bargaining and Migration					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.07	0.19	0.31	0.40	0.43
Consumption	0.15	0.27	0.35	0.41	0.43
Investment	2.15	0.41	0.51	0.56	0.57
Nominal before-tax wage	0.14	0.20	0.08	0.02	0.00
Real B-Tx consumption wage	0.06	0.11	0.04	0.01	0.00
Total employment (000's):	0.07	0.16	0.28	0.38	0.41
UK Manufacturing:	-0.07	-0.04	0.08	0.17	0.20
For. Manufacturing:	-0.05	3.00	3.11	3.18	3.20
Non-Manu traded:	0.00	0.02	0.17	0.29	0.34
Sheltered:	0.22	0.02	0.12	0.19	0.21
Unemployment rate (%)	-0.56	-1.01	-0.35	-0.09	-0.01
Labour participation rate (%)	0.02	0.03	0.01	0.00	0.00
Total population (000's)	0.0	0.02	0.24	0.36	0.41
Price of value added:					
UK Manufacturing	0.09	0.17	0.10	0.03	0.00
For. Manufacturing	0.09	0.20	0.10	0.03	0.00
Non-Manu traded	0.14	0.22	0.12	0.04	0.00
Sheltered	0.28	0.21	0.09	0.03	0.00
Capital rental rates:					
UK Manufacturing	-0.09	0.05	0.14	0.04	0.00
For. Manufacturing	-0.02	0.20	0.13	0.03	0.00
Non-Manu traded	0.14	0.26	0.20	0.06	0.01
Sheltered	0.88	0.25	0.14	0.03	0.00
Consumer price index	0.07	0.09	0.04	0.01	0.00
Value-added:					
UK Manufacturing	-0.05	-0.04	0.07	0.17	0.20
For. Manufacturing	-0.03	3.00	3.11	3.18	3.20
Non-Manu Traded	0.00	0.01	0.16	0.29	0.34
Sheltered	0.18	0.01	0.12	0.19	0.21
Sectoral Output:					
UK Manufacturing	-0.04	-0.01	0.09	0.17	0.20
For. Manufacturing	-0.01	3.05	3.13	3.18	3.20
Non-Manu Traded	0.01	0.03	0.17	0.29	0.34
Sheltered	0.19	0.02	0.12	0.19	0.21
Capital stocks:					
UK Manufacturing	0.00	0.00	0.06	0.16	0.20
For. Manufacturing	0.00	3.00	3.10	3.18	3.20
Non-Manu Traded	0.00	0.00	0.14	0.28	0.33
Sheltered	0.00	0.00	0.11	0.19	0.21
Exports:					
UK Manufacturing	-0.10	-0.18	-0.10	-0.03	0.00
For. Manufacturing	-0.06	3.84	3.91	3.95	3.97
Non-Manu Traded	-0.20	-0.31	-0.17	-0.05	-0.01
Sheltered	-0.52	-0.39	-0.17	-0.05	-0.01
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.22	0.36	0.39	0.42	0.43
Firms disposable	0.31	0.42	0.47	0.47	0.47

Figure 7.9 - Change in total employment and employment by sector for an Export FDI shock with regional bargaining and LNJ migration closure - Model 2

7.4-4 Model 2 with Regional Bargaining and LNJ Migration.

Tables 7.18 reports the changes in key economic variables and Figure 7.9 plots the change in employment by sector as a result of the export FDI shock. Recall that with the LNJ migration function, regional net in-migration is positively related to the regional relative real wage and negatively related to the relative unemployment rate. The period 1 impacts, for Model 2, are unchanged from the standard LNJ bargaining wage closure reported in the previous section, as the effects of increased population do not occur until period 2.

As reported previously, for the same simulation with regional bargaining and migration (Model 1), in-migration has both strong demand and supply-side effects. The qualitative nature of the effects of in-migration does not change essentially by incorporating the structural characteristics of both manufacturing sectors within the model. These effects have been discussed in section 7.3.4. Recall that the increase in population augments the exogenous FDI shock by both stimulating regional consumption and pushing down the real consumption wage by re-instating the original unemployment rate within the region. By incorporating in-migration with this closure, labour market crowding-out in the foreign and UK-owned manufacturing sectors is eliminated by periods 3 and 5, respectively, with the employment impacts in both the non-manufacturing traded and sheltered sector positive through-out. Table 7.21 reports the log run impact on GDP, HHDY and employment by sector (including multiplier values) for the same export FDI shock with regional bargaining and migration using both Models 1 and 2.

Table 7.19 – Comparison of GDP, HHDY and the employment impact and multiplier values generated for a 100% Export FDI shock with regional bargaining and migration using both AMOSFDI Models 1 and 2.

	Model 1	Model 2	Model 1 Employment Multiplier:	Model 2 Employment Multiplier:
GDP	**£192m**	**£144m**		
HHDY	**£167m**	**£124m**		
Direct Employment	**5,162**	**3,392**		
Total Employment	13,422	9,256	2.60	2.73
UK-Owned Manufacturing	948	840	0.18	0.25
Foreign-owned Manufacturing	5,686	3,624	1.10	1.07
Non-Manufacturing Traded	4,369	2,881	0.85	0.85
Sheltered Sector	2,420	1,910	0.47	0.56

As before, Model 1 substantially over-estimates the long-run impact on GDP, HHDY and total employment for the same export FDI shock with regional bargaining and migration, compared with Model 2. The long-run employment multipliers, generated by the export FDI shock in each model are similar in magnitude. However, these results are not achieved over a relatively short time period. For both Models 1 and 2, total employment is only 70 per cent of its long-run total by period 10. Moreover, the long run results, reported for Model 2 in Table 7.19, are identical to the results generated for the same export FDI shock with national bargaining and migration (section 7.4.2). However, with the national bargaining and migration closure, 92 per cent of the total employment impact is generated by period 10. Obviously, with the regional bargaining and migration closure the speed of adjustment to long run equilibrium is very protracted. i.e. it is period 72 before the long run outcome is achieved.

7.4-5. Summary of model results where the 'true' structural characteristics of sectors are incorporated within the model.

Model 2 incorporates the actual structural characteristics of both the foreign and UK-owned manufacturing sectors. The key difference in terms of the model results is that Model 1 over-estimates the region-wide impact of the export FDI shock, compared with Model 2, regardless of the labour market closure employed in each model. Thus, for a given absolute change in exports (£248m) and corresponding capacity, Model 1 over-estimates the direct employment impact, from the export FDI shock, by 1,770 jobs, which is one and half times the direct employment generated by Model 2. This stems directly from the structure of Model 1, where foreign manufacturing employment (and labour intensity) is taken to be, inaccurately, larger than is the actual case (Model 2), in order to approximate identical structure for the manufacturing sectors in this model. Moreover, estimates of the impact of the export FDI shock on regional GDP and HHDY are also larger in Model 1, due to these effects.

Clearly, incorporating the actual structural characteristics for each sector within the model does have an important impact particularly in terms of the employment. Note, however that the long-run employment multipliers generated by each model are similar, which implies that if you could identify the direct employment generated by the FDI plant, the long-run employment estimates, based on these multipliers, would be relatively close. However, to simulate the same direct employment shock (3,392 jobs) in Model 1, you would require a different investment and export stimulus (a 13.13% increase in foreign manufacturing investment with a 2.95% increase in export demand).

Finally, the choice of labour market closure, within each model, does have a significant effect on the impact of the export FDI shock. Qualitatively, the results for each labour market closure, for both models, are similar, apart from where the regional bargaining labour market closure is used. With this closure in Model 2, there is permanent labour market displacement in the UK manufacturing sector. However, with Model 1, the export FDI shock with regional bargaining leads to permanent crowding-out in both the UK and sheltered sector and net labour market displacement in the foreign manufacturing sector. This result stems primarily from the differences in the direct employment generated by the export FDI shock in Model 1, which results in a larger permanent rise in the real wage, which reduces the competitiveness of these sectors by more.

Where the regional bargaining and migration function is employed, in both Models 1 and 2, the adjustment to long run equilibrium is more protracted. In both Models, the long run results for this closure are identical to the corresponding case for the national bargaining and migration closure. However, with the regional bargaining and migration closures in both Models, the period 10 employment impacts are substantially less than the corresponding impacts for the national bargaining and migration closures, irrespective of structure. Thus, in both cases, period 10 employment with the regional bargaining and migration closure is only 75% of the corresponding impact for the national bargaining and migration case. Accordingly, the choice of labour market closure does have a significant impact on the build up of employment.

7.5 – Model 3 - Incorporating both Structural and Behavioural Characteristics within the Model.

The previous section reported the results from simulating the impact of FDI, using Model 2, which incorporated the structural characteristics of both UK and foreign-owned manufacturing. In the previous simulations using Models 1 and 2 I have assumed the hypothesis of identical behaviour in both manufacturing sectors. However, in Model 3, I assume that the foreign-owned manufacturing sector is less sensitive to local price changes than the indigenous manufacturing sector. Recall that the motivation for this set-up is production for 'domestic' markets with output allocated via the MNC parent company. This is captured in the model via the assumption of widespread Leontief functional form for this sector.

The other sectors in the model are assumed to have the same behavioural characteristics as before. However, to keep the aggregate sensitivity of total manufacturing output the same, as in Models 1 and 2, I increase the elasticity of substitution and trade parameters, in the base year model data, for the UK manufacturing sector. This means that the aggregate sensitivity of total Scottish manufacturing output to changes in relative prices remains unchanged, although this price sensitivity is incorporated wholly in the UK manufacturing sector, given the behavioural specification chosen for the foreign manufacturing sector (this was discussed in detail in chapter 6). The following section reports the impact of these

Table 7.20 - Model 3 with National Bargaining and no Migration					
	Period 1	Period 2	Period 10	Period 25	Period 50
GDP (income measure)	0.13	0.30	0.39	0.42	0.42
Consumption	0.16	0.29	0.34	0.36	0.37
Investment	2.15	0.60	0.56	0.56	0.56
Nominal before-tax wage	0.00	0.00	0.00	0.00	0.00
Real B-Tx consumption wage	-0.05	-0.05	-0.01	0.00	0.00
Total employment (000's):	0.16	0.30	0.37	0.39	0.39
UK Manufacturing:	0.04	0.11	0.17	0.19	0.19
For. Manufacturing:	0.05	3.18	3.19	3.20	3.20
Non-Manu traded:	0.09	0.16	0.27	0.31	0.31
Sheltered:	0.30	0.15	0.19	0.20	0.20
Unemployment rate (%)	-1.22	-2.28	-2.79	-2.97	-2.99
Labour participation rate (%)	0.04	0.07	0.08	0.09	0.09
Total population (000's)	0.00	0.00	0.00	0.00	0.00
Price of value added:					
UK Manufacturing	0.02	0.05	0.01	0.00	0.00
For. Manufacturing	0.00	0.01	0.00	0.00	0.00
Non-Manu traded	0.09	0.16	0.05	0.00	0.00
Sheltered	0.19	0.10	0.02	0.00	0.00
Capital rental rates:					
UK Manufacturing	0.08	0.25	0.06	0.00	0.00
For. Manufacturing	0.00	0.03	0.01	0.00	0.00
Non-Manu traded	0.31	0.54	0.15	0.02	0.00
Sheltered	0.98	0.49	0.08	0.00	0.00
Consumer price index	0.05	0.05	0.01	0.00	0.00
Value-added:					
UK Manufacturing	0.03	0.09	0.17	0.19	0.19
For. Manufacturing	0.05	3.18	3.19	3.20	3.20
Non-Manu Traded	0.07	0.11	0.26	0.31	0.31
Sheltered	0.24	0.12	0.18	0.20	0.20
Sectoral Output:					
UK Manufacturing	0.03	0.10	0.17	0.19	0.19
For. Manufacturing	0.05	3.18	3.19	3.20	3.20
Non-Manu Traded	0.07	0.13	0.26	0.31	0.31
Sheltered	0.24	0.12	0.18	0.20	0.20
Capital stocks:					
UK Manufacturing	0.00	0.00	0.14	0.19	0.19
For. Manufacturing	0.00	3.00	3.18	3.20	3.20
Non-Manu Traded	0.00	0.00	0.22	0.30	0.31
Sheltered	0.00	0.00	0.16	0.20	0.20
Exports:					
UK Manufacturing	-0.03	-0.08	-0.02	0.00	0.00
For. Manufacturing	0.00	3.97	3.97	3.97	3.97
Non-Manu Traded	-0.14	-0.24	-0.07	-0.01	0.00
Sheltered	-0.35	-0.18	-0.03	0.00	0.00
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.20	0.34	0.36	0.36	0.37
Firms disposable	0.40	0.58	0.48	0.45	0.45

Figure 7.10 - Change in total employment and employment by sector for an Export FDI shock with national bargaining - Model 3.

changes, in Model 3, for the same export FDI shock with national bargaining. However, the results for Model 3 should be considered as indicative, as the behavioural specification of the foreign manufacturing sector represent only one possible configuration.

7.4.1 Model 3 with National Bargaining and no migration.

Table 7.20 reports the results for key economic variables for a 100 per cent export FDI shock with national bargaining. Recall that the national bargaining labour market closure is motivated by the view that wages are set at the national level, which implies regional specific factors do not affect the nominal wage. By adopting this labour market closure, the AMOSFDI CGE model generates long-run I-O results as previously shown. Even with the different specification for the foreign-owned sector, Model 3 generates the same long run impacts as the corresponding case (section 7.4.1) with national bargaining and no behavioural differences (Model 2). However, the sectoral impacts of the export FDI shock and the built up of effects are quite different in this case.

Obviously, by changing the behavioural characteristics of the foreign manufacturing sector I am assuming that this sector operates quite differently from the UK manufacturing sector. The key differences in the model results are that foreign-owned employment, output and exports have adjusted almost fully by period 2. For instance, exports increase by the full 3.97 per cent in this period and employment, value added and output increase by 3.18 per cent, respectively. This almost instantaneous adjustment in exports, output and employment is consistent with a sector where technology is Leontief. Thus, output and capital adjust instantaneously and because exports are not price sensitive there is no adverse crowding out of exports in this sector. However, insofar as consumption and intermediate demand rises, through linkage effects with the other sectors, foreign manufacturing output will respond. Hence, the adjustments in output and employment after this period.

However, the impact of changes in local conditions (relative labour and capital prices) as a result of the export FDI shock, impacts on the other sectors in the model, particularly UK manufacturing. Recall that the parameter values for this sector were adjusted in order to maintain the aggregate sensitivity of Scottish manufacturing output as a whole, which is similar to Models 1 and 2. In UK manufacturing, the export FDI shock leads to an increase in value added prices and capital rental rates. Thus, by period 2 the value added price and capital rental rate in the UK manufacturing sector increases by 0.05 and 0.25 per cent, respectively. In comparison, in the foreign-owned sector, value added prices and capital rental rates increase by only 0.01 and 0.03 per cent, respectively.

The period 1 and 2 impacts are different for the UK and foreign-owned manufacturing sectors because production and investment in the foreign-owned sector are not as responsive to changes in the local economy. For instance, in period 1 fixed capacity in the UK manufacturing, non-manufacturing and sheltered sector means that capital rental rates and value added prices rise in these sectors, as a result of the initial investment shock. However, the increase in commodity prices leads to a fall in the real wage, which arises because of these initial capacity constraints. However, note that in period 1, there is no change in the value-added price or capital rental rate in the foreign-owned manufacturing sector. Recall that period 1 captures the impact of the 20 per cent increase in foreign manufacturing investment only. In this period, the supply of foreign manufacturing capital is assumed to be perfectly elastic at the initial base year prices.

Moreover, the small period 2 rise in the value-added price and capital rental rates in the foreign manufacturing sector stems from the increased consumption and intermediate demand generated as a result of the increased activity in the other sectors of the model. Thus, with Leontief technology, there is no substitution of capital for labour (despite the fall in the real wage). The increase in the value added price stems from the increased cost of capital, which is generated by the stimulus in activity in the other sectors of the model. Thus, changes in the capital rental rates in this sector reflect changes in activity in the other sectors of the model. Recall that given the specification chosen for the foreign manufacturing sector in Model 3, this sector is linked primarily to the regional economy through intermediate linkage and consumption effects.

Table 7.21 - Model 3 with National Bargaining and Migration					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.13	0.30	0.40	0.44	0.44
Consumption	0.16	0.29	0.40	0.43	0.43
Investment	2.15	0.60	0.58	0.58	0.58
Nominal before-tax wage	0.00	0.00	0.00	0.00	0.00
Real B-Tx consumption wage	-0.05	-0.05	-0.02	0.00	0.00
Total employment (000's):	0.16	0.30	0.38	0.41	0.41
UK Manufacturing:	0.04	0.12	0.18	0.20	0.20
For. Manufacturing:	0.05	3.18	3.20	3.21	3.21
Non-Manu traded:	0.09	0.16	0.29	0.34	0.34
Sheltered:	0.30	0.15	0.20	0.22	0.22
Unemployment rate (%)	-1.22	-1.93	-0.31	-0.02	0.00
Labour participation rate (%)	0.04	0.06	0.01	0.00	0.00
Total population (000's)	0.00	0.05	0.34	0.41	0.41
Price of value added:					
UK Manufacturing	0.02	0.05	0.01	0.00	0.00
For. Manufacturing	0.00	0.01	0.00	0.00	0.00
Non-Manu traded	0.09	0.16	0.05	0.01	0.00
Sheltered	0.19	0.10	0.02	0.00	0.00
Capital rental rates:					
UK Manufacturing	0.08	0.25	0.07	0.00	0.00
For. Manufacturing	0.00	0.03	0.01	0.00	0.00
Non-Manu traded	0.31	0.55	0.17	0.02	0.00
Sheltered	0.98	0.50	0.08	0.00	0.00
Consumer price index	0.05	0.05	0.02	0.00	0.00
Value-added:					
UK Manufacturing	0.03	0.09	0.17	0.20	0.20
For. Manufacturing	0.05	3.18	3.20	3.21	3.21
Non-Manu Traded	0.07	0.11	0.27	0.33	0.34
Sheltered	0.24	0.12	0.19	0.22	0.22
Sectoral Output:					
UK Manufacturing	0.03	0.10	0.18	0.20	0.20
For. Manufacturing	0.05	3.18	3.20	3.21	3.21
Non-Manu Traded	0.07	0.13	0.28	0.34	0.34
Sheltered	0.24	0.12	0.19	0.22	0.22
Capital stocks:					
UK Manufacturing	0.00	0.00	0.15	0.20	0.20
For. Manufacturing	0.00	3.00	3.18	3.20	3.21
Non-Manu Traded	0.00	0.00	0.24	0.33	0.34
Sheltered	0.00	0.00	0.17	0.21	0.22
Exports:					
UK Manufacturing	-0.03	-0.08	-0.02	0.00	0.00
For. Manufacturing	0.00	3.97	3.97	3.97	3.97
Non-Manu Traded	-0.14	-0.24	-0.08	-0.01	0.00
Sheltered	-0.35	-0.18	-0.03	0.00	0.00
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.20	0.35	0.41	0.43	0.43
Firms disposable	0.40	0.58	0.50	0.47	0.47

Figure 7.11 - Change in total employment and employment by sector for an Export FDI shock with national bargaining and LNJ migration - Model 3.

As noted, the long run results for Model 3 are identical to the corresponding case with national bargaining and no behavioural differences (Model 2). The main difference, between Models 2 and 3, is in the speed of adjustment towards long-run equilibrium. Figure 7.10 shows the change in employment by sector. Note that by period 2 and 10 the total employment impacts are 76 and 94 per cent (as compared with 74 and 93 per cent in Model 2) of the long-run total. However, by period 2, total foreign-owned employment is 99 per cent (98 per cent in Model 2) of its long-run total. The additional adjustment to the long-run total employment for the foreign manufacturing sector in Model 3 arises because of the increased intermediate and consumption demand, generated by the increased activity in the other sectors of the model.

Accordingly, with the national bargaining labour market closure, incorporating separate behavioural characteristics for the foreign manufacturing sector does not affect the long run equilibrium values generated by the export FDI shock. With this labour market closure, both Models 2 and 3 generates identical long-run results of an I-O nature.

7.5.2 Model 3 with National Bargaining and Migration.

The results for the same export FDI shock, with the national bargaining labour market closure and migration function, follow the same pattern as the national bargaining wage closure. Table 7.21 reports the results for key economic variables and Figure 7.11 plots the change in employment by sector. Note that this closure generates the same long run results as the simulation reported in section 7.4.2 for Model 2 with the corresponding labour market closure. The differences between these simulations again occur in the early periods, as was shown in the previous simulation for the national bargaining wage closure only. The FDI sector adjusts very quickly towards long run equilibrium. The impact of migration augments the exogenous demand stimulus by increasing regional demand and government spending, as a result of the increase in population within the region. The results are qualitatively the same as the national bargaining wage closure with population fixed.

In summary, with the national bargaining wage closure, with and without migration, the impact of this specific behavioural specification for the foreign-owned manufacturing sector is minimal. The long run results in both cases are identical to the simulation where there are no behavioural differences incorporated within the model. Where there are differences in the model results, these occur in the early periods of the shock and relate to the speed of adjustment towards the long-run values in the foreign manufacturing sector. For instance, the increase in the foreign manufacturing sector's output, employment and exports, generated by the export FDI shock, are almost fully adjusted by period 2. Essentially, with national bargaining, there are no long run changes in factor prices so that long run I-O results are generated for all sectors in the model, even with the different behavioural assumptions for both sectors. These findings are in keeping with the McGregor, *et al*, 1996 result that the long-run solutions of many quite different regional models converge in the long-run on the I-O solution.

7.5.3 Model 3 with Regional Bargaining and no migration.

The simulation results reported in Table 7.22 and presented here are for a 100% export FDI shock with the regional bargaining labour market closure. Figure 7.12 plots the change in employment by sector. The results for this case are particularly interesting. Recall from the simulations with Models 1 and 2, that with the regional bargaining labour market closure and no migration the export FDI shock generates a permanent rise in both the real and nominal wage rates within the region. In Model 3, the increase in the price of foreign manufacturing output, with regional bargaining, generates substitution effects for intermediate and consumption demand for the output of this sector. However, there is no substitution between capital and labour or export market crowding-out in the foreign manufacturing sector, as a result of the increase in foreign manufacturing prices. This stems directly from the assumptions of universal Leontief technology and demands for this sector. Accordingly, given the behavioural specification for the foreign sector in Model 3, there is no displacement of foreign-owned output, employment or exports.

In period 1, the exogenous increase in foreign-owned manufacturing investment leads to an immediate rise in employment and the real wage of 0.07 and

Table 7.22 - Model 3 with Regional Bargaining and no Migration					
	Period	Period	Period	Period	Period
	1	2	10	25	50
GDP (income measure)	0.06	0.18	0.20	0.21	0.21
Consumption	0.15	0.27	0.28	0.28	0.28
Investment	2.15	0.41	0.39	0.39	0.39
Nominal before-tax wage	0.13	0.21	0.21	0.21	0.21
Real B-Tx consumption wage	0.06	0.13	0.14	0.14	0.14
Total employment (000's):	0.07	0.14	0.16	0.16	0.16
UK Manufacturing:	-0.11	-0.12	-0.13	-0.13	-0.13
For. Manufacturing:	0.03	3.15	3.15	3.15	3.15
Non-Manu traded:	0.00	0.01	0.04	0.05	0.05
Sheltered:	0.23	0.01	0.02	0.02	0.02
Unemployment rate (%)	-0.54	-1.10	-1.20	-1.23	-1.23
Labour participation rate (%)	0.02	0.03	0.04	0.04	0.04
Total population (000's)	0.00	0.00	0.00	0.00	0.00
Price of value added:					
UK Manufacturing	0.09	0.16	0.18	0.18	0.18
For. Manufacturing	0.10	0.17	0.17	0.17	0.17
Non-Manu traded	0.14	0.22	0.18	0.16	0.16
Sheltered	0.28	0.22	0.18	0.18	0.18
Capital rental rates:					
UK Manufacturing	-0.10	-0.04	0.05	0.06	0.06
For. Manufacturing	0.00	0.08	0.06	0.05	0.05
Non-Manu traded	0.14	0.24	0.10	0.06	0.06
Sheltered	0.88	0.24	0.08	0.06	0.06
Consumer price index	0.07	0.09	0.07	0.07	0.07
Value-added:					
UK Manufacturing	-0.08	-0.09	-0.11	-0.11	-0.11
For. Manufacturing	0.03	3.15	3.15	3.15	3.15
Non-Manu Traded	0.00	0.01	0.05	0.06	0.06
Sheltered	0.18	0.01	0.03	0.03	0.03
Sectoral Output:					
UK Manufacturing	-0.07	-0.06	-0.07	-0.08	-0.08
For. Manufacturing	0.03	3.15	3.15	3.15	3.15
Non-Manu Traded	0.01	0.02	0.06	0.07	0.07
Sheltered	0.19	0.01	0.03	0.04	0.04
Capital stocks:					
UK Manufacturing	0.00	0.00	-0.05	-0.06	-0.06
For. Manufacturing	0.00	3.00	3.14	3.15	3.15
Non-Manu Traded	0.00	0.00	0.07	0.09	0.09
Sheltered	0.00	0.00	0.06	0.07	0.07
Exports:					
UK Manufacturing	-0.14	-0.25	-0.28	-0.28	-0.28
For. Manufacturing	0.00	3.97	3.97	3.97	3.97
Non-Manu Traded	-0.20	-0.32	-0.25	-0.24	-0.24
Sheltered	-0.51	-0.40	-0.34	-0.33	-0.33
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.22	0.35	0.35	0.35	0.35
Firms disposable	0.31	0.41	0.36	0.36	0.36

Figure 7.12 - Change in total employment and employment by sector for an Export FDI shock with regional bargaining - Model 3.

0.06 per cent, respectively. As before, period 1 employment is concentrated in the sheltered sector due to the construction of the FDI plant. The period 1 rise in the real wage leads to a fall in UK manufacturing employment, value added and sectoral output. Exports also fall in this period in the UK manufacturing, non-manufacturing traded and sheltered sector. In the foreign-owned sector there is no change in capital stock or exports, as the increased capacity does not come on stream until period 2. Moreover, foreign-owned employment, value added and sectoral output increase in this period by 0.03 per cent respectively, despite the increase in the real wage.

Manufacturing value added prices for the UK and foreign manufacturing divisions increase by 0.09 and 0.10 per cent in period 1. The point here is that both sectors face the same increase in relative wages (nominal wages rise by 13%). However the capital rental rates fall only in the UK manufacturing sector, as the supply of capital is assumed to be perfectly elastic (Leontief technology) in the foreign manufacturing sector at the initial base year prices. Moreover, given the labour intensity of the indigenous manufacturing sector we would perhaps expect the rise in the real wage to have a more adverse effect on value added costs in this sector, compared with the foreign manufacturing sector. However, given the fall in the UK manufacturing capital rental rates (0.10%) and the increased price sensitivity of this sector, there is substitution of capital for labour which reduces the cost of value added production in the UK sector.

The export FDI shock stimulates regional employment and GDP in period 1. However, note the period 1 fall in UK manufacturing employment (0.11%). In period 2, the foreign manufacturing capital stock increases by 3 per cent as the export FDI capacity comes on stream. With the export demand in this sector not affected by the rise in the real wage there is no displacement of foreign-owned employment or exports. Accordingly, exports in the foreign sector increase by the full 3.97 per cent and employment, value added and output all increase by 3.13 per cent in this period. The impact of the expansion of activity in the foreign-owned sector, particularly employment, puts further pressure on the regional bargained wage and leads to a further increase in that wage.

This adversely affects the competitiveness of the other sectors in the region and leads to a period 2 fall in exports in the UK manufacturing, non-manufacturing traded and sheltered sector, of –0.28, -0.25 and –0.34 per cent, respectively. Moreover, the increase in the real wage leads to above base rises in value-added prices and capital rental rates across all sectors in this period. The indirect effects of the export FDI shock, generated by increased intermediate demand, stimulates small increases in employment in the non-manufacturing traded and sheltered sector in this period. However, employment and value added in the UK manufacturing sector remain below their base values so that there is direct labour market crowding-out in this sector. Thus, UK manufacturing employment falls by 476 in period 2.

After period 2, the consumer price index (CPI) begins to fall as the effects of fixed capacity are eased. Capital stocks increase in all sectors apart from UK manufacturing. The value-added prices fall in the non-manufacturing traded and sheltered sector as the increased capacity in these sectors lowers the capital rental rates which facilitates further substitution of capital for labour. This reduction in value added costs eases export displacement in these sectors. However, in the UK manufacturing sector value-added prices increase further, after period 2, as the reduction in capital stock (from period 2 onwards) pushes up the capital rental rates and the cost of value-added production. In the foreign manufacturing sector value-added prices remain at their period 2 level. The subsequent (period by period) increases in the real wage, as employment continues to build up particularly in the non-manufacturing traded and sheltered sector, are offset in the foreign manufacturing sector by the reductions in the capital rental rates. These reductions in the capital rental rates stem from the subsequent small increases in foreign manufacturing capital stock.

In the long run, there is positive labour market crowding-out in the UK manufacturing sector and a fall in regional exports in the UK manufacturing, non-manufacturing traded and the sheltered sector. In comparison with the earlier regional bargaining case with no behavioural differences between sectors, there is no displacement of foreign-owned employment or output. However, the regional real wage, value-added price and capital rental rates remain above base values for all sectors in the model. Table 7.23 reports the long-run impact on GDP, HHDY and employment (including multiplier values) by sector, for the export FDI shock with regional bargaining, using the three different simulation models.

Table 7.23 – Comparison of the long-run impact on GDP, HHDY and employment (including multiplier values) generated for a 100% Export FDI shock with the regional bargaining labour market closure using both AMOSFDI Models 1, 2 and 3.

	Model 1		Model 2		Model 3	
GDP	**£83m**		**£69m**		**£68m**	
HHDY	**£136m**		**£102m**		**£99m**	
Direct Employment	**5,162**		**3,392**		**3,392**	
Total Employment	5,517	*1.07*	3,761	*1.11*	3,626	*1.07*
UK-Owned Manufacturing	-256	*-0.05*	-224	*-0.07*	-522	*-0.15*
Foreign-owned Manufacturing	5,086	*0.99*	3,407	*1.00*	3,559	*1.05*
Non-Manufacturing Traded	761	*0.15*	380	*0.11*	380	*0.11*
Sheltered Sector	-79	*-0.02*	194	*0.06*	211	*0.06*

The values in italics are the long-run employment multipliers. Note that the estimates of GDP and HHDY vary across the three models. Model 1 substantially over-estimates both GDP and HHDY compared with Models 2 and 3. The GDP estimate for Model 1 is 20 and 22 per cent higher than the corresponding estimates for Models 2 and 3. Similarly, the impact of the export FDI shock on HHDY in Model 1 is 25 and 27 per cent higher than in Models 2 and 3. The difference in the GDP and HHDY estimates for Models 2 and 3 are relatively small, which reflect the lower employment impact generated in Model 3.

Note that the total employment estimates and multipliers values vary across the three models. As noted previously, Model 1 over-estimates the total employment impact of the export FDI shock, with the distribution of the indirect employment effects implying negative spillover effects in the sheltered sector, which is different from both Models 2 and 3. (This result may seem surprising, but it stems directly from the structure of both foreign and UK manufacturing in Model 1.) Across all three Models, the actual structural and behavioural characteristics of the non-manufacturing traded and sheltered sector remain unchanged. Obviously, interactions (linkages) change between these sectors and the manufacturing sector as I vary the structure of UK and foreign manufacturing in Models 1 and 2. The reason why the export FDI shock with regional bargaining in Model 1 generates a negative long run impact in the sheltered sector is because of the labour intensity of the foreign manufacturing sector in Model 1.

The sheltered sector is the most labour intensive sector in the model. The export FDI shock in Model 1 leads to larger long run increases in total employment and the real wage, than in both Models 2 and 3. Therefore, the higher real wage impacts more adversely on the competitiveness of the sheltered sector, which is more dependent on labour. Thus, value added prices rise by 0.27 per cent and exports fall by 0.50 per cent, respectively. Moreover, the actual proportion of inputs sourced from the sheltered sector, by foreign manufacturing, is less in Model 1, than the actual structure implies in Model 2. Overall, employment falls in this sector by 0.01 per cent.

In comparing Models 2 and 3, these results capture the impact of including different behavioural assumptions for the foreign manufacturing sector within the model. (However, recall that the specification in the foreign-owned manufacturing sector provides only one limiting case.) The total employment impact, estimated by Model 3, is some 136 jobs less (around 4%) that the equivalent employment impact generated by Model 2. The lower employment estimates, generated by Model 3, stem primarily from the higher levels of labour market displacement in the UK manufacturing sector. Recall that the aggregate sensitivity of the manufacturing sector remains unchanged, which means that the UK manufacturing sector is more sensitive to changes in relative prices. Clearly, with the regional bargained labour market closure, incorporating these behavioural assumptions for the foreign-owned sector, within the model, does have an impact. With the UK manufacturing sector most adversely affected.

The speed of adjustment to long-run equilibrium also varies between the different sectors in Model 3. By period 2, total foreign employment is 99 per cent of its long-run impact. In contrast, by the same period, non-manufacturing traded and sheltered employment have achieved only 15 and 36 per cent respectively of their

Table 7.24 - Model 3 with Regional Bargaining and Migration					
	Period 1	Period 2	Period 10	Period 25	Period 50
GDP (income measure)	0.06	0.19	0.31	0.40	0.43
Consumption	0.15	0.27	0.35	0.41	0.43
Investment	2.15	0.43	0.51	0.56	0.57
Nominal before-tax wage	0.13	0.20	0.08	0.02	0.00
Real B-Tx consumption wage	0.06	0.11	0.04	0.01	0.00
Total employment (000's):	0.07	0.15	0.28	0.37	0.41
UK Manufacturing:	-0.11	-0.10	0.05	0.16	0.20
For. Manufacturing:	0.03	3.15	3.18	3.20	3.20
Non-Manu traded:	0.00	0.02	0.17	0.29	0.34
Sheltered:	0.23	0.02	0.13	0.19	0.21
Unemployment rate (%)	-0.54	-1.00	-0.35	-0.09	-0.01
Labour participation rate (%)	0.02	0.03	0.01	0.00	0.00
Total population (000's)	0.00	0.02	0.24	0.36	0.41
Price of value added:					
UK Manufacturing	0.09	0.15	0.09	0.03	0.00
For. Manufacturing	0.10	0.16	0.07	0.02	0.00
Non-Manu traded	0.14	0.22	0.12	0.04	0.01
Sheltered	0.28	0.21	0.09	0.03	0.00
Capital rental rates:					
UK Manufacturing	-0.10	-0.03	0.11	0.03	0.00
For. Manufacturing	0.00	0.06	0.03	0.01	0.00
Non-Manu traded	0.14	0.26	0.20	0.06	0.01
Sheltered	0.88	0.26	0.13	0.03	0.00
Consumer price index	0.07	0.09	0.04	0.01	0.00
Value-added:					
UK Manufacturing	-0.08	-0.08	0.04	0.16	0.20
For. Manufacturing	0.03	3.15	3.18	3.20	3.20
Non-Manu Traded	0.00	0.01	0.16	0.29	0.33
Sheltered	0.18	0.02	0.12	0.19	0.21
Sectoral Output:					
UK Manufacturing	-0.07	-0.05	0.06	0.16	0.20
For. Manufacturing	0.03	3.15	3.18	3.20	3.20
Non-Manu Traded	0.01	0.03	0.17	0.29	0.34
Sheltered	0.19	0.02	0.12	0.19	0.21
Capital stocks:					
UK Manufacturing	0.00	0.00	0.03	0.15	0.20
For. Manufacturing	0.00	3.00	3.16	3.19	3.20
Non-Manu Traded	0.00	0.00	0.14	0.28	0.33
Sheltered	0.00	0.00	0.11	0.19	0.21
Exports:					
UK Manufacturing	-0.14	-0.24	-0.14	-0.04	-0.01
For. Manufacturing	0.00	3.97	3.97	3.97	3.97
Non-Manu Traded	-0.20	-0.31	-0.17	-0.05	-0.01
Sheltered	-0.51	-0.39	-0.17	-0.05	-0.01
Nominal income:	0.00	0.00	0.00	0.00	0.00
Households disposable	0.22	0.36	0.39	0.42	0.43
Firms disposable	0.31	0.42	0.46	0.47	0.47

Figure 7.13 - Change in total employment and employment by sector for an Export FDI shock with regional bargaining and migration - Model 3.

long run employment totals. By period 10, employment in these sectors is 79 and 65 per cent, respectively. This rapid adjustment to long-run equilibrium in the foreign manufacturing sector stems from the assumptions of Leontief technology and export demands. Thus, exports adjust instantaneously which drives the rapid adjustment to long-run equilibrium in this sector. Finally, with Model 3 and the regional bargaining closure, labour market displacement occurs in the UK manufacturing sector in period 1, and remains positive through-out. In the next section I repeat this simulation for regional bargaining and LNJ migration function.

7.5.4 Model 3 with Regional Bargaining and LNJ Migration.

Table 7.24 reports the results for key economic variables and Figure 7.13 plots the period by period employment by sector. The period 1 impacts are identical from the previous section with the standard LNJ bargained wage closure, as the effects of increased population do not occur until period 2. The qualitative nature of the effects of in-migration does not change by incorporating separate structural or behavioural characteristics for the foreign and UK manufacturing sectors. These effects have already been discussed (sections 7.3.4 and 7.4.4).

The key difference, as compared with the corresponding closure for Model 2, stems from the impact of the initial rise in the bargained real wage on both the foreign and UK manufacturing sector and the speed of adjustment to long run equilibrium in both these sectors. Essentially, with the different behavioural specification for the foreign and UK manufacturing sector, the initial rise in the bargained real wage, as a result of the export FDI shock, has a less adverse impact on the foreign manufacturing sector. With this sector specified as Leontief, the initial rise in the real wage which increases both value-added and commodity prices across all sectors, impacts primarily on local intermediate and consumption demands in the foreign manufacturing sector. Thus, as in the previous case for the bargained regional wage only with Model 3, there is no initial or long run crowding-out in the foreign manufacturing sector. For the corresponding closure with Model 2, there was net labour market displacement in the foreign manufacturing sector until period 3.

With Model 3, the impact of increased population (in-migration), as in both Models 1 and 2, serves to reduce the real wage which further stimulates intermediate and consumption demand in all sectors. In the UK manufacturing sector there is initial labour market crowding out which persists until period 7. Note that the adjustment process with migration (increased population) is more protracted in this case, particularly in the UK manufacturing sector, where the initial impact of the export FDI shock has a more adverse impact, because of the increased sensitivity of this sector to changes in relative prices. Recall that the elasticity parameter values are increased for the UK manufacturing sector in Model 3 to maintain the aggregate sensitivity of the total Scottish manufacturing output.

In the long run, Model 3 with regional bargaining and migration generates results of an I-O nature, which are identical to the long run results generated for the corresponding national bargaining and migration closure. However, the long run impact for this case is not achieved until period 76.

7.5-5 - Summary of Model 3 results.

In these simulations, separate distinct behaviour is assumed for the foreign manufacturing sector and the sensitivity of the UK manufacturing sector is increased to maintain the overall sensitivity of Scottish manufacturing output. The motivation for this simulation model was discussed in chapter 6. The key differences in the results from Model 3 are that where regional bargaining is the relevant labour market closure, there is no crowding-out of foreign exports or employment. Moreover, the impact of labour market crowding-out in the UK manufacturing sector on both exports and employment is more pronounced. The speed of adjustment in the foreign manufacturing sector is almost instantaneous, given the wide-spread Leontief functional specification for this sector. In contrast adjustment in the other sectors, particularly for the regional bargaining and migration closure, is more protracted.

7.6 – Comparison of Results from Models 1,2 and 3.

Recall that Model 1 assumes the hypothesis of identical structural and behavioural characteristics for the foreign and UK manufacturing sector. Model 2 incorporates the actual structure of both manufacturing sectors, but maintains the hypothesis of identical behaviour, and Model 3 includes distinct structure, as well as, one alternative specification for the foreign-owned manufacturing sector. Table 7.2.5 reports the long run impact on GDP, HHDY and employment, for each of the four labour market closures, using simulation Models 1,2 and 3.

Table 7.25 – Summary of the long-run impact on GDP for the export FDI shock, for each of the four labour market closures, using AMOSFDI Models 1, 2 and 3.

	National Bargaining	National Bargaining + Migration	Regional Bargaining	Regional Bargaining + Migration
Model 1	£183m	£192m	£83m	£192m
Model 2	£138m	£144m	£69m	£144m
Model 3	£138m	£144m	£68m	£144m

Note that Model 1 over-estimates the long run impact on GDP across the four labour market closures. The GDP estimates by Model 1 are around one third larger than the corresponding estimates for Models 2 and 3 for each labour market closure, except the regional bargaining case. With this labour market closure, Model 1 over-estimates GDP by 20 and 22 per cent, respectively, compared with Models 2 and 3. Recall, from the model simulations that for three of the four labour market closures, the long run solutions for Models 2 and 3 converge.

Differences in the long run results for Model 2 and 3 occur when regional bargaining is chosen as the appropriate labour market closure. In terms of GDP, the difference is relatively small (£1m), which stems directly from incorporating distinct behaviour for the foreign and UK manufacturing sector in Model 3. Recall that the model base year parameters (elasticity of substitution and trade) are increased for the UK manufacturing sector so that the aggregate sensitivity of total manufacturing output remains unchanged. Thus, by assuming that the UK manufacturing sector is more sensitive (or exposed) to relative price changes the impact of the export FDI shock with regional bargaining, has a more adverse effect within this sector. With this closure in Model 3, there is increased displacement of UK exports and employment and there is more substitution of capital for labour. The increased substitution of capital for labour also has an adverse impact on household disposable income, as is reported for each Model in Table 7.26.

Table 7.26 – Summary of the long-run impact on household disposable income (HHDY) for the export FDI shock, for each of the four labour market closures, using Models 1, 2 and 3.

	National Bargaining	National Bargaining + Migration	Regional Bargaining	Regional Bargaining + Migration
Model 1	£138m	£167m	£136m	£167m
Model 2	£104m	£124m	£102m	£124m
Model 3	£104m	£124m	£99m	£124m

Note that the results for HHDY are qualitatively similar to those reported for GDP. Model 1 substantially over-estimates the impact on HHDY and the results from Models 2 and 3 converge for three of the four labour market closures. The case where the long run solutions are divergent between Models 2 and 3 is where the regional bargaining wage closure is employed. The difference in terms of the long run estimate of HHDY is £2.57 million, which stems from both the lower employment impact and increased labour market displacement in the UK manufacturing sector, in Model 3. Qualitatively, the results for the long run employment impact, generated by each model, follow a similar pattern as both GDP and HHDY, as reported in Table 7.27.

Table 7.27 – Summary of the long-run employment impact of the export FDI shock, for each of the four labour market closures, using the three different models.

	National Bargaining	National Bargaining + Migration	Regional Bargaining	Regional Bargaining + Migration
Model 1	12,791	13,422	5,517	13,422
Model 2	8,760	9,256	3,761	9,256
Model 3	8,760	9,256	3,626	9,256

Again, Model 1 substantially over estimates the long run employment impact across all four labour market closures. In Models 2 and 3, the long run employment results ultimately converge except for the regional bargaining case. In this case, Model 2 over-estimates the employment impact by around 135, which is not particularly large.

The choice of both labour market closure and Model has an impact on the level of employment generated. Of the labour market closures employed, the results across each model are most divergent where the regional bargaining labour market closure is used. Figure 7.14 plots the period by period total employment impact for the regional bargaining labour market closure generated by Models 1, 2 and 3. Note that even the long run total employment impact is different in each model under this closure. Moreover, in each Model, the choice of the appropriate labour market closure has a significant impact on the estimate of the total employment impact. Thus, contrast the total employment impact in each model generated with the national bargaining and regional bargaining labour market closures. Similarly, even where the long run employment results for both Models 2 and 3 ultimately converge, the build of employment effect varies considerably in each case.

The speed of adjustment for employment is important for regional policy evaluations, particularly where the total employment impact is typically discounted over a 10-year period (HM Treasury, 1995; 1997). Thus, any employment generated after period 10 is generally not included in any regional policy evaluation. (see Gillespie *et al*, 1998). In any case, the total employment impact in each period is typically discounted at a rate of 6 per cent (HM Treasury, 1995; 1997), from period 1, so that employment occurring in the later periods of the export FDI shock is discounted by more. Recall the concept of present value job years was discussed and illustrated in chapter 3 for the simulations with the original AMOS Model. In Table 7.28, I report the total present value job years (PVJY's) for periods 1 to 10, for the three models and simulations.[3]

[3] These total PVJY's estimates include period 1 employment. In official evaluations of regional policy, the period 1 employment impact is usually excluded as this is viewed as temporary employment which is typically associated with the construction of the plant (HM Treasury, 1995; 1997).

Figure 7.14 - Total employment generated by an Export FDI shock with the regional bargaining labour market closure using Models 1, 2 and 3.

Table 7.28 – Total discounted present value job years (PVJY's) for periods 1 to 10, for an export FDI shock, for each of the four labour market closures using Model 1, 2 and 3.				
	National Bargaining	National Bargaining + Migration	Regional Bargaining	Regional Bargaining + Migration
Model 1	72,029	73,516	33,882	47,267
Model 2	51,148	52,226	23,850	33,471
Model 3	51,795	52,951	23,352	33,159

Note the difference between the PVJY totals for each Model, particularly for the national bargaining and migration and regional bargaining and migration labour market closures. Recall from Table 7.27 that the long run results for these closures in each Model ultimately converge. However, where the adjustment process is slow or protracted, as is the case with regional bargaining and migration labour market closure, the total PVJY's generated by the export FDI shock will be much reduced. Clearly, the choice of labour market closure has a significant impact on the total discounted employment estimates. Moreover, the total PVJY's for Models 2 and 3 are not identical. However, the differences are relatively close across all four labour market closures.

Clearly, in adopting the same labour market closure in each model, incorporating the actual structure of both the UK and foreign manufacturing sector has a more significant effect on the system-wide impact of the export FDI shock, than behaviour. However, the choice of labour market closure in itself has an important impact on the total employment generated.

7.7 – Chapter Conclusions.

In this Chapter I use the AMOSFDI CGE Model to simulate the system-wide impact of FDI in Scotland under various assumptions. This chapter has considered explicitly the impact of separately identifying, through simulation, the impact of incorporating both distinct structure and behaviour for the UK and foreign manufacturing sectors within a system-wide modelling framework. In order to achieve this I have used three different variants of the AMOSFDI CGE model. In Model 1, I assume identical structural and behavioural characteristics for the foreign and UK manufacturing sectors. Model 2 incorporates the actual structure of both sectors but maintains the hypothesis of identical behaviour. Model 3 incorporates one characterisation of distinct FDI behaviour as well as incorporating the 'true' structural characteristics.

For each model I simulate the impact of a 20% increase in foreign manufacturing investment with all of the additional output going directly to exports (100% export intensity). However, due to the inclusion of the actual structure of both sectors in Models 2 and 3, the same proportionate manufacturing investment and export shock generates less direct employment in Models 2 and 3, than Model 1. This is because Model 1 assumes identical structure in both foreign and UK manufacturing, which is of course inaccurate. With 100% export intensity there is no direct product market displacement as a result of the export FDI shock. For each model, I use four different labour market closures in order to highlight the impact of both a passive and non-passive labour market with and without migration. The results indicate that incorporating structure does have an impact on the system-wide evaluation of inward investment.

Comparing the results from Models 1 and 2 illustrates the importance of capturing the actual sourcing patterns, capital and intermediate intensity levels, wage rates etc. for both UK and foreign manufacturing in the model base year data. Thus, where the actual structural characteristics are not incorporated within the model, as in Model 1, the model substantially over-estimates the system-wide impact of the export FDI shock.

Model 3 incorporates one specification of behaviour for the foreign manufacturing sector. The impact of specifying distinct behaviour in the foreign-owned manufacturing sector serves to make the sector less sensitive to local price changes than the indigenous sector. Moreover, in order to maintain the overall aggregate sensitivity of the manufacturing sector as a whole, the UK-owned component is also adjusted, which serves to make this sector more price sensitive. The long-run impacts from Model 3 are identical, across three of the four labour market closures, to the long run solutions generated for Model 2. However there are differences in these results for the early periods of the export FDI shock. The case where the long run solutions for Models 2 and 3 are divergent is where the regional bargaining labour market closure is chosen. With this labour market closure in Model 3, there is no crowding-out of foreign manufacturing exports or employment and I obtain long run impacts that no longer converge with Model 2. These differences between the results for Model 3 and 2, with regional bargaining and no migration, are typically small and relate specifically to the characterisation of FDI behaviour chosen for Model 3.

Moreover, the speed of convergence to the long run results between Models 2 and 3, where both models have the same structure and different behavioural characteristics, is dependent upon the choice of labour market closure. For instance, even though the long run results, in each model, for the national bargaining and migration closure converge with the regional bargaining and migration case, the adjustment to long run equilibrium in the latter case is much more pronounced. For instance, following Treasury guidelines and taking a 10 year time horizon, the total discounted present value job years (PVJY's) generated for the regional bargaining and migration closure, with each Model, is around 64% of the corresponding total for the national bargaining and migration closure. Recall that these results converge in the long run in each Model and across Models 2 and 3.

However, the differences in the foreign employment multipliers for Model 1 and Models 2 and 3, across the different labour market closures, are relatively small, which is a feature of the construction of Model 1. In that, in Model 1 the intermediate linkages and employment/output ratios of the foreign-owned sector are (inaccurately) larger. The former serve to increase the employment multiplier through generating larger indirect or knock-on effects and the latter reduce the employment multiplier by reducing the direct output supported per unit of employment. With the 'true' structure of the foreign-owned sector in Models 2 and 3 both of these components are reduced. However, in models where UK and foreign-owned plants are aggregated within the one sector these countervailing effects serve to balance out and generate an aggregate employment multiplier, such as that reported for Model 1, which is relatively close to the 'true' value. However, I would urge caution over the generality of this result as it would only hold where foreign and UK-owned plants displayed these distinct characteristics. Recall from chapter 5, however, that there was variation in the employment multipliers reported for different industrial sectors.

Finally, the chapter has illustrated through simulation using an ownership-disaggregated CGE model the importance of incorporating both structural and behavioural characteristics in any system-wide evaluation of FDI. However, the Model has incorporated only one specific characterisation of possible FDI behaviour and the results from Model 3 should be considered as instructive, given the various alternative specifications one could adopt for this sector. However, the aims of this chapter, and thesis in general, is to have a fully operational ownership-disaggregated CGE model in order to test through simulations the impact of FDI under various assumptions.

In future research, I would hope to develop and characterise a number of different behavioural assumptions typically associated with FDI. (This is discussed further in the thesis conclusions) The current model provides the ideal base for such work. Finally, the chapter results indicate the importance of capturing the actual structure of the foreign and UK manufacturing sector within the model base year data. By doing so many of the stylized facts relating to FDI are captured within the model.

7.8 – Chapter Bibliography.

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CHAPTER 8 – Overall Conclusions and Suggestions for Future Research.

"The advantage applied modelling offers is that we are able to *combine real world* data with formal theory as part of the mix of inductive and deductive reasoning that makes up economic analysis.... Having said this, the reader should also be aware that the results of numerical analysis can take on a life of their own when released into a policy environment" (Francois and Reinert, 1997, p. 20).

8.1 – Thesis Conclusions.

This thesis considers the system-wide impact of foreign direct investment in Scotland using both ownership-disaggregated input-output and regional computable general equilibrium models. At present, foreign-owned plants account for around 40, 35 and 23 per cent, respectively, of Scottish manufacturing output, gross value added and employment. Moreover, the attraction of FDI remains an important part of UK regional policy in Scotland with just under half of all expenditure on Regional Selective Assistance (RSA) awarded to foreign-owned firms. A key concern of this type of discretionary regional policy is whether such assistance is warranted.

FDI is thought to have a range of potential demand and supply-side effects, yet conventional regional economic models and FDI evaluations typically cannot capture, or ignore, many of these potential system-wide impacts. Moreover, foreign-owned manufacturing plants, in general, have quite distinct structural and behavioural characteristics, as compared with indigenous plants, which ought to be considered in any evaluation. In modelling terms, the foreign-owned manufacturing sector in Scotland represents a large and distinctive sub-sector of Scottish manufacturing. Moreover, given both the continued government support aimed at attracting this type of investment to Scotland and the distinctiveness of this sub-sector, the case for developing a comprehensive ownership-disaggregated modelling framework is compelling. In this thesis I consider both the potential demand and supply-side impacts of FDI in Scotland and illustrate the use of both ownership-disaggregated

Scottish Input-Output and Computable General Equilibrium Models, as appropriate tools for providing a comprehensive regional evaluation framework.

The starting point for my analysis is the identification of the potential demand and supply-side effects of FDI within a regional economy such as Scotland. There is an extensive literature on potential FDI impacts. What is clear however is the need to not only separately identify foreign-owned manufacturing within the modelling approach, but the modelling framework must also be able to deal with supply-side issues in order to satisfactorily capture the system-wide impact of FDI. The main objective of the thesis is to develop a regional modelling framework, which can capture the system-wide impact of inward investment in Scotland. The main contributions of this thesis to the FDI and regional modelling literature are as follows:

The thesis extends the existing FDI literature relating to the regional impact of foreign direct investment. Chapters 1 and 2 review both the theoretical and applied literature relating to the potential impact of FDI within a regional economy. This literature identified both potential demand and supply-side impacts from FDI in the following areas:

- Patterns of linkages.
- Efficiency and capital intensity of value-added production.
- Behaviour in the labour market.
- Research and Development activity.
- Degree of export orientation.
- Flow of profit income.
- Agglomeration economies
- Efficiency Spillovers.

However, regional evaluations of FDI typically focus on demand-side issues, predominately the pattern or scale of linkages. Moreover, these studies cannot accommodate either the distinct 'structural' or 'behavioural' characteristics of foreign-owned plants. More importantly, however, the modelling framework or approach adopted, are demand-oriented which prohibits any analysis of supply-side impacts, particularly labour market and 'efficiency spillover' effects, which have been well documented in the FDI literature.

Through the adoption of the CGE model AMOS I am able to extend these existing demand-based approaches, by illustrating the potential supply-side impacts of FDI. For instance, I quantify a number of potential supply-side impacts of FDI, in particular, I identify the effects working through: changes in capacity; the expansion of exports; the impact on regional wage-setting and migration; and efficiency spillovers. The results indicate that bargaining in the regional labour market has a potentially important effect on the time path of the increase in regional employment. Therefore, if inward investment does put upward pressure on wages, significant labour-market displacement is likely to occur, at least in the short-run. Moreover, the admittedly speculative estimates of impacts arising from efficiency spillovers from externally-owned plants, provides employment effects which are markedly lower than those associated with plausible export injections accompanying inward investment. More important, however, is that the induced employment impacts from efficiency spillovers are typically larger in other sectors, due to implicit labour savings in the sector which receives the exogenous shock.

This analysis also provides a comparison of the total employment effects of FDI as estimated by a CGE model, which includes supply-side effects (labour market and efficiency spillovers), against an I-O evaluation. The results indicate that I-O overestimates the employment effects of FDI in the short to medium run, but may underestimate these effects in the long-run. Even adopting the 10 year time horizon recommended for official evaluations, the use of I-O significantly overestimates the total discounted present value job years (PVJY's) for the incoming FDI plant. Further, by using an I-O model the analysis is restricted to only demand-side impacts. However, these results should be considered illustrative as many of the adjustment parameters and values used in the AMOS model reflect "best" guess estimates and are thus not all econometrically estimated.

Moreover, in the analysis undertaken in Chapter 3 I was unable to accommodate certain key structural differences in the production process which are typically exhibited by foreign and domestically-owned plants, and normally, at least to some extent, incorporated in demand-side approaches (Hill & Roberts, 1995). However the novelty of the analysis in this chapter is in the attempt to quantify the supply-side impacts of FDI which are typically ignored in both academic and government-sponsored, demand-based evaluations. Moreover, the strong assumptions required in order to motivate the FDI simulations in this chapter have actually been adopted in the FDI literature (Alexander & Whyte, 1995). Accordingly, the analysis in this chapter should be viewed as complementary to the existing demand-side approaches.

To overcome these specific limitations I construct an ownership-disaggregated CGE model. The novelty of this model is that it extends the existing AMOS CGE framework by incorporating distinct foreign and UK-owned manufacturing sectors. The first step, however, involves the construction of an ownership-disaggregated Input-Output Database for Scotland, as existing published Scottish I-O accounts do not distinguish between ownership. The construction of the ownership-disaggregated database satisfies two main objectives:

- The ownership-disaggregated I-O data are necessary in order to provide a snapshot of the structure and interaction of foreign and UK-owned sectors in Scotland for a given period of time. This, in itself, is a useful approach for providing descriptive information about the different ownership characteristics of Scottish manufacturing.
- These data also provide an important input into modelling and form the basis for calibrating system-wide ownership-disaggregated I-O and CGE models for Scotland.

The construction of the new ownership-disaggregated database is derived from the existing Scottish Input-Output Table for 1989. In this analysis I disaggregate the manufacturing component of the Scottish I-O table by ownership. All additional data sources used in the model construction are Scottish and all adjustments are based on the original survey-based Scottish I-O data for 1989. The adjustment methods adopted in each part of the table reflect the availability of appropriate Scottish data. The approach adopted in the construction of the database sought to maximise the use of all available ownership-disaggregated Scottish data. However, data limitations were apparent, particularly in the disaggregation of exports The strength of my approach is that it reconciles various data sources within a coherent framework. However, in doing so I have had to accept the data in the original *Scottish I-O Table for 1989* as the base data and reconcile the ownership-disaggregated data within this framework. This procedure implicitly maintains the integrity of the existing Scottish I-O Table so that by aggregation one can always return to the original Scottish I-O values.

The construction of the ownership-disaggregated Scottish I-O Table provides a unique Scottish database that captures both UK and foreign-owned manufacturing within a coherent framework. Chapter 5 analyses the structural differences that are apparent between both sectors using the ownership-disaggregated Scottish I-O Table as both an accounting framework and model. The model results indicate that there are substantial structural differences between the foreign and UK-owned manufacturing sectors in Scotland. In general, the foreign-owned manufacturing sector is more capital intensive, has greater import (and export) intensities, and pay's higher wages.

The ownership-disaggregated sectoral I-O output and employment multipliers, obtained from the I-O model, capture the production characteristics of these plants. Type I & II output multipliers are typically larger for the UK-owned manufacturing divisions, reflecting both the more in-depth linkage structure and labour intensity of production in these divisions. However, the employment multipliers, which are perhaps the most important multiplier given the emphasis on employment by government evaluations, are typically larger in the foreign-owned manufacturing divisions. This result, which was rather unexpected, reflects the high wage rates and high intermediate intensity adopted by these divisions.

The ownership-disaggregated Scottish I-O Table and Model also provides a framework for considering how embedded or integrated foreign-owned manufacturing is within Scotland. The results indicate, in general, that the foreign-owned manufacturing divisions are less 'embedded' or reliant on the region for either intermediate production inputs or sales. However, the differences in sourcing patterns (intermediate linkages) are relatively small. The different production methods (intermediate and capital intensity levels) employed by the foreign-owned divisions, rather than the differences in intermediate linkages, would appear to have a more significant impact in determining the overall contribution of these divisions to the region. Moreover, the use of employment multipliers as a measure of relative 'embeddedness' is shown to be incorrect.

The 'hypothetical extraction' method provides a further measure of the total linkage and employment supported by the foreign manufacturing sector in Scotland. Using this approach, applied to the ownership-disaggregated I-O model, indicates that in 1989 the foreign-owned manufacturing sector supported total Scottish output of £13.5 billion and some 155 thousand jobs. Of the components of total foreign-owned manufacturing sector, the electrical and instrumental engineering (E&IE) division (Electronics) is the most important with supported output and employment of around £6 billion and 60 thousand jobs, respectively. Many of the results presented in this section are impossible to obtain otherwise and are specific to an I-O (or other accounting) type framework. However, the I-O model can only provide a partial analysis of the impacts of FDI given the restrictive assumptions underlying the model. The ownership-disaggregated I-O Table does however provide a comprehensive set of regional accounts that can be used to identify many of the important characteristics of both indigenous and foreign-owned manufacturing in Scotland.

In summary, foreign-owned manufacturing plants in Scotland are typically more capital and intermediate intensive and pay higher wages, as compared with indigenous-owned plants. Moreover, foreign-owned plants source a higher proportion of their intermediate inputs from outwith the region. As a result, Type I and II output multipliers are typically larger for indigenous-owned manufacturing divisions. In contrast, the Type I and II employment multipliers are larger for the foreign-owned manufacturing divisions, which is important for employment-based evaluations.

However, the main purpose for constructing the ownership-disaggregated Scottish I-O Table and wider Social Accounting Matrix (SAM) is to calibrate an ownership-disaggregated CGE model for Scotland. AMOSFDI is a variant of the AMOS CGE model, which has been constructed specifically to capture the structural characteristics of foreign-owned manufacturing in Scotland and allow specification of distinct 'behaviour' in the foreign-owned manufacturing sub-sector.

The main purpose for developing this framework is to generate an ownership-disaggregated CGE model, which can accommodate the distinct structural and behavioural characteristics that are typically associated with FDI. Moreover I develop three specific simulation models in order to separately identify the impact of incorporating the distinct 'structural' and 'behavioural' characteristics of foreign-owned manufacturing plants within a system-wide model. To accommodate this task I construct a simulation framework which allows me to measure the extent to which this distinctiveness in structure governs the regional impact of FDI, and to what extent differences in 'behaviour' prove important in this context.

The AMOSFDI Model 1 assumes that the foreign-owned sector is identical to the domestically owned sector, in every respect except scale. The prime purpose of Model 1 is, of course, to provide a useful benchmark that assists in the identification of the structural and behavioural influences of inward investment on the host region. The AMOSFDI Model 2, in contrast, acknowledges the true differences in the structures of the domestic and foreign-owned sectors, but maintains the hypothesis of identical behaviour. The AMOSFDI Model 3 allows for the possibility that the behaviour of the foreign-owned sector is distinctive, as well as accommodating the structural differences embodied in the SAM used to calibrate Model 2. Model 3 embodies one theory of the behaviour of the foreign-owned sector, namely that it is very much less sensitive to local price changes than is the indigenous sector. This specification, as such, however provides only one limiting case for the behaviour of the foreign-owned sector.

Comparative simulation of Models 1 to 3 allows the impact of separately identifying, through simulation, the impact of incorporating both distinct structure and behaviour for the UK and foreign manufacturing sectors within a system-wide modelling framework. For each model, I simulate the impact of a 20% increase in foreign manufacturing investment with all of the additional output going directly to exports (100% export intensity). This means that there is no direct product market displacement from the export FDI shock. For each model, I use four different labour market closures in order to highlight the impact of both a passive and non-passive labour market with and without migration.

The results indicate that incorporating the 'true' structure within the model has a more significant impact on the estimates of the region-wide employment impact of the FDI shock, than incorporating 'distinct' foreign-owned behaviour. Comparing the results from Models 1 and 2 illustrates the importance of capturing the actual sourcing patterns, capital and intermediate intensity levels, wage rates etc. for both UK and foreign manufacturing in the model base year data. Thus, where the actual structural characteristics are not incorporated within the model, as in Model 1, the model substantially over-estimates the system-wide employment impact of the export FDI shock.

Model 3 incorporates one distinct set of behavioural characteristics for the foreign manufacturing sector. The impact of incorporating the additional behavioural element is however not as pronounced as incorporating structure. The long-run impacts from Model 3 are identical, across three of the four labour market closures, with the long run solutions for Model 2. However there are differences in these results for the early periods of the export FDI shock. The case where the long run solutions for Models 2 and 3 are divergent is where the regional bargaining labour market closure is chosen. With this labour market closure in Model 3, there is no crowding-out of foreign manufacturing exports or employment and I obtain different long run impacts from Model 2 and substantially different estimates from Model 1. These differences between the results for Model 3 and 2 are typically small and relate specifically to the characterisation of FDI behaviour chosen for Model 3.

In Models 2 and 3, where both models have the same structure and different behavioural characteristics, the long-run results for the Export FDI shock converge on the same solution for two of the four labour market closures: national bargaining and migration and regional bargaining and migration. However, the adjustment to long run equilibrium in the latter case is much more prolonged. For instance, following Treasury guidelines and taking a 10 year time horizon, the total discounted present value job years (PVJY's) generated for the regional bargaining and migration closure, with each Model, is around 64% of the corresponding total for the national bargaining and migration closure. Therefore, even where results converge ultimately, any regional policy evaluation would typically focus only on the first 10 years, which has a significant impact on the estimated total present value job years (PVJY's) generated.

Finally Model 3 incorporated only one specific characterisation of possible FDI behaviour and the results from Model 3 should be considered as instructive, given the various other possible specifications for this sector. Although characterising such behaviour always involves a degree of choice and a number of implicit assumptions. However, the main aim of this thesis is to develop a fully operational ownership-disaggregated CGE model in order to test through simulations the impact of FDI under various assumptions. Accordingly, the model results should be viewed as illustrative. In future research, I would hope to develop and characterise a number of different behavioural assumptions typically associated with FDI. The current model provides a useful basis for such work. The results indicate the importance of capturing the actual structure of the foreign and UK manufacturing sector within the model base year data.

8.2 – Current and Future Developments

Possible future extensions of this analysis include consideration of the sensitivity of the thesis findings to alternative models of foreign-ownership. In particular to extend the spectrum of behaviour for the foreign-owned manufacturing sector and develop a distinctive theory of FDI with an allowance for product market displacement. For instance, FDI flows to the region, which are presently exogenous in the fist instance, could be determined within the model. Further model development could also include further disaggregation of both domestically owned and foreign-owned sub-sectors of manufacturing.

Future work could also extend the analysis considering the impact of "efficiency spillovers" from FDI using the ownership-disaggregated CGE framework. Similarly, much of the analysis undertaken with the original AMOS CGE model (Chapter 3) could be extended using the ownership-disaggregated variant of this model (AMOSFDI). Possible future work could also incorporate the possible impact of FDI on trade flows (e.g. Barrell and Pain, 1997). While these extensions undoubtedly constitute a major research challenge, the ownership-disaggregated CGE Model developed in this thesis provides an ideal framework for accommodating them.

Current extensions to the work outlined in this thesis which I am presently involved with include the construction of an ownership-disaggregated Input-Output and CGE model for Scotland for 1994.[1] Construction of the ownership-disaggregated Table follows the same approach as outlined in Chapter 4. However, the I-O table not only separates total Scottish manufacturing by ownership, but also disaggregates the foreign-owned manufacturing sub-sector by ownership type: FDI-developmental, FDI non-developmental and other foreign-owned. The preliminary findings from the database complement the results reported in this thesis that there is *prima facie* evidence for difference across manufacturing sectors by ownership.

Moreover, a further development of the ownership-disaggregated Input-Output Table for 1994, which has been implemented, is the construction of plant-level I-O output and employment multipliers. This involves essentially stripping the plant from the appropriate I-O column and row and constructing individual I-O output and employment multipliers. The general methodology follows the approach developed in this thesis although I have additional specific case study information for each plant. These results also indicate significant variation in the reported multipliers for foreign-owned plants across both industrial sectors and ownership categories.

I am also currently undertaking regression-based analysis (with the Scottish Office) on individual plant level ACOP data for 1994 in order to explain variations in accounting-based performance indicators across Scottish manufacturing plants on the basis of ownership type, size, age, industrial sector etc. By doing so we hope to identify how far there are genuine ownership-status effects, and how far differences between, say, foreign owned developmental and other plants are explained by characteristics of developmental plants such as their size and industrial locations. This work is presently on going. Finally, with the construction of the ownership-disaggregated Scottish CGE Model for 1994, we aim to extend the framework

[1] This project is sponsored and funded by Scottish Enterprise National and the work has been undertaken with Peter McGregor and Kim Swales at the Fraser of Allander Institute, University of Strathclyde.

outlined in the thesis to include both more manufacturing sectors and different ownership types, including simulations with specific plants. This all represents current on-going work.

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