University of Strathclyde
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Fiscal Devolution in Scotland:
A Multi-Sectoral Analysis

Presented in fulfilment of the requirements for
the degree of Doctor of Philosophy

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Abstract

This thesis employs multi-sectoral modelling techniques to analyse the potential impact of Fiscal Devolution for Scotland. A Social Accounting Matrix (SAM) is constructed, which captures the flows of funds in Scotland for 2009.

The SAM is then disaggregated to identify the three government sectors operating in Scotland, namely the UK Government, the Scottish Government and the Local Government. Also, the tax account is disaggregated to identify three tax accounts, each corresponding to one of the three government sectors. Moreover, the unified household sector in the SAM is disaggregated to identify seven household sectors by type. The disaggregated government and household accounts are then combined into one SAM.

Next, the Type II Input-Output multiplier model and the SAM multiplier model are tested and analysed. Three variants of the Type II output multiplier are tested against the SAM multiplier as a baseline. The results here establish that the SAM multiplier captures the flows of funds in the Scottish economy in the most accurate and comprehensive way.

The standard SAM model is then extended to endogenise part of the Government sector in Scotland, the Scottish Government and the Local Government. This enables the model to capture the effects of an exogenous demand shock under different degrees of fiscal devolution for Scotland. The results indicate that a more fiscally autonomous Scotland is subject to higher sensitivities to shocks.

Finally, this thesis employs a Computable General Equilibrium model (*AMOS*) for Scotland. The model is extended to capture the three Government accounts in the SAM. The model is used to simulate a balanced budget fiscal expansion, where the increase in tax revenue funds a rise in government consumption. The results suggest that a positive valuation of the increase in public amenity provision and a full reflection of that in the wage bargaining process are crucial for a net growth outcome.

Declaration of Author's Rights

This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

Signed:

Date:

Statement of Contribution of Co-Authors

In the case of Chapter 2[1] contributions to the work involved the following:

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Tobias Emonts-Holley	Conception and formulation of research, Literature review, Developing and employing the method, Data analysis, Draft and finalise the chapter	Emonts-Holley, T., Ross, A., Swales, K. (20.74). A Social Accounting Matrix for Scotland. Fraser of Allander Institute Economic Commentary, 38(.7), 84-93.
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[1] Note this chapter is identical to Chapter 2 in Andrew Ross' thesis

In the case of Sections 4.1 - 4.5 from Chapter 4[2], contributions to the work involved the following:

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[2]Note that these sections are in part identical to Chapter 4 in Andrew Ross' thesis, however, a different type of household disaggregation is used

In the case of Chapter 5[3], contributions to the work involved the following:

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[3] Note this chapter is identical to Chapter 5 in Andrew Ross' thesis

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Chapter 1

Thesis Prelude

1.1 Introduction

An increasing range of fiscal powers are devolved to Scotland through recent legislation and this is likely to be extended further in coming years (The UK Parliament, 1998, 2012, 2015). These powers enable the Scottish Government to pursue a fiscal policy that is significantly different to that of the rest of the UK. Therefore, it is vital for policy-makers and economic researchers to have detailed data and modelling tools which can assess the potential impacts of the devolved fiscal powers for Scotland.

Multi-sectoral modelling tools can help assess the potential macro-economic impact of shocks to the Scottish economy. The level of detail that these models can capture is dependent on the underlying data and in particular, the aggregation level of the SAM.

Input-Output (IO), Social Accounting Matrix (SAM) and Computable General Equilibrium (CGE) models are well established multi-sectoral models, which are based around national accounts data. These models can be employed for policy analysis, such as shocks to a sector's output as well as fiscal policy shocks (CGE model specifically for the latter). The models allow for a flexible degree of sectoral aggregation. They capture the key agents in the Scottish economy, with the Household, the Corporate and the Government sector.

SAM and CGE models are particularly useful for the analysis of the Scottish fiscal framework, since they capture the flow of funds to a more complete degree than IO models. Furthermore, CGE models extend the analysis by incorporating elements of agents' behavioural responses to shocks.

Traditionally, Scottish SAMs have treated the Household sector as unified and the Government sector as unified. However, this treatment limits the analysis with respect to both the impact of fiscal devolution for Scotland as well as the distributional impacts that devolved fiscal powers might have.

This thesis builds a SAM based around the 2009 IO tables for Scotland, which is then disaggregated by both Households and Government. The disaggregated SAM identifies seven Household types, three Government sectors as well as three Tax accounts assigned to a corresponding Government.

Furthermore, this thesis develops a data and modelling framework, which can analyse the potential impacts of the different degrees of fiscal autonomy for Scotland as well as the effect of fiscal policy shocks on the Scottish economy. This is done through a SAM model with a partially endogenous Government sector and an extended variant of the *AMOS* CGE model, respectively.

This work is particularly timely with further devolution of fiscal powers to Scotland likely to come in the next few years. Furthermore, the Scottish Rate of Income Tax is about to come into effect in Scotland and, as this thesis shows, utilising this policy tool could have a wide ranging economic impact for Scotland (The UK Parliament, 2015; Scottish Parliament, 2015).

1.2 Chapter Overview

This section gives an overview for all chapters.

Chapter 2: 2009 Social Accounting Matrix for Scotland

Chapter 2 constructs a Social Accounting Matrix (SAM) for Scotland. The 2009 SAM for Scotland details the flows of income and expenditure through the Scottish economy.

These data are essential for both SAM-based and Computable General Equilibrium models, which can simulate the responses of the economy to shocks.

SAMs for Scotland have been produced on a semi-regular basis over the past decades. However, thus far no consistent method for building a SAM for Scotland had been produced. This chapter develops a method, which is based around the 2009 Input-Output (IO) tables for Scotland and other UK national statistics.

A key component for building the SAM is the construction of the Income and Expenditure accounts, which are largely based on data that is not available in IO tables. Each of these entries are discussed in detail. Chapter 2 is the building block for the following Chapters and the method developed here enables the disaggregation of individual accounts in the SAMs.

Chapter 3: Government and Tax Account Disaggregation in the 2009 Scottish SAM

Chapter 3 disaggregates the unified Government and the Tax accounts given in the SAM from chapter 2. The Government account now identifies three separate Government sectors operating in Scotland, namely, the UK Government, the Scottish Government and the Local Government. Furthermore, the Tax account is disaggregated to capture the flows of devolved taxation, which is assigned to one of the three Government sectors in Scotland.

The method developed in this chapter retains the flow of funds from the 2009 SAM for Scotland (from chapter 2). However, it also captures the inter-governmental transfer payments, such as the annual 'block grant' that the UK Government pays the Scottish Government. The SAM constructed in chapter 3 can be employed to represent different degrees of fiscal autonomy for Scotland.

Chapter 4: Household Sector Disaggregation in the 2009 Scottish SAM

Chapter 4 disaggregates the Household account in the SAM by seven Household types. The method developed for the disaggregation of the Household account retains the flow of funds of the 2009 SAM for Scotland from chapter 2. Furthermore, it identifies a disaggregated Household sector with a full industry classification of 104 industries in Scotland. Disaggregating the Household account provides, inter alia, the basis for capturing distributional effects in the CGE model.

Next, chapter 4 links the disaggregated Government account from chapter 3 with the disaggregated Household account. This creates a SAM for Scotland with three Government and three Tax accounts as well as seven Household accounts. The 'Disaggregated SAM' allows for a more detailed tracking of the flow of funds to and from the Government-and Household sector, such as through taxes and benefit payments. Also, it provides the data framework for the analysis of fiscal devolution in Scotland through multi-sectoral modelling techniques.

Chapter 5: Type II Multiplier Analysis

Chapter 5 compares methods for calculating Input-Output (IO) Type II multipliers. These are formulations of the standard Leontief IO model which endogenise elements of household consumption. An analytical comparison of the two basic IO Type II multiplier methods with the Social Accounting Matrix (SAM) multiplier approach identifies the treatment of non-wage income generated in production as a central problem.

The multiplier values for each of the IO and SAM methods are calculated using Scottish data for 2009. These results can be used to choose which Type II IO multiplier to adopt where SAM multiplier values are unavailable. Additionally, these results confirm that the IO Type II method employed by the Scottish Government gives the 'best fit'.

Chapter 6: Degrees of Fiscal Devolution - A SAM Modelling Approach

Chapter 6 employs the 'Disaggregated SAM' from chapter 4 to model different stages of fiscal devolution for Scotland with a SAM multiplier model. These stages are the fiscal framework for Scotland under: the Scotland Act 1998, the Scotland Act 2012, the Scotland Bill 2015-16 and Fiscal Devolution. This chapter extends the standard

SAM multiplier (discussed in chapter 5) to endogenise part of the Government sector, here the Scottish Government and the Local Government.

The SAM model is then shocked with an increase in exogenous demand of £500m. The shock is performed on four models, calibrated on the four SAMs reflecting different stages of fiscal devolution for Scotland. Also, two sectors are shocked separately. The model results provide evidence on the sectoral linkages in the Scottish economy and more importantly on the changes in sensitivity to shocks of the Scottish economy under more autonomous fiscal frameworks.

Chapter 7: AMOS

Chapter 7 outlines the basic CGE modelling framework and the standard forward-looking *AMOS* model. This model variant has the household sector disaggregated, but this feature has not been utilised until now due to a lack in data. Next, the unified Government sector in the model is disaggregated to identify three separate Government accounts, as in the SAM. Due to the disaggregation of the Government account, the model is able to be calibrated with the Household and Government account disaggregated SAM.

Chapter 8: Scottish Fiscal Policy: Towards a Scandinavian Model?

Chapter 8 employs the extended *AMOS* model to examine a potential tax directive that the Scottish Government could pursue with its given fiscal powers. Specifically, the question on how the Scottish economy might fare under income tax levels reflecting Scandinavian rates is explored.

Three models impose an 8 percentage point hike on the average rate of income tax in Scotland in a balanced budget scenario. These models capture different wage bargaining and public amenity valuation of workers and potential migrants. The results show that the values for these parameters are critical for the overall response of the economy to the shock. Also, the results suggest that this type of fiscal policy shock, and specifically of that size, is likely to result in an economic contraction.

Chapter 9: Conclusion

Chapter 9 summarises each of the chapters and highlights their contribution to the thesis. Also, this chapter identifies areas for future work.

Chapter 2

2009 Social Accounting Matrix for Scotland

2.1 Introduction

This chapter outlines the method used to construct the 2009 Social Accounting Matrix (SAM) for Scotland. A SAM is a set of accounts which identify the flow of goods, services and factor inputs, and the corresponding flow of funds between agents in an economic system for a given time period (Hosoe et al., 2010). Essentially, the SAM extends the Scottish Input-Output (IO) tables by incorporating Income and Expenditure (IncExp) Accounts.

Thus, the IncExp accounts contain information on institutional accounts that are not recorded within the IO tables. Therefore the SAM can be used to analyse the economy and the impact of social and economic policy in a more comprehensive way. The structure of a SAM and the main benefits of adopting this accounting framework are outlined in section 2.2. Next, the computed IncExp accounts and the 2009 Scottish IO tables are combined to complete the 2009 SAM for Scotland (section 2.3). In the section 2.4 the IncExp accounts and the methods used to compute these Accounts are described in detail.

2.2 Social Accounting Matrices

The SAM can be considered as an extended IO table which not only records macro economic aggregates and their sectoral disaggregation but also the distribution and redistribution of income. The focus of a SAM therefore lies in recording interrelationships at the meso-level with emphasis on distributive aspects (Keuning & de Ruuter, 1988). It is concerned with the systematic organisation of information about the economic and social structure of a country, region, or city, in a particular time period - usually a year (King, 1981).

In contrast to IO tables, the SAM records flows from producing sectors to factors of production and then on to institutional accounts and finally back to the demand for goods (Adelman & Robinson, 1986). That is, IO tables show payments to factors of production (wages and OVA) but do not show subsequent flows to institutions. As such, a SAM is different from an IO table in that it contains complete information on institutional accounts (i.e. households, government and corporations), instead of solely tracing income and expenditure flows associated with the production of commodities (Breisinger et al., 2010). The main features of a SAM can be divided into three sections (Round, 2003).

First, the row sums in the SAM show the total receipts and the column sums show the total payments of funds in individual accounts. Importantly, each row sum must equal its corresponding column total. That is, the total revenue must equal total expenditure in each account (Hosoe et al., 2010). Each cell in the SAM represents a flow of funds from a column account to a row account, thereby documenting the interconnections between these accounts in an explicit way.

Second, the SAM is considered to be comprehensive as it shows economic activity in terms of consumption, production, accumulation and distribution (although not necessarily in equivalent detail).

Third, the SAM is considered to be flexible in the degree of disaggregation, whilst at the same time following a basic accounting framework (Breisinger et al., 2010). The degree of disaggregation generally depends on the motivation behind the construction of the SAM (e.g. depending on the location of the initial shock and the outcome variables) and more restrictively, the availability of data (Round, 2003).

There are many benefits from constructing a SAM. The additional information contained in the SAM, compared to IO tables, can be used to extend and improve the multiplier modelling capacity to include the behaviour of the non-production part of the economy. In particular, the more explicit link between activity and household income should improve the Type II multiplier.

Thus, a key benefit of extending the IO table to a SAM stems from the added ability of modelling households in more detail. When examining the income effects of an external policy shock on households, IO models allow for analysing different effects on household income. SAM-based multiplier models, however, can additionally detail distributional effects on households (Round, 2003).

Moreover, the SAM can incorporate a highly disaggregated social breakdown. This is particularly important as a large number of economic interactions happen within the household sector. That is, the household account can be further disaggregated to record income and expenditure flows of households determined by, for example, income and age-groups. This in turn allows for more accurate analysis of distributional effects of policy (Stuttard & Frogner, 2003b).

An important side-effect of the SAM compilation process is that data gaps and inconsistencies can be identified. This information can be used to improve and extend survey methods, definitions, classifications and the overall compatibility of data sources (Keuning & de Ruuter, 1988).

The main utility, however, of a SAM is that it provides a comprehensive and consistent record of the interrelationships of an economy at the level of individual production sectors, factors and institutions. Thereby, the SAM makes available an internally consistent statistical foundation, or benchmark, for the creation of plausible economic models (e.g. Computable General Equilibrium models) which simulate changes to the economy (Reinert & Roland-Holst, 1997).

2.3 Social Accounting Matrix for Scotland

The main components of the Scottish SAM are the latest IO tables for Scotland (Scottish Government, 2013a) and the IncExp accounts. This is the 2009 Industry by Industry (IxI) basic-price table for Scotland. It is a symmetric IxI IO table with 104 industries defined using the SIC07 classification. The IxI table presentation allows the interdependence of industries to be formally examined as each industry is shown as intermediate purchasers of their own and other industries output. A detailed description of the methods and data sources used for the construction of the Scottish Government Supply and Use Tables and Analytical Input-Output tables can be found in the 'Input-Output Methodology Guide' from the Scottish Government (2011a).

Table 2.3.1 is an aggregate version of the 2009 IxI table for Scotland. Focusing on the first row and column, the row gives the expenditure on Scottish goods/services, whilst the column details the cost breakdown of the Scottish production sectors. The IO tables define the production cost entries in the column as: intermediates, labour costs, Other Value Added (OVA), Government and Imports from RUK and ROW. The production income entries are defined as: Capital, Household expenditure on Scottish goods/services, Government, and exports to the RUK and ROW.

The first row total of £210,920m in the aggregated IxI table 2.3.1 gives the total turnover of all production and service activity in the Scottish economy (total aggregate demand of gross outputs). It is labelled as 'Activities'. This includes private, public and voluntary sector production activity. This total is broken down to show these interactions in more detail. That is, the largest flow of funds within Activities take place within sales and purchases of Scottish goods/services (intermediate demand) at £63,607m.

This is followed by combined exports at £54,045m (with exports to the RUK comprising 68% of total exports), Household consumption expenditure on goods/services at £49,802m, Government payments (or grants) to Activities (such as Universities and public services) at £29,486m, and lastly Investment expenditure at £13,981m. The disaggregate version of the IxI table details these interactions at full 104 industry level.

The first column in the IO table can be read as expenditures made by productive Activities £210,920m. It can also be interpreted as the full cost of generating these activities. These expenditures are again further broken down into expenditures to 'factors of production' (labour and Other Value Added - including capital and land), Government and imports. Payments to factors of production comprise 48 percent of total expenditures (costs) to Activities. The remaining payments go to to Government and imports. Also note that, 75 percent of total imports to Activities stem from the RUK.

The IxI table 2.3.1 shows the destination of industry output, for example primary manufacturing products. The columns of the IxI table show purchases made by industries and final demand from each Scottish industry's output arising from both principal production and intermediate demand. Conversely, the rows provide a breakdown of industry receipts by origin.

This data on industry linkages can be used in conventional multiplier analysis to estimate knock-on effects throughout the Scottish economy of a change in final demand. Note that the sum of all final demands across all sectors is equal to the sum of all value added (Scottish Government, 2011a).

It must be noted, that the economic activity arising from resource extraction occurring in the North Sea is not directly included in these Scottish accounts. The Scottish 2009 IO tables therefore only include mainland activity. However, onshore activity servicing the extractive activities are identified in the Scottish IO tables as exports to the RUK.

Table 2.3.1: Aggregate Industry by Industry Table, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. OVA	5. Households	6. Government	7. RUK	8. ROW	Total
1. Activities	63,607	-	13,981	-	49,802	29,486	36,879	17,166	210,920
2. Labour	63,561	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	-	-	-	-	-
4. OVA	38,441	-	-	-	-	-	-	-	38,441
5. Households	-	-	-	-	-	-	-	-	-
6. Government	4,779	-	1,495	-	6,568	-	193	129	13,165
7. RUK	30,274	-	3,358	-	13,875	-	4,362	2,890	54,759
8. ROW	10,258	-	1,097	-	4,424	-	3,057	161	18,997
Total	210,920	-	19,930	-	74,669	29,486	44,491	20,346	

Source: Scottish Government (2013a)

The aggregate IxI table 2.3.1 shows that Total Final Demand equals Total output at basic prices within the Activities account. That is, all expenditures are balanced by receipts within the Activities account (£210,920m - £210,920m = 0). IO tables, however, do not attempt to link the elements of Value Added (Wages and OVA) with the elements of Final Demand (Consumers, Government and Investment).

This is in contrast to a SAM where the “missing" data on transfers between these accounts is recorded. Recoding these flows is done by compiling IncExp accounts and linking these together with the IxI table to generate a fully balanced square matrix. It must also be noted, that in order to record transfers between accounts a ‘Corporations’ account is added which does not feature in the IxI table. The Corporations account is outlined in detail in Appendix 2.

Table 2.3.2 depicts an aggregate version of the SAM that is derived by combining the IxI table and the IncExp accounts. For illustrative purposes disaggregation within accounts has been suppressed, as in Table 2.3.1. For example, the 104 industries contained in the SAM are aggregated to one industry (Activities).

However, it must be emphasised that for modelling purposes a much more detailed

SAM is used. The aggregated 2009 SAM for Scotland is a square matrix with 9 column and 9 corresponding row accounts. This aggregated SAM contains the following main accounts: Activities, Labour, Capital, Other Value Added OVA (Profits), Households, Corporations, Government, Rest of UK (RUK), and Rest of the World (ROW).

The row and column entries in the SAM are considered to be receipts and expenditures receptively. The rows in the SAM show income sources for each Account in detail. For example, the Household account shows that total Household income is £107,877m, of which £63,561m (58 percent) comes from Labour income. Conversely, the columns in the SAM depict the expenditures of each account in detail. Again, total Household expenditure is £107,877m, of which £49,802m (46 percent) are payments to productive Activities i.e. Household consumption on goods/services produced in Scotland.

The first row and the first column of the SAM include all the aggregated information from the IxI IO tables, and thus balance. That is the £210,920m from the IxI table (see Table 2.3.1) are fully incorporated. Thus, IO tables provide key macroeconomic variables (GDP and total wage income) as well a breakdown of flows between Scottish industries. Yet, the SAM links up these accounts and thereby presents a more comprehensive and consistent overview of economic activity. For instance, the Government account in the IO table (see Table 2.3.1) identifies only five sources of total Government income and only one source of its expenditures. Thus, in contrast to the SAM, only 17 percent (£13,165m/£76,694m) of total Government income is recorded in the IO table.

Similarly, only 38 percent (£29,486m/£76,694m) of total Government expenditure is recorded in the IO table. It must be noted that imports from RUK and ROW include 'Non-resident household expenditure in Scotland'. If this was not the case, imports to Government from RUK and ROW would be zero.

The additional information contained in the SAM is vital in improving the multiplier modelling capacity. As mentioned in section 2.2, the additional information contained

Table 2.3.2: Aggregated 2009 SAM for Scotland, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Households	6. Corporations	7. Government	8. RUK	9. ROW	Total
1. Activities	63,607	-	13,981	-	49,802	-	29,486	36,879	17,166	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	5,070	24,828	119	- 5,217	- 4,871	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	38,441
5. Households	-	63,561	-	5,289	-	15,103	19,835	1,853	2,237	107,877
6. Corporations	-	-	-	29,456	6,401	-	5,722	5,964	5,964	53,507
7. Government	4,779	-	1,495	3,697	27,947	5,248	13,165	20,234	129	76,694
8. RUK	30,274	-	3,358	-	14,113	3,768	8,368	4,362	2,890	67,133
9. ROW	10,258	-	1,097	-	4,544	4,560	-	3,057	161	23,676
Total	210,920	63,561	19,930	38,441	107,877	53,507	76,694	67,133	23,676	

The fully disaggregated SAM can be accessed at: https://www.strath.ac.uk/fraser/research/sam/

in the SAM, compared to the IO Tables, can be used to extend and improve the multiplier modelling capacity to include the behaviour of the non-production part of the economy as well. In particular, the more explicit link between activity and household income should improve the Type II multiplier.

The IxI table 2.3.1 gives a breakdown of total Household (£74,669m) consumption on Activities (domestic goods/services), Government and Imports. However, the IxI table does not detail other sources of expenditure, and more importantly, no explicit sources of Household income. In contrast, the SAM in Table 2.3.2 provides a more detailed breakdown of Household expenditure on savings, Corporations, Taxes, and Imports. Total Household expenditure is thereby estimated to be £107,877m.

Thus, in comparison to the SAM, the IxI table only captures 69 percent of total Household expenditure. The SAM also presents a detailed breakdown of Household income by Labour, OVA, Corporations, Government and Exports. The SAM thereby provides additional sources of Household income that are not captured in the IxI table. The mode detailed information within the Household account should improve the Type II multiplier.

The entries that were added to the IO Tables to compute the more detailed SAM are derived from the balanced IncExp accounts. This approach assures that every expenditure total and its corresponding receipt total balance and therefore retain the integrity of the IO accounts when constructing the SAM. The SAM thereby incorporates the information of sales and purchases of Scottish goods and services at 104 industry level, at both intermediate and final demand; and also income and transfers among the transactors.

Thus, the SAM is meant to link together existing IO tables and other national statistics. Data necessary for the construction of the SAM that are not contained within the IO table are derived by computing the IncExp accounts. These accounts record income and expenditure of households, corporations, government, capital and the external sector in detail.

2.4 The Income and Expenditure Accounts for 2009

The IncExp accounts provide a detailed picture of flows of funds for the main local transactors (Households, Corporations and Government), as well as for the Capital and External sectors in Scotland. The IncExp accounts are compiled by using publicly available data, sourced from both the UK and the Scottish Government, including the 2009 IO Tables for Scotland (Scottish Government, 2013a).

Section 2.3 outlined the role that the IncExp accounts have in extending the 2009 IO Tables into the 2009 Scottish SAM. This section provides an overview of the IncExp accounts and how these accounts are constructed. This includes a discussion of the data sources, an illustration of the layout and an overview of the calculations and the internal balancing of the Accounts. Appendix 2 provides a detailed description of how each of the entries in the Accounts is calculated.

2.4.1 Data

The data used in the construction of the IncExp accounts are derived from either UK or Scottish Government sources and are all publicly available. The information presented in the Accounts is for the calendar year 2009. This is the format used for the IO Tables, which is carried forward to the SAM. However, some data, for example those from the Government Expenditure and Revenue Scotland (GERS) publication (Scottish Government, 2013b), are given for financial years.

This format is specified as starting from the beginning of April in one year to the end of March in the next year. Therefore the financial year 2008/09 covers the period from 01.04.08 to 31.03.09. In order to transform these data to the calendar year format for 2009, a one-quarter share of the data entry for the financial year 2008-09 is combined with a three-quarter share of the data entry for the financial year 2009-10.

The main data sources used for the construction of the Accounts are identified in Figure 2.4.1. This figure gives an indication of the proportion of the required data that is taken from the main sources. The shares are calculated by de-constructing each entry in the Accounts and is calculated identifying the source of each component.

Note that individual data entries taken from external sources are only counted once for the calculation of the volume of sources in Figure 2.4.1. This is done as some entries from external sources are used a number of times in the calculation of the IncExp accounts[1]. Included in the calculation of Figure 2.4.1 are the sources of the shares (see Equations 2.6.80 to 2.6.86), which are used to transform UK data to Scottish data[2].

[1]See section 2.4.3 for a more detailed discussion of this.

[2]see the Subsection "Shares" below for a full discussion on deriving Scottish data from UK sources.

Data in financial year format is counted as one entry after it has been annualised, following the process outlined above. The total of the individual entries used for the derivation of the IncExp accounts is then used to calculate the share of where the data for the Accounts originating in different sources (see Figure 2.4.1).

For example, the SAM entry showing payments from Households to Government at £21,379m given in Table 2.3.2 is a direct entry from the IncExp accounts[3]. This entry is calculated by summing up the tax payments from Households to Government, which are Income Tax, Capital Gains Tax, Inheritance Tax, Stamp Duties, Half Insurance Premium Tax and Social Security Contributions.

The figures for these tax payments are derived from GERS (Scottish Government, 2013b), which presents entries in the financial year format. Therefore the figures are annualised following the above-mentioned process. Each annualised tax payment is counted as one entry for the derivation of the volume of sources in Figure 2.4.1. This cell in the IncExp accounts thus attributes seven entries to the GERS source(Scottish Government, 2013b).

Figure 2.4.1: Shares of data sources in Income and Expenditure Accounts

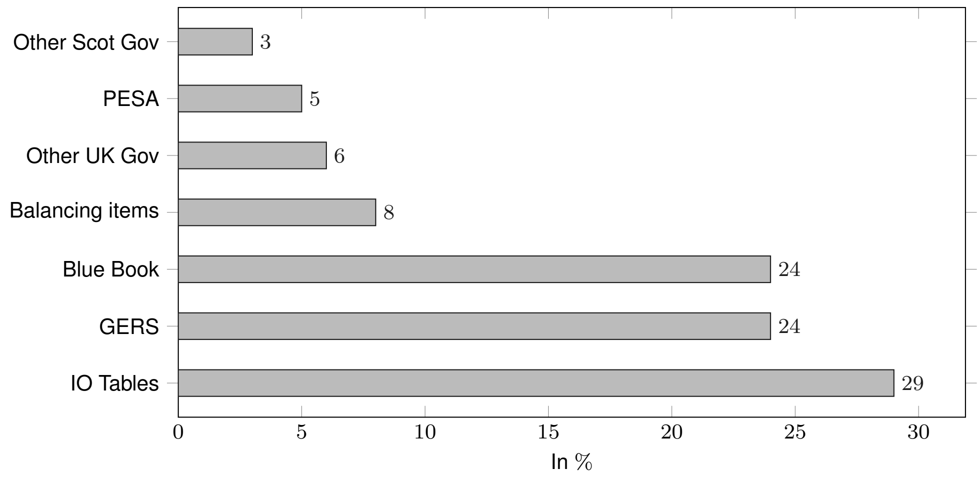


Figure 2.4.1 shows that the largest source of data for the IncExp accounts origi-

[3]This entry corresponds to (Cell 13) in the IncExp accounts. The cell reference method for the Accounts is presented in section 2.4.2

nates from the 2009 IO Tables for Scotland with 29% (Scottish Government, 2013c). The other two major data sources are depicted as GERS with 24% (Scottish Government, 2013b) and the ONS Blue Book, i.e. the UK National Accounts, with 24% (ONS, 2013b). Figure 2.4.1 also highlights that the majority of data used in the compilation of the IncExp accounts originates from Scottish data.

Summing up the shares of 2009 IO Tables, GERS and other Scottish Government sources shows that approximately 56% of data is of Scottish origin. The total amount based on UK data sources is calculated at 35%, which is the sum of the shares of the ONS Blue Book, Other UK Government and Public Expenditure Statistical Analysis (PESA) (Treasury, 2012)[4].

[4]The shares are 24%, 6% and 5% respectively.

Figure 2.4.1 shows furthermore that Balancing Items account for 8% of total individual entries in the Accounts. Essentially, these are elements which are determined through the requirement that the expenditures and receipts in each account must balance. Note that a full discussion on Balancing Items can be found in section 2.4.3. Data consistency of the IncExp accounts is ensured since only a small number of data-consistent official sources are used (see Figure 2.4.1).

Data Sources

The largest data source for the calculation of the IncExp accounts are the 2009 IxI (IO) Tables. The 2009 Tables are the latest IO Tables released by the Scottish Government at the time of this publication and henceforth they determine the year for which the Scottish SAM is built. The IO Tables furthermore determine the accounting period of the IncExp accounts and the SAM, which is the calendar year format. The Scottish IO Tables and thus the Scottish SAM represent the Scottish onshore economy only, and do not include revenue from North Sea oil and gas operations.

It has to be noted that other data sources used in the compilation of the IncExp accounts, for example the ONS Blue Book (ONS, 2013b), include revenue from North Sea operations. This directly affects the Scottish GDP as a share of total UK GDP (see Equation 2.6.80), which is derived by figures from the IO Tables and the ONS Blue Book respectively (Scottish Government, 2013c; ONS, 2013b). The Scottish GDP is underestimated in this instance in relation to the UK GDP figure.

The second largest source for data used in the IncExp accounts is Government Expenditure and Revenue Scotland (GERS), which is an annual publication by the Scottish Government. GERS uses both UK and Scottish Government finance statistics in order to capture all public sector expenditures and receipts in Scotland. This source provides, inter alia, household and corporate tax payments as well as total public spending control totals for the IncExp accounts[5]. The data in GERS are presented in financial year format and have to be transformed to the calendar year format (as discussed above) for the IncExp accounts (Scottish Government, 2013b).

[5] This corresponds to (Cell 43)

The third largest data source used here is the ONS Blue Book, i.e. the UK National Accounts, which is an annual UK National Statistics Publication. The Blue Book is constructed using governmental financial statistics, both from the UK- as well as international government sources. It provides a detailed sectoral breakdown of the UK economy as well as its economic activities with the rest of the world (ROW). The Blue Book data are used for a wide variety of entries in the Accounts, for example, public and private dividend payments to household. The data is in the calendar year format and do not require transformation (ONS, 2013b).

The fourth largest single source for the IncExp accounts is the data from the annual HM Treasury Public Expenditure Statistical Analysis (PESA) publication. Here Local and Central Government spending is detailed, including the budgets of UK government department.

PESA is a major source for the GERS publication by the Scottish Government (Scottish Government, 2013b). The data used in the IncExp accounts originating from PESA are public sector identifiable, non-identifiable and total spending. The data are presented in financial year format and have to be transformed to the calendar year format for the IncExp accounts (Treasury, 2012).

Finally, there are other UK and Scottish Government sources. These include, for example, figures used for the derivation of Scottish households as a share of total UK households (see Equation 2.6.82) (Scottish Government, 2012; ONS, 2012).

Shares

As mentioned above, several shares are used in order to transform UK data for the Scottish IncExp accounts. These shares are essential as some data are only available on the UK level. For example, the Total Managed Public Sector Expenditure in PESA (Treasury, 2012), which is used to estimate the total public expenditure in Scotland[6].

The various shares are used throughout the derivations of the individual cells of the IncExp accounts. The three shares used for the majority of UK data transformation are

[6] This is the Total Government Expenditure Balancing Total (Cell 43) in the IncExp accounts

given below. These are the GDP share at 8.22% (see Equation 2.6.80), the Population share at 8.41% (see Equation 2.6.81) and the Households share at 9% (see Equation 2.6.82). Other shares, such as the Scottish share of Total UK Other Value Added at 8.31% (see Equation 2.6.85) are also used in the calculations (see Appendix 2 for further details). These shares are all close in value. However, theoretical considerations favour different shares for specific UK data as outlined below.

First, the GDP share is applied when UK data is transformed for the Scottish jurisdiction. For example, Governmental and Corporate transfers payments (ONS, 2013b) are multiplied by the GDP share following the framework set out by Hermannsson et al. (2010). Second, the Population share is used for public sector spending, which is allocated to the different jurisdictions within the UK through size estimates of the relevant region. This is in line with the methodology applied in GERS (Scottish Government, 2013b) for transforming PESA (Treasury, 2012) data for Scotland. Third, the Household share is applied to transform UK Dividend Payments to a Scottish figure, which follows UK calculations in transforming total dividend payments to the household level (ONS, 2013b).

The majority of data used in the IncExp accounts is derived from Scottish sources as outlined above. Nevertheless, many statistics are only available on the UK level and the Scottish figure has to be inferred as a share of that. Increasing the volume of entries calculated from direct Scottish data would result in more accurate IncExp accounts.

2.4.2 Layout

The IncExp accounts (see Table 2.4.1) are divided into five sectors (Households, Corporations, Government, Capital and External) as well as the Scottish Trade and External balance with both the RUK and the ROW. Each of those sectors is divided further into an income and an expenditure section (left-hand side and right-hand side respectively), hence the name for these Accounts.

Each numerical entry in the IncExp accounts (see Table 2.4.1) is referred to as a cell and is identified for convenience through the number code given to each entry. For example, (Cell 19) refers to the Profit Income (OVA) of the Corporations' Income Account.

Every account has a Total Income and a Total Expenditure figure, which is a summation of the entries in each section (highlighted in bold). The total expenditure and the total income for each of the main transactors as well as for the Capital account are equal to each other. This is essential for the balancing of the SAM and is discussed in more detail in section 2.4.3 under "Balancing Items".

In addition to the totals derived by summing up the individual entries in each of the main transactors' accounts, the Household and Government sector have additional Control Totals from external sources. For the Household Sector this is (Cell 1), which is the Total Household Income from the GDHI figures (ONS, 2011c). For the Government sector the Control Total is (Cell 43), which is the total public sector expenditure in Scotland derived from GERS and the PESA accounts (Scottish Government, 2013b; Treasury, 2012).

The main transactors (Households, Corporations and Government) have a similar cell breakdown. The largest share of entries in these accounts are Income from- and payments to the other main transactors as well as flow of funds to and from the External account. Note that due to the accounting identity used in the IncExp accounts, the receipt that, for example, sector A receives form sector B is equal to the payment made by sector B to sector A. This is discussed in more detail in section 2.4.3 under "Corresponding Figures".

The External payments are comprised of goods & services payments and receipts to and from Scotland to both RUK and ROW. Additionally, they show the sums of the transfers to and from RUK and ROW by the main transactors. For example, (Cell 53) are the Transfers that Scotland pays to RUK, which is the sum of (Cells 14, 27 and 41). Furthermore, all main transactors have a Profit Income (OVA) entry and a Payments to Capital[7] entry on the Income and on the Expenditure side, respectively.

[7] These are equal to savings made by the individual sector and the Payments to Capital of each sector are used to derive the Capital account.

Table 2.4.1: Income-Expenditure Accounts for Scotland (in £million)

HOUSEHOLDS					
1. **Income**	**107877**		10. **Expenditure**	**107877**	
2. Income from Employment	63561		11. IO Expenditure	74669	
3. Profit Income (OVA)	5289		12. Payments to Corporations	6401	*
4. Income from Corporations	15103		13. Payments to Government	21379	
5. Income from Government	19835		14. Transfers to RUK	238	
6. Transfers from RUK	1853		15. Transfers to ROW	119	
7. Transfers from ROW	2237		16. Payments to Capital (Savings)	5070	
9. **Total Household Income**	**107877**		17. **Total Expenditure**	**107877**	**
CORPORATIONS					
18. **Income**	**53507**		24. **Expenditure**	**53507**	
19. Profit Income (OVA)	29456		25. Payments to Households	15103	**
20. Income from Households	6401	**	26. Payments to Government	5248	
21. Income from Government	5722	**	27. Transfers to RUK	3768	
22. Income from RUK	5964		28. Transfers to ROW	4560	
23. Income from ROW	5964		29. Payments to Capital (Savings)	24828	*
GOVERNMENT					
30. **Income**	**63530**		37. **Expenditure**	**63530**	
31. Profit Income (OVA)	3697		38. IO Expenditure	29486	
32. Net Commodity Taxes	13165		39. Payments to Corporations	5722	*
33. Income from Households	21379	**	40. Payments to Households	19835	**
34. Income from Corporations	5248	**	41. Transfers to RUK	8368	
35. Income from RUK	20041	*	42. Payments to Capital (Savings)	119	
36. **Total Gov Inc Balancing Total**	**63530**	**	43. **Total Gov Exp Balancing Total**	**63530**	
CAPITAL					
44. **Income**	**19930**		49. **Expenditure**	**19930**	
45. Households	5070	**	50. IO Expenditure	19930	
46. Corporations	24828	**			
47. Government	119	**			
48. RUK/ROW	-10087	**			
EXTERNAL					
51. RUK Income from Scotland	67133		58. RUK Expenditure in Scotland	70597	
52. Goods & Services from RUK	54759		59. Goods & Services to RUK	42739	
53. Transfers to RUK	12374		60. Transfers from RUK	27858	
54. ROW Income from Scotland	23676		61. ROW Expenditure in Scotland	27378	
55. Goods & Services from ROW	18997		62. Goods & Services to ROW	19178	
56. Transfers to ROW	4679		63. Transfers from ROW	8201	
			64. Tourist Expenditure in Scotland	2921	
57. **Total Income**	**90808**		65. **Total Expenditure**	**100896**	
			66. Surplus/Deficit	-10087	
G&S TRADE BALANCE			**TOTAL BALANCE OF PAYMENTS**		
67. RUK	-12020		69. RUK	5217	
68. ROW	181		70. ROW	4871	
			71. Total Balance of Payments	10087	
EXTERNAL BALANCE					
72. Income from Employment	-3464				
73. Profit Income (OVA)	-3703				
74. Income from Corporations	-2921				
75. Income from Government	-10087				

Balancing Item: * — Row Entries (Element determines Column)

Corresponding Figure: ** — Row Entries (Element determines Column)

Appendix 2 provides a detailed description of how each of the entries in the Accounts is calculated.

2.4.3 Calculation Overview and Internal Balancing

The structure used for compiling the IncExp accounts follows a framework set out by Hermannsson et al. (2010), which also used data from both the Scottish IO Tables as well as other external sources. As stated above, the largest share of data entries originates from the 2009 IO Tables for Scotland (Scottish Government, 2013c). The entries in the IncExp accounts, which are calculated solely with data from the IO Tables, do not have to be transformed in order to fit these into the SAM framework. For example, (Cell 11) and (Cell 38) are summations of several IO entries.

Linking together the IncExp accounts (see Table 2.4.1) and the IxI table (see Table 2.3.1) is described in the following by the means of using the Government account as an example. Table 2.4.2 depicts the Government account in an aggregate 2009 Scottish SAM. In the parenthesis of the SAM figures the location within the IncExpAccounts or IO table is detailed. For example, the £29,486m Government expenditures on Activities stem from the IO table (Table 2.3.1). The £119m of Government expenditures on Capital stem from the IncExp accounts and can be found in (Cell 49) in Table 2.4.1.

Due to the aggregation of the SAM (Table 2.4.2) it is necessary to combine IO and IncExp data for several entries. For example, the £27,947m Government income from Households is the sum of (Cell 33) ‘Payments to Households to Government’ and the IO entry ‘Taxes on Expenditure’. Thus, it mus be stressed again, that this aggregation is for illustration purposes only and that the fully disaggregated table should be consulted when evaluating the figures contained within the SAM.

Additional to the IO Tables and the other data sources discussed in the section 2.4.1, the IncExp accounts contain internally derived cells. These are notated with a single star (*) for Balancing Items and with two stars (**) for Corresponding Figures (see Table 2.4.1).

Table 2.4.2: Linking together IO tables and the IncExp accounts, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Households	6. Corporations	7. Government	8. RUK	9. ROW
Government Expenditures	29,486	-	119	-	19,835	5,722	13,165	8,368	-
(Column in SAM)	(IO)	-	(Cell 49)	-	(Cell 40)	(Cell 39)	(Cell 32)	(Cell 41)	-
Government receipts	4,779	-	1,495	3,697	27,947	5,248	13,165	20,234	129
(Row in SAM)	(IO)	-	(IO)	(Cell 31)	(Cell 33+IO)	(Cell 34)	(Cell 32)	(Cell 35+IO)	(IO)

Note: The location of the figures in the IncExp accounts and the IO Tables are detailed in the parenthesis.

Balancing Items

Balancing Items are used to balance the Total Income and the Total Expenditure of the main transactors. The method used for allocating Balancing items to the various accounts is as follows. The Household and Government accounts have control totals and in order to balance total income with total expenditure for these accounts, manual balancing is needed.

Thus, there is a Balancing Item on the income and on the expenditure side for each one of these accounts. The Corporate Account does not have control totals, however. Within the Corporate account, the income entries are more robust than the expenditure ones. Therefore the balancing is imposed on the latter. Generally, Balancing Items are imposed on those cells, for which data availability or quality is least robust.

Balancing Items are calculated by summing up all figures of one sector on the relevant account side (apart from the cell used as a Balancing Item) and deducting the Total figure by that calculated sum. For example, Corporations' Payments to Capital (Cell 29) is calculated through deducting the sum of (Cell 25) to (Cell 28) from the total Expenditure (Cell 24).

Corresponding Figures

As outlined in the previous section, based on the accounting identity used for the IncExp accounts, the income that sector A receives from sector B is equal to the payment that sector B makes to sector A. Thus there is a correspondence between payments of the main transactors to each other in the IncExp accounts. For example, the Income from Corporations received by the Government (Cell 34) is equal to the Payments to Government made by Corporations (Cell 26).

It must be noted that the sequence of the Accounts determines the use and presence of Corresponding Figures. The sequence of the IncExp accounts is set out to be: 1.Households, 2.Corporations, 3.Government, 4.Capital to last 5.External. Corresponding Figures between the main transactors occur only in the accounts that follow the Household account. The Household account's Total Expenditure (Cell 17), is an 'account internal Corresponding Figure' referencing Total Household Income (Cell 9) and thus not an entry corresponding to another main transactor.

The use of Corresponding Figures is only then problematic when it corresponds to a cell that is calculated as a Balancing Item. For example, all income entries for the Capital account are Corresponding Figures, as these are equal to the Payments to Capital entries by each of the Primary sectors (Cells 16, 29 & 42) as well as the net External balance (Cell 66). The entry that could cause a 'compounded error' due to reusing a Balancing Item, here, is Capital Income from the Corporate account (Cell 46) which corresponds to the Corporations' Payments to Capital (Cell 29), which is a Balancing Item.

Table 2.4.3 provides details of the cells of the IncExp accounts, which highlights, inter alia, whether cells are derived through external sources or through internal calculation. Cells noted as "Regular" are simply cells in the IncExp accounts, which are marked as neither Balancing Items nor Corresponding Figures (see Table 2.4.1). The slight majority of the "Regular " cells is derived through internal calculations (with 29 internally calculated cells versus 28 externally calculated cells).

For example, Total Household Income (Cell 9), which is the total of all cells in the Households' income account, is internally calculated. The cells noted as being externally calculated are those, which were derived through figures external to the IncExp accounts. For instance, the Households' Payments to Government (Cell 13) is calculated through figures taken solely from GERS (Scottish Government, 2013b).

The second row of Table 2.4.3 shows that there are a total of 5 Balancing Items in the IncExp accounts. These are all internally derived, following the method outlined above. Note that three of those Balancing Items are used within the Accounts as Corresponding Figures and could thereby be the source of a 'compounding error'[8].

Cells noted as Corresponding Figures in the IncExp accounts are detailed in row three of Table 2.4.3. Four of these cells are denoted as being derived from internally calculated cells. Three of those are the above-mentioned Balancing Items, which are also used as Corresponding Figures. The fourth internally derived Corresponding Figure is the Household sector's Total Expenditure (Cell 17). This cell is equal to Total Household Income (Cell 9), which is a summation of all income of the Household sector. All other Corresponding Figures are equal to externally calculated cells.

For example, Government's Payments to Households (Cell 40) is equal to Household's Income from Government (Cell 5), which are derived through figures from both both GERS and the ONS Blue Book (Scottish Government, 2013a; ONS, 2013b). Note that although thirteen cells are identified as Corresponding Figures in the Accounts, in effect 26 cells have corresponding entries to other cells.

[8] Where Corresponding Figures refer to a cell that is calculated as a Balancing Item, it is marked as such in the detailed breakdown in Appendix 2

If the ordering of the Accounts were different, for example the Household account would follow the Government account, then Household's Income from Government (Cell 5) would be a Corresponding Figure of Government's Payments to Households (Cell 40). Thus (Cell 5) would be noted as a Corresponding Figure and (Cell 40) would not be.

Table 2.4.3 highlights that in total 38 cells are calculated through external sources, whilst 37 cells in the Accounts are derived through internal calculation. The entries of the main transactors are mainly obtained through external sources whilst the majority of entries from the Capital account and below (see Table 2.4.1) are derived through internal calculations.

Table 2.4.3: Income and Expenditure Cell Details

	Internal	External	Total
1. Regular	29	28	57
2. Balancing Item	5	-	5
3. Corresp. Figure	4	9	13
Total	38	37	75

Concerning future work on the IncExp accounts, the reliance on Balancing Items could be looked into further. As Figure 2.4.1 shows, these cells account for 8% of the total individual entries for the IncExp accounts. Currently, the cells for which there are the least robust data are chosen in order to balance the accounts of the main transactors. If robust estimates for these entries could also be obtained, then the balancing of the account could be distributed across a number of cells in an account. However, determining the balancing share of each entry might prove difficult and could result in a number of robust estimates to be skewed.

2.5 Conclusion

This chapter developed a method for the construction of Scottish SAMs that is replicable and utilises data that is publicly available. The way that the 2009 Scottish SAM is constructed allows for any of the raw data, that is used to compute the entries, to be easily updated. That is to say that the work presented in this chapter results in SAMs based on other base years, for example, to be built in a very short span of time.

Also, the 2009 Scottish SAM provides the framework for several more highly disaggregated variants. For example, with the unified Government sector disaggregated (see chapter 3) or the unified Household sector disaggregated (see chapter 4).

Chapter 3

Government and Tax Account Disaggregation in the 2009 Scottish SAM

3.1 Introduction

The public sector has traditionally been treated as a single account in Scottish SAMs (Lecca, McGregor, Swales, & Yin, 2014; Emonts-Holley, Ross, & Swales, 2014). However, three distinct Government sectors are operating in Scotland: the UK Government, the Scottish Government and the Local Government. All three Government sectors operate separately from each other as well as interdependently in the Scottish economy. For example, each of the Governments purchases Scottish industry output for its own consumption, whilst also being recipients of inter-governmental transfers.

In addition to the three Government sectors, there are also three separate Tax accounts operating in Scotland. There are the UK Tax, the Scottish Tax and the Local Tax account. Again, these have been historically treated as a unified account in Scottish SAMs (Lecca et al., 2014). However, the increasing level of fiscal autonomy for Scotland, under the Scotland Act 2012 and the current Scotland Bill (The UK Parliament, 2012, 2015), necessitates a more detailed modelling of the flow of taxes in Scotland.

Disaggregating the 2009 SAM for Scotland by both the Government and the Tax account is a key component in this thesis' aim of providing a more detailed SAM database for Scotland. The disaggregation of the public sector produces a more detailed picture of the flow of funds in Scotland for 2009 (The UK Parliament, 1998).

Additionally, the disaggregated SAM can be transformed to capture different stages of fiscal devolution, like the tax and inter-governmental transfer changes in the Scotland Act 2012 (The UK Parliament, 2012).

This chapter is structured as follows. Section 3.2 discusses the Government and the Tax account in the aggregated SAM and details how Government and Taxes are treated in the Industry-by-Industry (IxI) table, which underlies the SAM. Next, the Government sector in the Income and Expenditure (IncExp) accounts is outlined. Section 3.3 outlines the method of disaggregating the three Government sectors in the SAM. This is split into the disaggregation of the Governments' consumption expenditure stemming from the IxI table and the disaggregation of the IncExp accounts. Section 3.4 discusses the data used for the disaggregation. Section 3.5 details the disaggregation and section 3.6 analyses the disaggregated Government SAM. Lastly, section 3.7 concludes.

3.2 The Government and the Tax Account in the 2009 Scottish SAM

This section outlines the Government account in the 2009 SAM for Scotland (henceforth also referred to as the 'base SAM'). This includes a brief analysis of the two databases that provide the data for the SAM, the IxI table and the IncExp accounts. Table 3.2.1 is an aggregated 2009 SAM for Scotland. It shows that the Government sector's income and expenditure balance and the total is £63,530m. Note that the full SAM is discussed in Chapter 2, and that Appendix 2 provides a full breakdown of the calculation for all entries outlined here.

The expenditure column shows the Government sector's purchases of Scottish industries' output, which is aggregated to the "Activities" sector in Table 3.2.1. The Government's consumption expenditure total is £29,486m, which is taken straight from the IxI table. The payments to "Capital" of £119m is also taken from the IxI table (see Appendix 2, Equation 42 for a detailed breakdown).

The Government makes transfer payments to "Households" of £19,835m, for example in form of benefit payments or housing support. Furthermore, "Corporations" also receive funding from the Government of £5,722m. Note that this figure is a balancing item (as defined in Section 2.4.3). The last entry in the Government column is spending on the "External" sector of £8,368m. This is 'non-identifiable spending', which is a population-based share of expenditures undertaken by the UK Government on behalf of Scotland, like defence spending, but not necessarily in Scotland (see Table 9.4.3).

The Government receives income, as identified in the "Government" row in Table 3.2.1. Other Value Added (OVA) provides £3,697m of income, which is the 'Gross Operating Surplus' of government-owned industries, such as 'Public Administration', taken from the IxI table. "Households" pay taxes to the Government, which are: Income Tax, Capital Gains Tax, Inheritance Tax, Council Tax and Social Security Contributions, of £21,379m. "Corporations" also pay taxes to the Government of £5,248m

Table 3.2.1: Aggregated 2009 SAM for Scotland, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Households	6. Corporations	7. Government	8. Net Commodity Taxes	9. External	Total
1. Activities	63,607	-	13,981	-	49,802	-	29,486	-	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	5,070	24,828	119	-	-10,087	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	38,441
5. Households	-	63,561	-	5,289	-	15,103	19,835	-	4,090	107,877
6. Corporations	-	-	-	29,456	6,401	-	5,722	-	11,928	53,507
7. Government	-	-	-	3,697	21,379	5,248	-	13,165	20,041	63,530
8. Taxes on Exp.	4,779	-	1,495	-	6,568	-	-	-	322	13,165
9. External	40,532	-	4,455	-	18,657	8,328	8,368	-	10,470	90,808
Total	210,920	63,561	19,930	38,441	107,877	53,507	63,530	13,165	90,808	661,739

and these are: Corporation Tax, Non-Domestic Rate, Other Taxes and Royalties as well as Interest and Dividends.

There are other taxes, both direct and indirect, which are captured under the “Taxes on Expenditure” account, see below for details. These taxes flow back to the Government under “Net Commodity Taxes” at a total of £13,165m. All of these figures come from the IxI table, which are given as ‘Taxes less subsidies on products’ and as ‘Taxes less subsidies on production’. The biggest single tax captured here is Value Added Tax (VAT) alongside some other direct and indirect taxes[1].

The Tax account’s income stems from the following sectors. The “Activities” sector reports a tax payment of £4,779m, the “Captial” account pays £1,495m, “Households” pay £6,568m and the “External” sector pays £322m. Note that the “External” sector aggregation here includes ‘Tourist expenditure’, which also pays VAT for purchases made in Scotland, for example (Scottish Government, 2013a).

The last entry is the payment from the “External” sector of £20,041m. This is a balancing item, but is close in value to the funding gap between taxes collected in Scotland and public sector total spending. Total current revenue in Scotland for 2009 is £42,124m with Total Expenditure at £61,275m. Hence, the shortfall is £19,152m. This can be treated as a transfer from the RUK to Scotland, or here, the Government sector in Scotland (Scottish Government, 2013b).

3.2.1 The Government and the Tax Account in the IxI table

The IxI table provides the framework for the SAM and most of the data in the SAM stems from the IxI table. In order to disaggregate both the Government and the Tax account in the 2009 SAM for Scotland, the data covering the public sector coming from the IxI table needs to be disaggregated first. Hence, the data contained in the IxI table is outlined below.

[1]These taxes are: Aggregates levy; Agriculture levies; Air passenger duty; Alcohol duties; Betting, gaming and lottery duties; Channel 4 funding; Climate change levy; Fossil fuel levy; Gas levy; Hydro benefit tax; Hydrocarbon oils duty; Insurance premium tax; Landfill tax; Lottery fund; Protective duty on imports; Renewable obligation certificates; Stamp duties; Strategic Rail Authority rail franchise premia; Sugar levy; Tobacco duty (Scottish Government, 2011a)

The Government sector in the 2009 Scottish IxI table is split between Central Government and Local Government. The former comprises both the UK Government in Scotland and the Scottish Government whilst the latter is the Local Government, i.e. Scottish Local Authorities. Note that the UK Government in Scotland is referred to as the UK Government only from here onwards.

Table 3.2.2 shows an aggregated version of the 2009 Scottish IxI table. Please refer to Chapter 2 for a full discussion on this, as the emphasis here is on the Government and the Tax account only. The IxI table identifies the Government sectors' spending on "Activities" as the only public sector expenditure. The Central Government spends £19,296m and the Local Government £10,190m. The IxI table does not record any Government sector income. It does however, capture some tax income, under "Taxes on Expenditure" of £13,165m. Recall that this is mainly VAT income as well as some other direct and indirect taxes, as outlined in the section above.

Table 3.2.2: Aggregate Industry by Industry Table, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Households	6. Central Government	7. Local Government	8. External	Total
1. Activities	63,607	-	13,981	-	49,802	19,296	10,190	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	-	-	-	-	
4. Other Value Added	38,441	-	-	-	-	-	-	-	38,441
5. Households	-	-	-	-	-	-	-	-	-
6. Central Government	-	-	-	-	-	-	-	-	-
7. Local Government	-	-	-	-	-	-	-	-	-
8. Taxes on Expenditure	4,779	-	1,495	-	6,568	-	-	322	13,165
9. External	40,532	-	4,455	-	18,299	-	-	10,470	73,755
Total	210,920	-	19,930	-	74,669	19,296	10,190	64,837	

Source: Scottish Government (2013a)

There are two broad categories of data that flow from the IxI table (see Table 3.2.2) to the SAM (see Table 3.2.1). First, the Government sector's expenditure on industry products and the income from "Taxes on Expenditure". These two items from the IxI table have to be disaggregated to identify the three Government and Tax accounts in the disaggregated SAM. Note that the IxI table does not identify a column vector for the Tax account, as this is captured in the Government account column. All other information stem from the IncExp accounts, which are discussed below.

3.2.2 The Government and the Tax Account in the Income and Expenditure Account

Table 3.2.3 shows the Government account in the (aggregated) IncExp accounts from the 2009 SAM for Scotland from Chapter 2. The Government IncExp account identifies all aggregate entries for the Government and the Tax account in the SAM. This includes the Government's tax income from "Net Commodity Taxes" (cell 32) as well as direct tax payments from Households and Corporations (Cells 33 & 34).

The Government sector in Table 3.2.3 includes the UK, Scottish and Local Governments. Hence, the income and expenditure entries are aggregated totals. These entries are also the control totals for the disaggregated IncExp accounts. Note that the disaggregated account includes additional data, however, which inflates the combined total of the Government's account.

Table 3.2.3 does not capture inter-governmental transfers, such as the 'block grant' that the Scottish Government receives from the UK Government (The UK Parliament, 1998). It does show, however, the expenditure support that the Government sector in Scotland receives, since total tax income is smaller than public sector expenditure (Scottish Government, 2013b). This entry is the "Income from RUK" of £20,041m. Also, Table 3.2.3 captures expenditure that the UK Government does on behalf of Scotland. This includes public sector debt payments and is the "Transfers to RUK" of £8,368m.

Table 3.2.3: Government in the 2009 IncExp accounts for Scotland (in £million)

GOVERNMENT			
30. **Income**	**63,530**	37. **Expenditure**	**63,530**
31. Profit Income (OVA)	3,697	38. IO Expenditure	29,486
32. Net Commodity Taxes	13,165	39. Payments to Corporations	5,722
33. Income from Households	21,379	40. Payments to Households	19,835
34. Income from Corporations	5,248	41. Transfers to RUK	8,368
35. Income from RUK	20,041	42. Payments to Capital (Savings)	119

The Government sector in the IncExp accounts captures all flows of funds that are either received by the Government or flow from it to other sectors. For example, "Payments to Households" (Cell 40) is equal to the Household sector's "Income from Government". Therefore it is sufficient to disaggregate the entries shown in Table 3.2.3, in order to disaggregate the Government in the IncExp and in the SAM. Recall that by balancing the IncExp accounts, the SAM balances automatically, since all entries flow through the IncExp accounts.

3.3 Method

The disaggregation of the Government and Tax Account is split into two distinct parts. First, the Government's consumption expenditure stemming from the IxI table is disaggregated. Second, the IncExp accounts are disaggregated by splitting the Government account (see Table 3.2.3) into a UK Government, Scottish Government and Local Government account. This section outlines the method employed for the disaggregation and section 3.5 details the disaggregation.

3.3.1 Disaggregation of the Government Consumption Expenditure

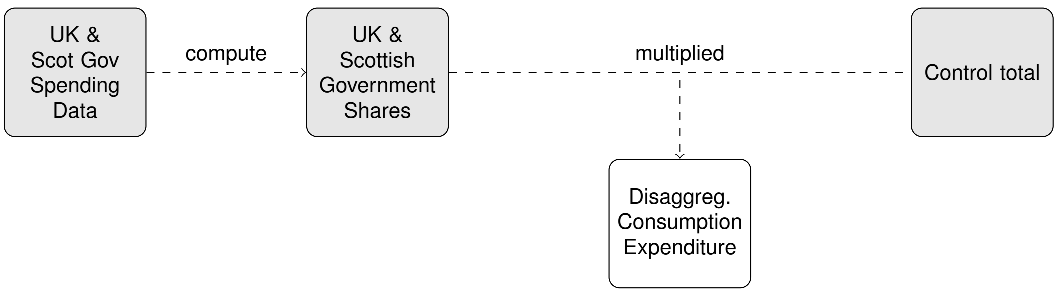
All three Government sectors purchase goods & services from Scottish industries (Scottish Government, 2013b). The Government consumption expenditure in the SAM stems from the IxI table. This is shown as the expenditure of the Government account in Table 3.2.1 on the "Activities" sector of £29,486m.

The IxI table already identifies two Government accounts, the Central and the Local Government (see Table 3.2.2). The Central Government spending by industry in the IxI table is a 104×1 vector that includes both the UK and the Scottish Government. Hence only the Central Government vector needs to split between the UK Government and the Scottish Government in order to obtain all three Government's consumption expenditure vectors.

That is to say that the Central Government 104×1 vector is disaggregated into a 104×2 matrix (UK and Scottish Government). Combined with the Local Government vector, 104×1, the disaggregated Government consumption expenditure is a 104×3 matrix. This matrix identifies the UK Government, the Scottish Government and the Local Government purchases of Scottish output, by 104 industries.

Figure 3.3.1 illustrates how the Central Government consumption expenditure vector from the IxI table is disaggregated. First, data identifying both UK Government and Scottish Government spending on Scottish industry output are obtained. These data stem from the Government Expenditure and Revenue Scotland (GERS) publication (Scottish Government, 2013b). Note that section 3.4 details the data sources employed in this Chapter.

Figure 3.3.1: Central Government Consumption Expenditure Vector Disaggregation



Next, the 'UK & Scottish Government Spending Data' are transformed to identify shares for the UK Government and the Scottish Government, respectively. This step is the 'computing' of "UK and Scottish Government Shares" in Figure 3.3.1. Note that shares for nine industries (out of 104) are computed, which identify UK versus Scottish

Government consumption expenditure. These nine industries account for 99.96% of all Central Government expenditure in the IxI table[2]. The remaining industries are disaggregated by using the share of UK versus Scottish Government 'total identifiable spending' (Scottish Government, 2013b).

The last step in disaggregating the 104×1 Central Government consumption expenditure vector is to multiply the UK and Scottish Government Shares with the control total. The control total here is the Central Government consumption expenditure vector from the IxI table (see Central Government purchases of the Activities sector in Table 3.2.2; £19,296m). This produces a 104×2 matrix which identifies the spending of the UK Government and the Scottish Government (separately) on Scottish output classified by 104 industries. Adding the 104×1 Local Government vector to this produces the final 104×3 matrix, as outlined above.

3.3.2 Disaggregation of the Income and Expenditure Account

The second step in disaggregating the Government account in the 2009 SAM for Scotland is the disaggregation of the IncExp accounts. Recall that the IncExp accounts capture the Household, Corporate, Government, Capital and External accounts. The disaggregated IncExp accounts identify three Government accounts, the UK, Scottish and Local Government, and the flows between the disaggregated Government and the other sectors.

Therefore, the other sectors in the IncExp accounts expand as well in order to capture the disaggregated Government flows. For example, the Household sector now needs to identify the flows to and from each of the three Government accounts. It is sufficient to identify the three Government accounts only in the disaggregated IncExp accounts as these capture the additional flows to the other sectors. That is to say by disaggregating, for example, welfare payments to Households from each of the Government accounts, Household income from the three Government sectors is identified simultaneously[3].

[2]The GERS data identify spending by sectors, not industries. However, these correspond well to the SIC07 industry classification of the IxI table. Section 3.4 discusses this in more detail.

[3]These flows are called "Corresponding Figures" as detailed in chapter 2, section 2.4.3

The IncExp accounts are disaggregated by splitting the entries from the aggregated IncExp accounts shown in Table 3.2.3. Some of the data used to compute the entries in the aggregated IncExp accounts identify the three different Government sectors already. That is to say that the data was aggregated for the IncExp accounts of the base SAM. Hence, some entries are disaggregated by simply utilising the data that identify different Government sectors already.

For example, direct Household taxation is calculated by adding up the different Household tax liabilities in the IncExp accounts. In the disaggregated IncExp the devolved tax liabilities (see The UK Parliament (1998) and The UK Parliament (2012)) are then assigned to the corresponding (disaggregated) Government sectors.

Other entries from the aggregated IncExp accounts are disaggregated by computing shares for the different Government sectors, which are then multiplied by the appropriate control total. Note that the control totals are the corresponding entries in the aggregated IncExp accounts. Overall, the disaggregated entries from Table 3.2.3 match up with the aggregated IncExp accounts. That is to say that collapsing each of the disaggregated entries to one entry again, reproduces the same values as shown in Table 3.2.3.

The disaggregated IncExp accounts introduce two unique changes to the structure of the accounts. First, inter-governmental transfers are now captured and second, taxes are treated differently. The purpose of disaggregating the Government account in the SAM is to be able to capture the public sector more accurately and subsequently, to model shocks to the Scottish economy in more detail. The inter-governmental transfers, i.e. the block grant paid from the UK Government to the Scottish Government as well as the grants paid from the Scottish Government to the Local Government, are key to the structure of public finances in Scotland.

With the disaggregation of the Government account, the Tax account needs disaggregating, too. In order to provide a clearer breakdown of which of the three Government accounts receives taxes, the disaggregated IncExp introduces a ‘UK Tax’, a ‘Scottish Tax’ and a ‘Local Tax’ account. This change in the treatment of the tax account also sets the Government SAM up to capture different fiscal arrangements for Scotland, such as under the Scotland Act 2012 (The UK Parliament, 2012). Chapter 6 models degrees of fiscal devolution using a number of appropriately modified SAMs.

Table 3.3.1 is a stylised Government account in the aggregated versus the disaggregated IncExp accounts. The left-hand-side shows the "Unified Government", which is the same as the Government sector in Table 3.2.3. The right-hand-side is a representative Government account of the "Disaggregated Government" sectors, here the Scottish Government.

Table 3.3.1: A Representative Government Account in the Aggregated versus the Disaggregated IncExp Accounts for Scotland

Unified Government		**Disaggregated Government**	
Income	**Expenditure**	**Income**	**Expenditure**
Profit Income (OVA)	IO Expenditure	Profit income (OVA)	IO Expenditure
Net Commodity Taxes	Payments to Corporations	Scottish Taxes	Payments to Corporations
Income from Households	Payments to Households		Payments to Households
Income from Corporations	Transfers to RUK		Transfers to RUK
		Transfers from UK Gov	Transfers to ROW
		Transfers from Local Gov	Transfers to UK Gov
Income from RUK		Income from RUK	Transfers to Local Gov
	Payments to Capital		Payments to Capital

The three notable differences in the structure between the two IncExp accounts are the treatment of taxes, the inter-governmental transfers and also the disaggregation of the transfers to the External sector flows. As stated above, the disaggregated IncExp accounts, and therefore the disaggregated SAM, identify regional taxes, here "Scottish Taxes". The "Net Commodity Taxes", "Income from Households" and "Income from Corporations" are aggregated to the corresponding regional Tax account. That is to say that the Household and Corporate account now show expenditures on the "UK Tax", "Scottish Tax" and the "Local Tax" account , as discussed below.

Additionally, the "Disaggregated Government" account captures the inter-governmental flows. Here, these are the transfers from the UK Government and from the Local Government as well as transfers to these Government accounts (see Table 3.5.1 for the actual figures for the Government sectors in the disaggregated IncExp accounts). Note that these are not captured in the aggregated IncExp accounts, but that the transfer payments in the disaggregated IncExp net out when compared with the aggregated IncExp accounts.

As mentioned above, the last difference between the two IncExp accounts in Table 3.3.1 is that the disaggregated Government account captures transfer payments to ROW and RUK. The aggregated account identified RUK transfers only. During the disaggregation process, this Chapter identified that some of the ‘non-identifiable’ payments captured under the “Transfers to RUK” are actually “Transfers to ROW”. This entry is detailed further in section 3.5.2. This change is motivated by the aim of providing a more detailed public sector in the Scottish SAM framework.

Most entries that are on both the income and expenditure side under the “Unified Government” and under the “Disaggregated Government” (see Table 3.3.1) match up on aggregate. These entries are for the income side: Profit Income, Income from Households and Income from Corporations. For the expenditure side: IO Expenditure, Payments to Corporations, Payments to Households and Payments to Capital. That is to say that the combined entries for the disaggregated entries are equal to the aggregated ones from Table 3.2.3.

As noted above, the disaggregated IncExp accounts incorporate inter-governmental transfers. As a result of these changes, the combined total of the Government account increases. Hence, the totals of the aggregated IncExp accounts do not match those of the disaggregated one. Note that collapsing the disaggregated IncExp accounts again to one Government sector would result in the same totals as in the aggregated IncExp accounts, since the inter-governmental transfers would simply net out.

The additional information contained in the disaggregated IncExp accounts result in changes to the SAM framework. Table 3.3.2 is a stylised aggregated SAM for Scotland with one Domestic sector[4], one Government sector, one Tax account and one

[4]The Domestic Sector captures, inter alia, all industries, Households, Corporations and the Capital. Essentially all sectors, apart from the Government, Tax and External (RUK + ROW) sectors.

external sector. This is the aggregated SAM structure representing the "Unified Government" in the IncExp accounts from Table 3.3.1, hence this is a stylised version of the SAM in Table 3.2.1.

The 'x's in Table 3.3.2 mark the SAM entries that flow into the SAM from the Government sector in the aggregated IncExp accounts. These entries are the Government transfers to the Domestic and to the External sector as well as tax payments by the Domestic and the External sector to the Government and to the Tax account. Also, the transfer of tax income to the Government account is identified here. See section 3.2 for a detailed breakdown of these flows.

Table 3.3.2: Stylised Aggregated SAM for Scotland

	Domestic Sector	Government	Net Commodity Taxes	External Sector
Domestic Sector	-	x	-	-
Government	x	-	x	x
Taxes on Expenditure	x	-	-	x
External Sector	-	x	-	-

Table 3.3.3 is a stylised disaggregated SAM for Scotland, which contains one domestic and one external sector as in the SAM in Table 3.3.2. But here, the additional and amended public sector flows of funds from the disaggregated IncExp accounts are also identified in the SAM. Table 3.3.2 shows the UK Government, Scottish Government and Local Government as well as the UK Tax, Scottish Tax and Local Tax account.

Table 3.3.3: Stylised Disaggregated SAM for Scotland

	Domestic Sector	UK Government	Scottish Government	Local Government	UK Tax	Scottish Tax	Local Tax	External Sector
Domestic Sector	-	x	x	x	-	-	-	-
UK Government	-	-	-	-	**X**	-	-	x
Scottish Government	-	**X**	-	-	-	**X**	-	-
Local Government	-	-	**X**	-	-	-	**X**	-
UK Tax	**X**	-	-	-	-	-	-	**X**
Scottish Tax	**X**	-	-	-	-	-	-	**X**
Local Tax	**X**	-	-	-	-	-	-	**X**
External Sector	-	x	-	-	-	-	-	-

The stylised disaggregated SAM contains the information of the disaggregated Government sector. Note that Table 3.3.3 captures the flows from the disaggregated IncExp accounts for all Government sectors. That is the transfers from the "Disaggregated Government" IncExp accounts in Table 3.3.1, but for the UK Government, Scottish Government and Local Government (Table 3.3.1 only showed the Scottish Government for illustrative purposes).

The lower case 'x's in Table 3.3.3 identify flows of funds that are also captured (on aggregate) in Table 3.3.2. The capital '**X**'s mark flows of funds that differ to those in the aggregated SAM. All entries are described below.

Table 3.3.2 identifies payments from the Government to the Domestic sector and these are also captured in the disaggregated SAM, but split between the three Government. Next, the Domestic sector makes payments to the Government in Table 3.3.2. These are mainly direct tax payments from Households and Corporations. Table 3.3.3 captures these tax payments differently, in that they are combined with the Domestic sector's payments to the "Taxes on Expenditure" account.

In Table 3.3.3, the Domestic sector makes payments to the three different Tax accounts (UK Tax, Scottish Tax and Local Tax) and this captures both direct and indirect tax payments. Similarly, Table 3.3.2 identified tax payments from the External sector to the "Taxes on Expenditure" account. These are disaggregated by the three Tax accounts in Table 3.3.3.

Note that the External sector's payments to Government are a transfer payment, i.e. not a tax payment, that covers the shortfall of public revenue receipts versus public expenditure in Scotland. This is allocated as an External Sector transfer to the UK Government in Table 3.3.3 and not disaggregated to the other Governments (see section 3.5.2 for further details on this entry).

Table 3.3.2 identifies a payment from the Government to the External sector, which is retained in Table 3.3.3 as a UK Government payment. This entry captures the 'non-identifiable' spending component of public sector expenditure in Scotland. It is UK Government spending that is done on behalf of Scotland, but not necessarily spent in Scotland, as for example spending on international embassies and consulates (see section 3.5.2 for further details on this entry).

Table 3.3.3 captures Government-to-Government transfers, which were not identified in Table 3.3.2. These are the block grant payment from the UK Government to the Scottish Government and the grants payments from the Scottish Government to Local Authorities (Local Government).

Finally, the "Net Commodity Taxes" sector transfer payment to the Government in Table 3.3.2. This is simply the tax revenue that is 'paid' to the Government, which Table 3.3.3 captures as the disaggregated Tax payments from the three Tax accounts to the three Government accounts.

3.4 Data

The Government and Tax account disaggregated SAM (Government SAM) employs the framework of the 2009 SAM for Scotland (base SAM) from chapter 2. Hence, the disaggregated accounts employ the same data sources as the base SAM. However, the disaggregation of some entries requires additional data to compute shares. These shares are computed using data from GERS and are then multiplied with the control totals from the base SAM. Additionally, the inter-governmental transfers are based on external sources.

3.4.1 GERS

The Government Expenditure and Revenue Scotland (GERS) publication is produced annually by the Scottish Government. It provides estimated national accounts for Scotland, which are based on the official National Accounts for the UK. GERS is the proxy for Scottish national accounts, since there are no official inter-regional fiscal accounts for the UK (Scottish Government, 2013b).

GERS data are largely based upon the Country and Regional Analysis (CRA), which is part of the Public Expenditure Statistical Analysis (PESA). These are published by the HM Treasury on an annual basis. CRA/PESA do identify some data on a regional basis, including for Scotland, but other variables are only available at the UK-level (Treasury, 2012; Scottish Government, 2013b).

Where data for Scotland have to be computed, GERS aims at providing robust estimates, which match the UK National Accounts. Hence, the accounting standards employed by GERS are the same as used by the UK Government, the European System of Accounts 1995 (Scottish Government, 2013b).

GERS provides data for three broad categories. First, it identifies tax revenue raised, second, it estimates total expenditure on public services for Scotland and third, it calculates the balance between revenues raised in Scotland and public expenditure. GERS captures the categories above both in totals as well as by UK versus Scottish revenue & expenditure. Note that the 'Scottish' level is a combination of both Scottish Government and Local Authorities in Scotland, i.e. Scottish and Local Government (Scottish Government, 2013b).

Revenue figures, i.e. taxes, are estimates of the financial burden imposed on either residents or businesses in Scotland. Expenditure figures, on the other hand, are estimated through identifying the benefit for Scotland. That is to say that the beneficiaries (people, businesses or organisations) of the payments from the UK, Scottish or Local Government have to be based in Scotland (Scottish Government, 2013b).

The Government SAM uses GERS specifically to compute the shares for the disaggregation of the Central Government consumption expenditure vector in section 3.5.1 (Scottish Government, 2013b).

3.4.2 Other Data Sources

The inter-governmental transfers are computed through data from two additional sources. First, the 'block grant' which the UK Government pays to the Scottish Government is from the Scotland Office (Scotland Office, 2012). This is a letter detailing the annual payments and was provided in response to a 'Freedom of Information' request. The source of the data is the Scotland Office.

Second, the total grant payment from the Scottish Government to the Local Government comes from the 'Scottish Local Government Financial Statistics 2009-10' publication (Scottish Government, 2011c). These are the official Scottish Government data for the Scottish Local Authorities, i.e. Local Government accounts. They are published annually and detail the different grants that the Scottish Government transfers to the Local Government to fund its operations.

Note that the grant payments from the two sources above are estimated since they are published in financial year format. The Government SAM is based on the 2009 calendar year, however. Thus the data are transformed by summing up a quarter share of 2008-09 data with a three quarter share of 2009-10 data. This method is employed throughout the SAM construction and disaggregation in this thesis.

3.5 Disaggregation of the Government Sector in the SAM

Section 3.3 outlined the method developed and employed in this chapter to disaggregate the Government and the Tax accounts in the 2009 SAM for Scotland. This section disaggregates the base SAM by Government and by Tax. First, the Government Consumption Expenditure vector is disaggregated. Next, the IncExp accounts are disaggregated to identify three Government accounts and three corresponding Tax accounts.

3.5.1 Disaggregation of the Government Consumption Expenditure Vector

Table 3.2.1 shows the total Government consumption expenditure of £29,486m. This is the 2009 figure for Government spending on Scottish industry output (104 industries), here aggregated to the "Activities" sector. The Government consumption expenditure is a 104×1 vector, which is the sum of the 'Central Government' and 'Local Government' consumption vectors from the IxI table. Thus, the IxI table already identifies the Local Government element of the Government consumption expenditure by 104 industries.

The Central Government vector captures both UK Government and Scottish Government spending. This needs to be disaggregated in order to identify spending by the three Government accounts. Table 3.2.2 shows that Central Government spending on Scottish industry output, here the "Activities" sector, is £19,926m for 2009.

Local Government spending on the "Activities" sector is £10,190m. Hence, the IxI table identifies the Local Government share of the total Government consumption expenditure vector for all 104 industries. The data provided by the IxI table is considered fixed, which is an assumption made for all elements of SAM computations throughout this thesis. That is to say that the Local Government share of the aggregated Government spending from the IxI table is fixed.

The next step is to identify the split between the Scottish Government and the UK Government for the 'Central Government' entry. Since, the IxI table does not provide details on which elements of Central Government spending are attributed to the Scottish Government and which to the UK Government, external data are used to disaggregate Central Government spending.

There are limited data that identify a UK versus Scottish Government split for Government consumption expenditure. However, GERS distinguishes public sector expenditure with a UK versus Scottish Government split on seven sectors[5] which correspond to the industry classification of the IxI table and the SAM. These seven sectors/industries make up over 99.6% of total Government consumption expenditure in the IxI table. The GERS data are employed to compute the seven industry specific shares and a total 'Identifiable Expenditure' share is used to disaggregate the remaining Central Government spending on Scottish industry output.

Note that the GERS data are utilised to compute the ratio of Scottish versus UK Government spending, only. The sector totals in GERS do not match the industry totals in the IxI table, which is why they cannot be used to compute the UK and Scottish shares directly (Scottish Government, 2013c, 2013b). That is to say that, the UK Government share stemming from GERS and the Local Government share stemming from the IxI table cannot be utilised without further transformations. Below is an example.

The total Government spending on the "Public Administration" sector's output is £11,050m in the IxI table and £10,623m in GERS. The IxI table identifies the Central Government spending on this sector's output of £8,548m and Local Government spending of £2,503m. Note figures subject to rounding. GERS data identify combined Scottish Government and Local Government spending on "Public Administration" of £3,434m and UK Government spending of £7,193m.

Expressed in shares, the IxI table gives a Central Government share of 77.4% and a Local Government share of 22.6% on "Public Administration" spending. GERS data identify Scottish Government and Local Government spending at 32.3% of total Government spending on "Public Administration" and UK Government spending on this sector of 67.7%.

The IxI table and GERS therefore provide a share for the Local Government consumption expenditure on "Public Administration" and a share for UK Government spending on that sector. The two shares are 22.6% and 67.7%, respectively. Using these

[5] These seven sectors are: Film, Video & TV; Broadcasting; Business Support Services; Public Administration & Defence; Education; Health; Cultural Services (Scottish Government, 2013c, 2013b)

shares, the remaining percentage of Government spending, i.e. Scottish Government spending, would be 9.7%.

Applying these shares to the total of Government consumption expenditure on the "Public Administration" sector (from the IxI table) gives: UK Government spending of £7,480m, Scottish Government spending of £1,068m and Local Government spending of £2,503m.

These figures do not correspond with the Local Government as well as the Scottish Government budget figures. These show, that Local Government spending is around £2.5bn, but that Scottish Government spending on the "Public Administration" sector is larger than Local Government spending. The figure in the Scottish budget is around £2.7bn (Scottish Government, 2008, 2011c). Therefore, the GERS data are utilised to compute the ratio of UK Government versus Scottish Government spending only.

The disaggregation of the Central Government consumption expenditure vector is detailed below. First, this is done by outlining the general method, second, by disaggregating the Central Government spending on the "Public Administration" sector as an actual example.

The first step in the disaggregation of the Central Government consumption expenditure vector, is to identify the Government shares from the IxI table. The Local Government share (Local Share) is calculated,

$$Local\,Share = \frac{IxI_{Local}}{(IxI_{Local} + IxI_{Central})} \tag{3.5.1}$$

The $Local\,Share$ is the ratio of the total spending of the Local Government (on a particular industry) divided by the combined total spending of Local Government and Central Government. The Local share is calculated through IxI data. Next, the Central Share is derived,

$$Central\,Share = 1 - Local\,Share \tag{3.5.2}$$

where the $Central\,Share$ is the difference between the combined total spending (Local Government and Central Government) minus the $Local\,Share$ calculated in Equation 3.5.1.

Next, the UK and Scottish shares need to be identified, in order to split the Central Government consumption expenditure vector,

$$UK\,Share = \frac{GERS_{UK}}{(GERS_{UK} + GERS_{Scotland})} \times Central\,Share \tag{3.5.3}$$

The $UK\,Share$ is the ratio of UK versus combined (Scottish and UK) spending from GERS, multiplied by the $Central\,Share$ from Equation 3.5.2. Dividing the UK spending by the combined spending on an industry from GERS, produces a ratio identifying GERS spending only, which, as stated above, does not match the IxI figures. Hence, this ratio is multiplied by the $Central\,Share$ in order to transform it to match the total IxI spending data. That is to say that the $Local\,Share + Scottish\,Share + UK\,Share = 100\%$.

The $Local\,Share$ and the $UK\,Share$ are computed above, thus the $Scottish\,Share$ is,

$$Scottish\,Share = 1 - UK\,Share - Local\,Share \tag{3.5.4}$$

where the $Scottish\,Share$ is the difference between total Government spending minus the shares of UK and Local Government spending. Note that the $Local\,Share$ is considered as 'given' since it is computed from IxI table data. The $UK\,Share$ is transformed, as outlined above, as it did not come from the IxI table.

However, identifying the Government shares only does not suffice to split the Central Government spending data from the IxI table. The last step is to compute the ratio of Scottish spending versus UK spending of the total Central Government spending. That is to say, the Scottish and UK ratio combined need to identify 100% of Central Government spending. The $Scottish\,Ratio$ then is,

$$Scottish\,Ratio = \frac{Scottish\,Share}{(Scottish\,Share + UK\,Share)} \tag{3.5.5}$$

which is the ratio of the $Scottish\,Share$ divided by the combined $Scottish\,Share$ and $UK\,Share$. The $UK\,Ratio$ is the difference of the total minus the $Scottish\,Ratio$,

$$UK\,Ratio = 1 - Scottish\,Ratio \tag{3.5.6}$$

The $Scottish\,Ratio$ and the $UK\,Ratio$ split all of Central Government spending. These ratios are computed for each industry separately (see Table 9.4.2 for the actual values of each industry's UK versus Scottish Government split). Note that the $UK\,Share$, $Scottish\,Share$ and $Local\,Share$, do identify all of Government spending on one sector, but the ratios are computed to split the Central Government spending only.

To help illustrate the above method, the "Public Administration" share/ratio is calculated below.

The $Local\,Share_{PA}$ is,

$$22.65\% = \frac{2,503}{(2,503 + 8,548)} \tag{3.5.7}$$

Hence the $Central\,Share_{PA}$ is,

$$77.35\% = 1 - 22.65\% \tag{3.5.8}$$

Using the data from GERS, the $UK\,Share_{PA}$ is computed,

$$52.36\% = \frac{7,193}{(7,193 + 3,434)} \times 77.35\% \tag{3.5.9}$$

Next, the $Scottish\,Share_{PA}$ simply is,

$$24.99\% = 1 - 52.36\% - 22.65\% \tag{3.5.10}$$

Note that the $UK\,Share$ and the $Scottish\,Share$ are not sufficient to split the Central Government spending. They account for a combined 77.35% (24.99% + 52.36%) of all of Government spending on “Public Administration”. Hence, in order to split the Central Government spending from the IxI table, the Scottish and UK ratios are calculated. The Scottish ratio is,

$$0.32 = \frac{24.99\%}{(24.99\% + 52.36\%)} \tag{3.5.11}$$

and the UK ratio is,

$$0.68 = 1 - 0.32 \tag{3.5.12}$$

These ratios enable the disaggregation of the Central Government spending on “Public Administration”. The figure from the IxI table is £8,548m, which becomes £5,786m for the UK Government (ratio of 0.68 of Central Government spending) and

£2,762m for the Scottish Government (ratio of 0.32 of Central Government spending). The Local Government spends £2,503m on “Public Administration”. This equals the combined £11,050m from the 2009 SAM for Scotland (see chapter 2). Note that all figures are subject to rounding.

3.5.2 Disaggregation of the Income and Expenditure Account

Table 3.3.1 outlines the differences between the aggregated (2009 SAM for Scotland) and the disaggregated (Government SAM) IncExp accounts. This section disaggregates the “Unified Government” IncExp, which is done by disaggregating each entry individually.

Table 3.2.3 gives the actual values of the aggregated IncExp accounts, which is the “Unified Government” account from Table 3.3.1. The first entry on the income side is the sum of the corresponding cells below, which is £63,530m in Table 3.2.3. This figure is equal to the total Government expenditure, which is a control total derived from GERS and PESA data (Scottish Government, 2013b; Treasury, 2012). Note that the disaggregated Government total (across all three Governments) differs from the £63,530m since inter-governmental transfers are included in the disaggregated accounts.

Income

The “Profit Income” (Cell 31 in Table 3.2.3) is computed from the ‘Gross Operating Surplus’ from industries which derive most of their revenue through Government contracts[6]. For a detailed computation of each of the IncExp accounts entries, refer to chapter 2 and Appendix 2. The focus here is on the disaggregation only.

Note that the disaggregation of both the “Profit Income” entry as well as the “Payments to Capital” entry is based on the data that is utilised for the computation of both entries in the 2009 SAM for Scotland (see chapter 2). As a result, the disaggregated SAM captures, on aggregate, the same information as the aggregated SAM.

[6]These industries are: Water & Sewerage; Public Administration & Defence; Education; Health; Residential Care; Social Work

The derivation for the “Profit Income” entry as well as for the “Payments to Capital” entry should be subject to review for future Scottish SAMs, however.

For the disaggregation of the “Profit Income” cell, a visual check of the Government consumption expenditure (see section 3.5.1) reveals which industries are linked with which Government accounts. For example, Industries 95) Residential Care and 96) Social Work, provide goods & services to the Local Government only. Hence, the ‘profit’ or ‘Gross Operating Surplus’ from these industries are assigned solely to the Local Government in the disaggregated IncExp accounts.

Some industries are linked to more than one Government account, however. These are: Education, Health and Public Administration & Defence. In order to assign the ‘profit’ share to the multiple Government accounts that are linked with these industries, shares are computed, which are multiplied by the corresponding industries’ ‘Gross Operating Surplus’ from the IxI table. The IxI figure is the control total in these calculations.

The shares are derived through the relevant Government consumption expenditure entries. For example, ‘Education’ industry’s output is purchased by all three Governments. According to the disaggregated Government consumption expenditure, the UK Government spent £2.5m, the Scottish Government £683.1m and the Local Government spent £3,588m on ‘Education’.

The share for each of the Governments’ is the ratio of their individual consumption expenditure over the sum of all Government consumption expenditure on the industry, here ‘Education’. The UK Government share for Education is,

$$UK_{Education} = \frac{2.5}{2.5 + 683.1 + 3,588} = 0.06\% \qquad (3.5.13)$$

The Scottish Government’s share for Education is,

$$UK_{Education} = \frac{683.1}{2.5 + 683.1 + 3,588} = 15.98\% \tag{3.5.14}$$

The Local Government's share for Education is,

$$UK_{Education} = \frac{3,588}{2.5 + 683.1 + 3,588} = 83.96\% \tag{3.5.15}$$

These shares are multiplied with the control total from the IxI table, the 'Gross Operating Surplus' of £462.7m. Therefore, the Profit/OVA income for the UK Government is,

$$0.06\% \times 462.7 = 0.27 \tag{3.5.16}$$

The Scottish Government's OVA income share for Education is,

$$15.98\% \times 462.7 = 73.96 \tag{3.5.17}$$

The Local Government's OVA income share for Education is,

$$83.96\% \times 462.7 = 388.47 \tag{3.5.18}$$

The method above is also applied to compute the OVA income for the Health and Public Administration industries. The total OVA income of £3,697m (see Table 3.2.3) is disaggregated to: UK Government = £529m, Scottish Government = £1,780m and Local Government = £1,388m.

The next entry in the IncExp accounts (see Table 3.2.3) is the "Net Commodity Taxes". This entry stems from data on taxes in the IxI table and includes various direct and indirect taxes[7]. The next two entries in the IncExp accounts, "Income from Households" and "Income from Corporations" capture direct tax payments from Households and from Corporations[8], respectively.

The disaggregated IncExp accounts (as well as the disaggregated SAM) change the way that taxes are captured compared to the base SAM. All taxes flow into one 'Tax account' for each Government, i.e. there are the "UK Tax", "Scottish Tax" and the "Local Tax" account now. This simplifies the analysis, in particular, of different stages of tax devolution as well as modelling the devolution of taxes to Scotland in a SAM model approach (see chapter 6).

Each of the Tax accounts' captures both direct and indirect taxes. This new system still identifies the origin of the taxes, i.e. who pays taxes, in the SAM. However, it distinguishes now more clearly which Government is assigned collection and revenue of the tax payments from the private sectors in the SAM framework. Also, taxes are still part of the corresponding Government's income.

According to the IncExp accounts, the aggregate total of taxes paid in Scotland in 2009 is £39,792m (see Table 3.2.3). The Government SAM captures the fiscal arrangement between Scotland and the UK for 2009. Hence, there are only two taxes, which are devolved to Scotland: the Council tax and the Non-Domestic rates. Both of these taxes are collected by the Local Government.

The disaggregated IncExp accounts identify that £35,221m of taxes are "UK Taxes",

[7] These taxes are: Aggregates levy; Agriculture levies; Air passenger duty; Alcohol duties; Betting, gaming and lottery duties; Channel 4 funding; Climate change levy; Fossil fuel levy; Gas levy; Hydro benefit tax; Hydrocarbon oils duty; Insurance premium tax; Landfill tax; Lottery fund; Protective duty on imports; Renewable obligation certificates; Stamp duties; Strategic Rail Authority rail franchise premia; Sugar levy; Tobacco duty (Scottish Government, 2011a)

[8] The Household taxes are: Income Tax; Capital Gains Tax; Inheritance Tax; Council Tax; Social Security Contributions (NI). The Corporate taxes are: Corporation Tax; Non-Domestic Rates; Other Taxes and Royalties; Interest and Dividends(Emonts-Holley et al., 2014)

i.e. these taxes are collected by UK Government authorities and are also part of the UK Government's income. The Council tax (paid by Households) and the Non-Domestic rates (paid by Corporations) generate a combined £3,761m, and these are "Local Taxes" in the disaggregated IncExp accounts (The UK Parliament, 1998).

Note that the combined total of the UK and Local Tax account is £38,982m[9]. The Scottish Government is not assigned any taxes here. However, further stages of fiscal devolution for Scotland, for example through the fiscal changes contained in the Scotland Act 2012 (The UK Parliament, 2012) are modelled in chapter 6.

The disaggregation of taxes is straightforward, as it simply requires taxes to be assigned to the responsible Government's corresponding Tax account. This allows both for a clearer analysis of the state of tax devolution for 2009 and any future changes to the fiscal arrangement for Scotland.

The last item on the income side of the IncExp accounts (Table 3.2.3) is the "Income from RUK" of £20,112m. This is the balancing item of the Government account. That is to say that all other entries in the Government account are based on actual figures, whereas the balancing item is used to ensure that total income matches total expenditure.

Although the "Income from RUK" does not stem from an actual figure, it is close to the revenue support that Scotland receives from the UK. GERS identifies total public sector income from Scotland as well as total expenditure in or on behalf of Scotland. It shows that there is a shortfall of £19,152m[10], i.e. the public sector expenditure is bigger than it's income from Scotland (Scottish Government, 2013b). Recall that all IxI and SAM figures used here exclude North Sea revenue, e.g. North Sea oil income is excluded.

[9]The difference compared to the IncExp accounts from the 2009 SAM is due to the treatment of the Stamp Duty. This was previously captured by both the "Net Commodity Tax" and the "Income from Households" entries. Note that this adjustment to the Tax account results in the Household account's balancing item to increase by the same amount as the adjustment in the Tax account.

[10]The annualised total public sector income is £42,124m and the annualised expenditure figure is £61,275m (Scottish Government, 2013b).

The “Income from RUK” remains the balancing item for all three Government accounts. This is therefore calculated as the last entry, after all other entries are computed/disaggregated. The value for this entry in the disaggregated IncExp accounts is discussed at the end of this section.

The above is the disaggregation of the income side from the IncExp accounts of the 2009 SAM (see Table 3.2.3). The additional entries in the disaggregated IncExp accounts (see the comparison in Table 3.3.1) are also discussed at the end of this section when the disaggregated IncExp accounts are analysed.

Expenditure

As mentioned above, the total Expenditure (£63,530m in Table 3.2.3) is the sum of the cells below. This figure is at the same time the control total for the sum of all Government expenditure. The control total for all of Government expenditure increases in the disaggregated IncExp, since inter-governmental transfers are now included. These are discussed for each Government account below.

The “IO Expenditure” entry (cell 38 in Table 3.2.3 of £29,486m) is the Government consumption expenditure. This entry is disaggregated above in section 3.5.1. The “IO Expenditure” for the UK Government is £5,924m, for the Scottish Government is £13,371m and for the Local Government is £10,190m.

The “Payments to Corporations” entry is the balancing item for the Government expenditure side in the aggregated IncExp accounts. In the disaggregated IncExp, the aggregate figure for this entry is held constant. However, it is split between the UK Government and the Scottish Government only. This is because the “Payments to Corporations” item corresponds to UK and Scottish Government expenditures on, for example, ‘Business and Enterprise development’ (Scottish Government, 2013b; Treasury, 2012). Note that the Local Government balancing item in the disaggregated IncExp accounts is the “Income from RUK”, discussed below.

The next entry in the IncExp accounts to be disaggregated is the “Payments to Households”. These are the welfare/benefit payments that the Government pays

Households. Under the Scotland Act 1998 (The UK Parliament, 1998) some of these welfare payments are devolved to Scotland, which are the responsibility of the Local Government. The Scottish Government does not make welfare payments here.

The UK Government pays welfare items such as, state pensions, income support and other social protection. The total for this is £13,519m in the disaggregated IncExp accounts. The Local Government is partly responsible for welfare payments tothe elderly, children as well as housing support. The total for the Local Government's "Payments to Households" is 6,316m. These payments are disaggregated by simply assigning the welfare payments to the corresponding Government account. The IncExp accounts of the 2009 SAM identify these payments in its calculation already.

Table 3.2.3 shows that the next entry on the expenditure side is the "Transfers to RUK" of £8,368m. This item captures the "Non-Identifiable" services that the UK Government provides on behalf of Scotland. This spending category includes several areas of public sector expenditure, such as defence and public sector debt interests (Scottish Government, 2013b). The disaggregated IncExp still assigns all of this spending to the UK Government.

The transfer payments to the External (RUK and ROW) sector are split further in the disaggregated IncExp accounts, however. The "Non-Identifiable" spending item does include payments that the UK Government does on behalf of Scotland, which flow to the ROW. These are 'International Services', 'Public Sector Debt Interest' and 'Defence'.

Hence, the "Transfers to RUK" are adjusted to £6,626m and the "Transfers to ROW" make up the remaining £1,741m. The total transfer payments to the External sector are held constant at £8,368m.

The last expenditure item is "Payments to Capital (Savings)". It is the sum of "Gross Fixed Capital Formation" (GFCF) of the sectors linked to the public sector from the IxI table, as discussed for the OVA entry above. That is to say that the industries are the same as for the OVA entry. The method is also the same, where visual inspection of the Government consumption expenditure confirms which Government account is linked to each industry.

Where only one Government account purchases the output of one industry, the GFCF is solely assigned to that Government sector. Where there are multiple Government accounts, a share is derived, which is multiplied by the control total, i.e. the GFCF entry from the IxI table. The industries' which are linked to the public sector here, are the same as under the OVA.

Table 3.5.1 shows part of the disaggregated IncExp accounts; the UK Government, Scottish Government and Local Government. The layout of the disaggregated IncExp is equal to the right-hand side of Table 3.3.1, and is discussed in section 3.3.2.

As noted above, the combined Government total is larger in the disaggregated IncExp/SAM, due to the inclusion of inter-governmental transfers. The UK Government paid a block grant of £25,303m to the Scottish Government in 2009 (Scotland Office, 2012), which is recorded as both a payment in the UK Government's account as well as under the Scottish Government's income side.

The Scottish Government paid a total of £10,644m as grant money to the Local Government in 2009. Again, note that this is an expenditure of the Scottish Government and an income for the Local Government in Table 3.5.1. The combined Government total is the sum of the UK Government total of £55,862m, the Scottish Government total of £27,082m and the Local Government total of £16,531m. Hence, the combined Government total is £99,475m in the disaggregated accounts.

Table 3.5.1: Disaggregated Income-Expenditure Accounts for Scotland (in £million)

UK GOVERNMENT			
35. **Total Income**	**55,862**	41. **Total Expenditure**	**55,862**
36. Profit income (OVA)	529	42. IO Expenditure	5,924
37. UK Taxes	35,221	43. Payments to Corporations	2,660
		44. Payments to Households	13,519
		45. Transfers to RUK	6,626
38. Transfers from Scottish Government	-	46. Transfers to ROW	1,741
39. Transfers from Local Government	-	47. Transfers to Scottish Government	25,303
40. Income from RUK	20,112	48. Transfers to Local Government	-
		49. Payments to Capital	89
SCOTTISH GOVERNMENT			
50. **Total Income**	**27,082**	56. **Total Expenditure**	**27,082**
51. Profit income (OVA)	1,780	57. IO Expenditure	13,371
52. Scottish Taxes	-	58. Payments to Corporations	3,062
		59. Payments to Households	-
		60. Transfers to RUK	-
53. Transfers from UK Government	25,303	61. Transfers to ROW	-
54. Transfers from Local Government	-	62. Transfers to UK Government	-
55. Income from RUK	-	63. Transfers to Local Government	10,644
		64. Payments to Capital	5
LOCAL GOVERNMENT			
65. **Total Income**	**16,531**	71. **Total Expenditure**	**16,531**
66. Profit income (OVA)	1,388	72. IO Expenditure	10,190
67. Local Taxes	3,761	73. Payments to Corporations	-
		74. Payments to Households	6,316
		75. Transfers to RUK	-
68. Transfers from UK Government	-	76. Transfers to ROW	-
69. Transfers from Scottish Government	10,644	77. Transfers to UK Government	-
70. Income from RUK	738	78. Transfers to Scottish Government	-
		79. Payments to Capital	25

The disaggregated IncExp balances, i.e. each account's total income is equal to its total expenditure. Each of the items in Table 3.5.1 flows direct into the Government SAM. The SAM balances automatically, since the disaggregated accounts balance. The disaggregated IncExp provide a more detailed snapshot of the public sector in Scotland in 2009 and enable more accurate modelling of the Scottish economy through a SAM model and/or a CGE model.

3.6 The Disaggregated Government Sector in the SAM

Table 3.6.1 is the Government and Tax account disaggregated 2009 SAM for Scotland. It captures the flow of funds of three Government accounts, the UK Government, Scottish Government and the Local Government, as well as three corresponding Tax accounts, UK Tax, Scottish Tax and Local Tax. The Government SAM classifies Scottish output by 104 industries, which are aggregated as the "Activities" sector in Table 3.5.1.

The disaggregation of the Government and the Tax account produces a SAM, which contains the same flows between the other sectors of the economy like the 2009 SAM for Scotland from chapter 2.

The disaggregated Government consumption expenditure as well as all entries from the disaggregated IncExp accounts flow into the SAM in Table 3.5.1. The Government SAM shows that the Scottish Government is the largest purchaser of Scottish industry output at £13,372m. The Local Government's total consumption expenditure is £10,190m the UK Government's spending is £5,924m.

Table 3.5.1 identifies that the UK Government is the largest of the public sector's in Scotland with a total of £55,862m. Second to that is the Scottish Government with a total of £27,082m and the Local Government is the smallest in terms of total income/expenditure with £16,531.

The UK Government is also the largest contributor to welfare payments to Households with £13,519m and the Local Government is responsible for another £6,316m.

The Government SAM captures inter-governmental transfers, which is new information that Scottish SAMs traditionally did not include (Hermannsson, 2012). Table 3.5.1 identifies the transfer payments, i.e. the 'block grant', from the UK Government to the Scottish Government at £25,303m. In turn, the Scottish Government pays a total of £10,644m in grants to the Local Government.

As stated above, the inclusion of inter-governmental transfers inflates the combined Government total when compared with the base SAM from chapter 2 (£99,475m

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Table 3.6.1: Government Disaggregated 2009 SAM for Scotland, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. OVA	5. Households	6. Corporations	**7. UK Government**	**8. Scottish Government**	**9. Local Government**	**10. UK Tax**	**11. Scottish Tax**	**12. Local Tax**	13. External	Total
1. Activities	63,607	-	13,981	-	49,802	-	**5,924**	**13,372**	**10,190**	-	-	-	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	5,070	25,007	**89**	**5**	**25**	-	-	-	-10,267	19,930
4. OVA	38,441	-	-	-	-	-	-	-	-	-	-	-	-	38,441
5. Households	-	63,561	-	5,289	-	15,103	**13,519**	-	**6,316**	-	-	-	4,090	107,877
6. Corporations	-	-	-	29,456	7,031	-	**2,660**	**3,062**	-	-	-	-	11,298	53,507
7. UK Government	-	-	-	**529**	-	-	-	-	-	**35,221**	-	-	**20,112**	**55,862**
8. Scottish Government	-	-	-	**1,780**	-	-	**25,303**	-	-	-	-	-	-	**27,082**
9. Local Government	-	-	-	**1,388**	-	-	-	**10,644**	-	-	-	**3,761**	**738**	**16,531**
10. UK Tax	**4,779**	-	**1,495**	-	**25,356**	**3,269**	-	-	-	-	-	-	**322**	**35,221**
11. Scottish Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12. Local Tax	-	-	-	-	**1,961**	**1,801**	-	-	-	-	-	-	-	**3,761**
13. External	40,532	-	4,455	-	18,657	8,328	**8,367**	-	-	-	-	-	10,470	90,808
Total	210,920	63,561	19,930	38,441	107,877	53,507	**55,862**	**27,082**	**16,531**	**35,221**	-	**3,761**	90,808	723,502

compared to £63,530m). However, the inter-governmental transfer payments are an important piece of information when analysing the Scottish economy's public sector.

Especially in light of the (proposed) future changes to the Scottish budget, the balance between Scottish tax powers and block grant money is key. Including the transfer payments here allows for the Government SAM to be adjusted to include "Scottish Taxes", such as the Scottish Rate of Income Tax (SRIT), and this to be balanced out with a reduction in the block grant (The UK Parliament, 1998, 2012). Furthermore, capturing these changes is allows SAM (and potentially CGE) modelling to evaluate the benefits of a more devolved fiscal framework for Scotland.

The other significant change to the traditional Scottish SAM framework, is the disaggregation of the Tax account in the Government SAM. The tax payments to the "Taxes on Expenditure" row (see Table 3.2.1) are now captured under the "UK Tax" row (see Table 3.5.1). This includes the £4,779m paid by the "Activities" sector as well as £322m from the External sector.

Note that the new treatment of taxes combines the flow of taxes for some sectors. For example, Households made payments to the "Taxes on Expenditure" sector as well as direct payments to Government in Table 3.2.1. These payments are both captured under Households paying £25,356m in taxes to the "UK Tax" account.

Additionally, the split of Tax accounts for each of the Governments operating in Scotland (UK Tax, Scottish Tax and Local Tax) allows devolved taxes to be tracked in the SAM framework now. For example, the payments from Households to Government in Table 3.2.1 included taxes devolved to the Local Government. These are now captured under the "Local Tax" account (of £1,961m) in Table 3.5.1.

The Government SAM also clearly identifies the total of regional taxes, with £35,221m for the "UK Tax" account and £3,761m fior the "Local Tax" account. The total tax income flows to the corresponding Government sector in the SAM as income.

In summary, the Government SAM provides greater detail on the public sector in Scotland. The disaggregation of both the Government and the Tax account creates a clearer framework for adjusting the changing fiscal framework for Scotland. That is to say that, the Government SAM can be adjusted to clearly show, for example, the tax and block grant changes of both the Scotland Act 2012 as well as the current Scotland Bill (The UK Parliament, 2012, 2015). This is done in chapter 6.

3.7 Conclusion

This chapter disaggregated the unified Government and Tax account of the 2009 SAM for Scotland (chapter 2) to identify three Government accounts and three corresponding tax accounts. The disaggregation introduced some changes to the SAM framework, in particular the treatment of taxes differs in the Government SAM compared to the base SAM of chapter 2. Overall, the Government SAM contains the same base information, however.

The disaggregated Government account allows for more accurate analysis and modelling of the Scottish public sector. The method developed for the disaggregation in this chapter employs publicly available data and is therefore replicable for other Scottish SAMs.

Furthermore, the disaggregation enhanced the accuracy of the traditional Scottish SAM framework. This was done through a thorough analysis of each of the components of the public sector's flow of funds in the SAM, and where necessary, adjustments were made to provide a more exact breakdown of the flow of funds for the Government and Tax accounts.

The Government SAM is the first part of a more detailed SAM framework for Scotland developed in this thesis. Next, chapter 4 disaggregates the Household account in the SAM. The disaggregated Government SAM and 'Household SAM' are subsequently linked to create a SAM for Scotland, which identifies both a disaggregated Government account as well as a disaggregated Household account.

Chapter 4

Household Account Disaggregation in the 2009 Scottish SAM

4.1 Introduction

This chapter disaggregates the 2009 Scottish SAM by Household type. Additionally, the disaggregated Government account from chapter 3 is combined with the disaggregated Household account from this chapter. This creates a Scottish SAM, which is the base for a SAM model (chapter 6) capturing three Government and three Tax accounts operating in Scotland as well as seven Household types.

Recall that the aim of this thesis is to provide the numerical and theoretical framework to model tax policies for Scotland in more detail than previously possible. By disaggregating the Household account in this chapter and combining the 'Government' and 'Household' SAM, a more detailed tracking of the flow of funds to and from the Government-and Household sector, such as through taxes and benefit payments, is possible.

So far only a small number of attempts to disaggregate the Household account for a Scottish SAM have been made e.g. De Fence and Turner (2010); Xu and Thomson (2012). There is no agreed method to build on for this chapter. The method employed here is a novel approach for the Scottish Household account. It uses the 2009 SAM Household totals (for both income and expenditure figures) as control totals and provides a full industry disaggregation (104 industries) in the SAM.

Two possible ways to disaggregate the Household sector are either by Household type, e.g. working families with children or pensioners, or by income group, e.g. quintiles. This chapter disaggregates the Household account by type, as this matches the intended study of and provision of a framework (for the Scottish Government) to analyse current policy relevant questions. For example, the effect of income tax changes on households with children as well as tackling wealth inequality across households (Scottish Government, 2015c).

This chapter disaggregates the Household account by seven types. These are: 1) Working without children, 2) Working with children, 3) Non-working without children, 4) Non-working with children, 5) Pensioners, 6) Multiple tax units without children and 7) Multiple tax units with children. All Types capture both single households as well as couples living together. Note that the Scottish Government's research objectives informed the classification of the Household types.

A Household is 'working' if there is at least one adult in employment, including self-employment. "Pensioners" refers to a household where all household members of working age or above receive a pension as their main source of income. Types 6) and 7) identify households that are not captured by the former definitions. For example, Households that have more than 2 working adults or a mix of pensioners and working or non-working adults.

The Scottish IxI table used for the construction of the 2009 SAM (see chapter 2) has one Household consumption sector, with data for the Household income account stemming from additional sources (Scottish Government, 2013c). The sources used for the construction of the (aggregated) 2009 SAM do not identify individual Household types. Therefore, additional data are needed to disaggregate the SAM by Household type.

This chapter uses three external sources to identify different Household types in the SAM, the Living Cost and Food Survey (LCFS), the Household Final Consumption Expenditure (HHFCE) from the 2009 UK Supply and Use Table and the Intra-Governmental Tax and Benefit Model (IGOTM) of which the Scottish Government holds a variant (ONS, 2011b, 2014, 2015). The LCFS and IGOTM data are for Scotland, whereas the HHFCE data are UK based. These three sources contain sufficient data in order to disaggregate both the part of the SAM based on the IxI table as well as the additional part of the SAM constructed through the use of external data (see 2).

This chapter is structured as follows. Section 4.2 outlines the aggregated Household account in the 2009 SAM and analyses how the account can be disaggregated with reference to previous disaggregation methods. Section 4.3 outlines the method employed for the disaggregation and section 4.4 describes the data used. Section 4.5 disaggregates the Household account. Section 4.6 links the disaggregated Household and Government Accounts and section 4.7 provides more detail on the fully disaggregated SAM through some summary statistics. Section 4.8 concludes.

4.2 The Household account in the SAM

The 2009 IxI table has one Household consumption account and the 2009 SAM has one Household account capturing both consumption and income. The IxI table provides the framework and main data source for the SAM. However, the Household account for the SAM requires a significant input from external data sources.

This section starts with a brief overview of how the Household account is computed in the 2009 Scottish SAM as a means of review before the following sections detail the Household disaggregation[1]. Next, a brief overview of recent papers disaggregating the Household account in a UK and a Scottish SAM concludes this section.

Table 4.2.1 shows the aggregated 2009 IxI table. It shows that the Household sector in the Input-Output IxI table purchases goods & services from the Activities sector, from the Rest Of the UK (RUK) and from the Rest of the World (ROW). Additionally, Households make payments to the Government, which are indirect tax payments. e.g. VAT. However, the IxI table does not identify any flows from any sector to Households, e.g. wage income and Government benefit payments.

[1] Note that chapter 2 describes in detail how the SAM is built and how each entry for the Household account is calculated.

Table 4.2.1: Aggregate Industry-by-Industry IO Table, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. OVA	5. Households	6. Government	7. RUK	8. ROW	Total
1. Activities	63,607	-	13,981	-	49,802	29,486	36,879	17,166	210,920
2. Labour	63,561	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	-	-	-	-	-
4. OVA	38,441	-	-	-	-	-	-	-	38,441
5. Households	-	-	-	-	-	-	-	-	-
6. Government	4,779	-	1,495	-	6,568	-	193	129	13,165
7. RUK	30,274	-	3,358	-	13,875	-	4,362	2,890	54,759
8. ROW	10,258	-	1,097	-	4,424	-	3,057	161	18,997
Total	210,920	-	19,930	-	74,669	29,486	44,491	20,346	

Source: Scottish Government (2013a)

Table 4.2.2 is an aggregated version of the 2009 SAM with one "Activities" sector and one Government sector[2]. The SAM expands on the IxI table and captures more flows of funds from Households to the rest of the economy as well as identifying flows of funds to Households. The SAM identifies additional Household expenditure (total at £107,877m) compared to the IxI table (total at £74,669m). This increase is made up of spending on sectors already associated with household consumption, such as additional spending on the RUK and ROW sectors.

Also savings, which are captured by spending on the Capital sector of £5,070m, as well as of additional tax payments to the Government sector (a rise from £6,568m to £27,947m). For more details on the breakdown of each of those entries see chapter 2. Note, that the SAM identifies Household income (see the Household row), which is not found in the IxI table. The additional data are calculated in the balanced Income and Expenditure account (IncExp), see section 4.5.

[2]Recall that chapter 3 disaggregated the SAM by Government, but the Household account remained aggregated.

Table 4.2.2: Aggregated 2009 SAM for Scotland, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Households	6. Corporations	7. Government	8. RUK	9. ROW	Total
1. Activities	63,607	-	13,981	-	49,802	-	29,486	36,879	17,166	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	5,070	24,828	119	- 5,217	- 4,871	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	38,441
5. Households	-	63,561	-	5,289	-	15,103	19,835	1,853	2,237	107,877
6. Corporations	-	-	-	29,456	6,401	-	5,722	5,964	5,964	53,507
7. Government	4,779	-	1,495	3,697	27,947	5,248	13,165	20,234	129	76,694
8. RUK	30,274	-	3,358	-	14,113	3,768	8,368	4,362	2,890	67,133
9. ROW	10,258	-	1,097	-	4,544	4,560	-	3,057	161	23,676
Total	210,920	63,561	19,930	38,441	107,877	53,507	76,694	67,133	23,676	

Table 4.2.2 shows the aggregated Household account cells, which need to be disaggregated in order to identify different Household types. As noted above, all entries in the Household row (income account) are created using external data sources (not from the IxI table). The expenditure on "Activities" is the only entry in the Household column that is solely derived from the IxI table. All other entries are computed using both data given in the IxI table and external sources or just from external data. Recall that since the IxI table identifies only one Household sector, it cannot be used to disaggregate this account.

The other main data sources used in the construction of the Household account, mainly the Government Expenditure and Revenue Scotland (GERS) publication and the ONS Blue Book (Scottish Government, 2013b; ONS, 2013b) which make up around half of all IncExp account entries (see chapter 2, section 2.4.1), identify only one Household account, too. The disaggregation of Households in the SAM thus needs external data sources additional to those already used in constructing the aggregate SAM.

However, the values calculated for all Household entries in the 2009 Scottish SAM are taken as control totals, and this mirrors the method employed for the Government account (see chapter 3). Therefore, the fully disaggregated SAM can be collapsed to a single Household and/or Government sector, and the entries for each cell are identical to that of the 2009 SAM.

The construction of UK and Scottish SAMs around IO Accounts is done on a regular basis in the updating of the standard *AMOS* model. However, as stated earlier, the Household account has only been disaggregated a small number of times.

McNicoll and McLellan (2003) extend the 1999 Scottish IO tables by introducing internal satellite accounts for different household income classes. Dewhurst (2006) disaggregates the 2001 Scottish IO tables by age and also identifies single households, and households with children.

De Fence and Turner (2010) disaggregate the Household sector of a 2004 UK IO Table and SAM by income groups. They used gross income for five household groups in order to divide the Household account into quintiles. De Fence and Turner (2010) use an income share spent on the products of a sector in order to determine the total expenditure of each quintile on the specific sector. It uses a six-sector aggregation of all industries in the IO Table and the SAM. Thus the shares calculated in De Fence and Turner (2010) cannot be applied in this case, which uses the full 104 IO sector disaggregation.

Xu and Thomson (2012) disaggregate the Household account of a 2007 SAM for Scotland by income quintiles and by urban-rural location. Their paper employs the same methodology as De Fence and Turner (2010) but applies the disaggregation to Scotland, instead of the UK, but for a SAM only. Note that it is not possible to extract the disaggregated Household consumption account for the IO accounts from this. Here, the economy is split into eleven industrial sectors, thus again producing a dataset limited to the initial aggregation, which does not allow for a more disaggregated industry structure. In summary, current attempts at disaggregating the Scottish or UK Household sectors produce a limited dataset, which restricts wider applicability.

This chapter contributes to the current regional research employing disaggregated IO and SAMs in three distinct ways. First, the Household account is disaggregated by Household type. Second, Household consumption expenditure is disaggregated by 104 industries. Third, the method employed can be replicated easily in order to either update the dataset or chose a different level or kind of household disaggregation, for example by income group or different Household types than specified here. The next section describes the method employed for the disaggregation by Household type.

4.3 Method

This section outlines how the Household account in the SAM is disaggregated. A bottom-up approach is employed where the individual Household entries from the IxI table and from the IncExp account are firstly estimated and subsequently matched to the SAM control totals. That is to say, summing up all disaggregated Household entries match the aggregated Household entries of the 2009 SAM for Scotland computed in chapter 2 (also see section 4.2).

This method used for the disaggregation of the Household account by type, offers a full 104 industry disaggregation, as in the IxI table and in the SAM. Furthermore, the method is replicable for Scottish SAMs based on different base years and with flexible sectoral aggregation to match the intended research objective. Although the data sources will be briefly touched upon here, the next section (4.4) discusses these in full.

There are two distinct parts to the disaggregation of the Household account in the SAM. The first part is the disaggregation of the consumption expenditure vector, which stems from the IxI table. The second part is disaggregating the IncExp account, which captures all the income and expenditure flows of all seven Household types. Sections 4.3.1 and 4.3.2 outline the approach taken to disaggregating each part, respectively. These parts are outlined below and described in detail in section 4.5.

4.3.1 Method - Household Consumption Expenditure

For the first part, the Household consumption vector from the IxI table identifies a unified Household sector that purchases goods & services from 104 industries, i.e. this is a 104×1 vector. The goal for a full industry disaggregation (104 sectors) by the seven Household types is to separate the Household consumption vector into a 104×7 matrix. This matrix identifies each Household type's consumption expenditure by industries, where the aggregate consumption expenditure by industries equals the initial, 104×1, Household consumption vector from the IxI table.

Table 4.3.1 provides a detailed overview of the matrices and vectors employed for the disaggregation of the Household consumption expenditure. The first column in the table gives the name of the matrix/vector, which is followed by a description of the data and its source, in the following columns. Furthermore, Table 4.3.1 identifies the dimensions and units for each matrix/vector as well as additional 'Comments'. Table 4.3.1 is aimed at providing a reference guide for the reader.

Table 4.3.1: Household Consumption Expenditure Vector Disaggregation: Matrix Overview

Matrix/ Vector	Description	Source	Dimensions	Units	Comments
K	Household consumption by spending category and household type	LCFS	12×7	12 spending categories by 7 Household types	UK data, in £m, purchaser price, COICOP
L	Household final consumption expenditure (HHFCE)	UK Supply & Use Table	106×42	106 products by 42 industries	UK data, in £m, basic price, CPA & COICOP
A_1	Aggregation matrix 1	Self-constructed	42×12	Binary matrix	Matrix matches industries to enveloping spending categories
L_A	Aggregated HHFCE	Constructed through matrix multiplication	106×12	106 products by 12 spending categories	UK level, in £m, basic price
A_2	Aggregation matrix 2	Self-constructed, following ONS guidelines	104×106	Diagonal matrix in percentages	Matrix matches products to corresponding industries
M	Transformed HHFCE	Constructed through matrix multiplication	104×12	104 industries by 12 spending categories	UK level, in £m, basic price
A_3	Aggregation matrix 3	Self-constructed	104×104	Diagonal matrix	Elements are inverse of corresponding column totals from M matrix
B	'Bridge'-matrix	Constructed through matrix multiplication	104×12	104 industries by 12 spending categories	Matrix identifies % of industry output used for total HH consumption by spending category, column sum = 1
hh_i	ith Household type consumption expenditure vector	Constructed through matrix multiplication	104×1	104 industries by ith Household type	Industry share of ith Household's consumption
hh_T	Total Household consumption expenditure matrix by HH type	Constructed through vector addition	104×7	104 industries by 7 Household types	Combined shares of Household consumption by industry
A_4	Aggregation matrix 4	Self-constructed	104×104	Diagonal matrix	Elements are inverse of corresponding row totals from hh_T matrix
hh_F	Total Household type consumption expenditure matrix	Constructed through vector addition	104×7	104 industries by 7 Household types	Combined shares of Household consumption by industry and HH type
IxI_{HH}	Household consumption expenditure from IxI table	Scottish Government	104×104	Diagonal matrix, 104 industries and unified Household sector	Matrix elements are the entries from the HH consumption vector from the IxI table, control total for disaggregation, SIC07
HH	Final disaggregated Household consumption expenditure	Constructed through matrix multiplication	104×7	104 industries by 7 Household types	Row sums equal corresponding industry entry from IxI_{HH}

The first step in obtaining the above-mentioned 104×7 Household consumption expenditure matrix, is to obtain Household spending data disaggregated by Household type. The Living Cost and Food Survey (LCFS) identifies Household consumption expenditure by the seven Household types specified above (ONS, 2011b). However, the data are classified in "Classification of Individual Consumption according to Purpose" (COICOP), not in the Standard Industrial Classification (SIC07) like the IxI table, and the data are given in 12 broad spending categories (see section 4.4 for details on the classifications). Hence, the LCFS data are given as a 12×7 matrix, K, tracking the flows of Household consumption expenditure between the 12 spending categories and the 7 Household types.

The issue now is to link the 12 spending categories to the 104 industries. There is no data source which can directly link and disaggregate the 12 COICOP spending categories to the 104 SIC07 industries. Therefore, this chapter constructs a matrix which can link these, henceforth referred to as the 'bridge'-matrix. This matrix tracks the flows between the 12 spending categories and the 104 industries, hence it is a 104×12 matrix.

The 'bridge'-matrix identifies the shares of these flows, where each entry is divided by the corresponding column total, resulting in each column total of the 'bridge'-matrix summing up to one. That is to say that the 'bridge'-matrix identifies the shares of the basket of commodities (by industry) that is required in order to produce 1 unit of final Household consumption expenditure demand by spending category.

Table 4.3.2 provides further reference for the reader. For example, it shows the steps of how the HHFCE data is transformed into the 'bridge'-matrix. Also, it captures the steps of disaggregating the base information on Household type consumption contained in the K matrix into the disaggregated Household type consumption expenditure matrix by 104 industries. Table 4.3.2 captures each of the matrices or vectors identified in Table 4.3.1, including their dimensions. This table is aimed at aiding the reader in this section and in section 4.5 in particular. Note that the steps outlined in Table 4.3.2 are discussed in detail in section 4.5.

Table 4.3.2: Household Consumption Expenditure Disaggregation: Matrix Computation Overview

1)	$\underset{106 \times 42}{L}$	$\times$	$\underset{42 \times 12}{A_1}$	=	$\underset{106 \times 12}{L_A}$
2)	$\underset{104 \times 106}{A_2}$	$\times$	$\underset{106 \times 12}{L_A}$	=	$\underset{104 \times 12}{M}$
3)	$\underset{104 \times 104}{A_3}$	$\times$	$\underset{104 \times 12}{M}$	=	$\underset{104 \times 12}{B}$
4)	$\underset{104 \times 12}{B}$	$\times$	$\underset{12 \times 1}{K_i}$	=	$\underset{104 \times 1}{hh_i}$
5)			$\sum_{i=1}^{7} hh_i$	=	$\underset{104 \times 7}{hh_T}$
6)	$\underset{104 \times 104}{A_4}$	$\times$	$\underset{104 \times 7}{hh_T}$	=	$\underset{104 \times 7}{hh_F}$
7)	$\underset{104 \times 104}{IxI_{HH}}$	$\times$	$\underset{104 \times 7}{hh_F}$	=	$\underset{104 \times 7}{HH}$

The 'bridge'-matrix is based on the Household Final Consumption Expenditure (HHFCE) table from the 2009 UK Supply and Use table (ONS, 2014). This table tracks Household consumption expenditure by products and industries and it is a 106×42 matrix, L. The rows of the HHFCE table are classified in the "Classification of Products by Activity" (CPA) 2008 and the columns are in COICOP. There are two initial problems with the HHFCE data that need to be addressed. First, the format of the matrix needs to be transformed from a 106×42 matrix, L, to a 104×12 matrix, L_A (see Table 4.3.2).

The L matrix is transformed into the L^A matrix, where the 42 columns identifying industries are aggregated into 12 broad spending categories, which match those of the LCFS data. This aggregation is done by multiplying the L matrix with the A_1 (see Table 4.3.1). Note that the A_1 is self-constructed, through manually matching industries to spending categories.

Second, the row classification of the L_A need to be transformed. The 'bridge'-matrix identifies industry by spending category flows, whereas the HHFCE matrix tracks product by industry flows. This process is a standard conversion method also employed by the ONS and produces a converted table which retains the information from the raw data more accurately (ONS, 2011a). Matching the 106 products to 104 industries produces a new 104×12 matrix, M, which identifies Household consumption expenditure industry by spending category.

The second equation in Table 4.3.2 shows that the 106 products are matched to 104 industries by pre-multiplying the L_A matrix with the aggregation matrix A_2 (see Table 4.3.1 for reference). The A_2 matrix is again self-constructed, by manually matching products to industries, following the approach outlined by the ONS (ONS, 2011a). This process is discussed in more detailed in section 4.5.

The M matrix now has the correct format for the 'bridge'-matrix. Pre-multiplying the M matrix by the A_3 matrix (see Table 4.3.1 for reference) effectively divides each entry in the M matrix by the corresponding column total. This produces the final 'bridge'-matrix.

In order to disaggregate the Household consumption expenditure for each Household type, the corresponding Household vector from the LCFS's matrix, K is multiplied by the 'bridge'-matrix. This produces seven 104×1 matrices, hh_i, which track the flows between the individual Households, i, and the 104 industries.

The totals of each of the seven Household vectors are equal to the corresponding Household total from the LCFS data. Combining these vectors produces a 104×7 matrix, hh_T, which identifies total Household consumption expenditure by industries and Household type. The data from the LCFS, however, do not match total consumption in the IxI table. Therefore, the hh_T matrix identified above, needs to be transformed.

Pre-multiplying the hh_T matrix with the aggregation matrix A_4 (see Tables 4.3.1 and 4.3.2) produces a new 104×7 matrix, hh_F. This step effectively divides each entry of the hh_T matrix by the corresponding row total. Hence, the hh_F matrix now identifies the percentage of industry output by Household type. That is to say that the rows in the hh_F matrix sum up to one.

The final step is to pre-multiply the hh_F matrix with the control totals from the IxI table, IxI_{HH}. This 104×104 matrix is a diagonal matrix, where each entry corresponds to the the industry total of Household consumption expenditure from the IxI table. The final matrix, HH, is a 104×7 matrix, which is the disaggregated Household consumption expenditure by seven Household types. That is to say that this matrix can, as stated above, be aggregated up to the 104×1 vector from the IxI table.

4.3.2 Method - Household Income and Expenditure Account

The second part of the disaggregation of the Household account in the SAM is identifying seven Household types in the IncExp account. The IncExp captures all Household income and expenditure that the SAM also identifies, which includes the Household consumption expenditure discussed above. The full IncExp account also identifies the income and expenditure of the Corporate, Government, Capital and External account. Some entries are linked between these accounts as corresponding figures. For example, Households make payments to the Government, which are also identified as Government income from Households. Hence, disaggregating only the Household account in the IncExp account is sufficient, as any corresponding flows between accounts are captured simultaneously.

The IncExp account is disaggregated by first estimating each entry. This is done through several data sources, which provide data on Household income and expenditure disaggregated by the seven Household types. Recall from chapter 2 section 2.4 that the IncExp account identifies six individual income sources and six individual expenditure categories, which balance on aggregate and are equal to the Household Total in the SAM. All of the Household income entries and one of the expenditure entries are estimated through data from the Scottish Government's variant of the IGOTM model.

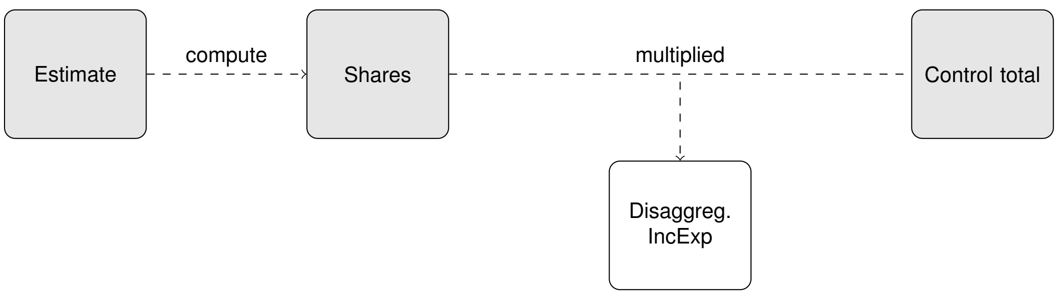
Four expenditure entries are estimated from LCFS data (this includes the IxI disaggregation, which also flows through the IncExp account). The remaining expenditure entry ("Transfers to RUK") is disaggregated through imputing the entries, since there are no matching data to estimate this entry. Note that the method of imputing this entry mirrors the approach used in building the base IncExp account.

The estimated entries in the IncExp account do not match the control totals from the 2009 SAM IncExp account. Therefore, the estimated IncExp is used to compute shares which are subsequently multiplied by the control totals. That is to say that the estimated IncExp accounts are transformed into shares, where each entry is divided by the sum of the corresponding entries across Household types.

For example, total income for each Household is divided by the sum of all total incomes across the seven Household accounts. The relevant share is then multiplied with the control total, which produces IncExp accounts that are disaggregated by seven Household types. Thus all seven total income figures sum up to the control total from the 2009 SAM.

This process is illustrated in Figure 4.3.1. The estimated IncExp account is used to compute the shares, which are multiplied with the control total in order to produce the disaggregated IncExp account.

Figure 4.3.1: Household Disaggregation of the IncExp Account



All data used for the disaggregation of the Household consumption expenditure vector from the IxI table are for 2009 or centred around 2009 (see section 4.4 for details). The data from the Scottish Government's variant of IGOTM are for 2013. The data sources provide sufficient information to identify most of the income and expenditure entries for the disaggregated Household account, but not complete coverage.

Where there is a lack of data, as for some of the expenditure entries for the disaggregated Household accounts, the missing entries are imputed. However, this is done in a manner consistent with the construction of the base SAM. For example, the estimated figures do not provide information on the expenditure item "Transfers to RUK" (see Table 4.5.1). Using the base SAM's entry for this as a control total, the different Household types are assumed to transfer the same share to the RUK as they do to the ROW, for which data are available.

The method employed for the disaggregation of the Household account identifies Household consumption expenditure by 104 industries as well as all entries of the IncExp account for seven Household types. Data availability is of crucial importance for an accurate estimate of each Household type account. The method employed here is affected by the lack of information on some entries.

A key assumption of the disaggregation outlined above is that data presented in different classifications can be matched to each other. This implies, for example, that the 'bridge'-matrix can match entries classified as products to industries (see (ONS, 2011a) for details on the classifications). Overall, however, this method can be replicated for Scottish SAMs using other base years as well as for SAMs for other regions/nations. Section 4.4 discusses the data used for the disaggregation of the Household account by type and section 4.5 discusses the disaggregation in detail.

4.4 Data

This section outlines the data used in the disaggregation of the Household account. The data for the disaggregation come from additional external sources, since the original sources for the construction of the (aggregated) SAM identify only one Household sector. The different Household types are disaggregated using the method outlined above with data from the Living Cost and Food Survey (LCFS), the Household Final Consumption Expenditure (HHFCE) from the 2009 UK Supply and Use Table and the Intra-Governmental Tax and Benefit Model (IGOTM) of which the Scottish Government holds a variant (ONS, 2011b, 2014, 2015).

Recall that the LCFS provides the disaggregation of seven Household types by spending categories. The HHFCE identifies Household purchases at product-by-industry level. And IGOTM provides the disaggregated Household income as well as tax payments for the IncExp account. The remainder of this section outlines each of the data sources in detail and critically analyses the data employed in the disaggregation.

4.4.1 The Living Cost and Food Survey

The Living Cost and Food Survey (LCFS) is an annual survey, based on the European standard "Classification of Individual Consumption by Purpose" (COICOP)[3]. The survey collects detailed information on household expenditure, including tax payments as well as information on household income, including wage-and benefit income. Thus the data do not provide individual income and expenditure details, but identifies these on the household level.

The LCFS defines a household as "one person or a group of people who have the accommodation as their only or main residence" (ONS, 2011b). The sample of the survey is 'a multi-stage stratified random sample with clustering'. Thus, it ensures that all regions in Great Britain are accounted for, whilst randomly selecting households from within that region. The LCFS dataset includes both the 'raw variables' as well as the 'derived variables'. This study uses the latter, as only these variables categorise household income and expenditure by, for example, Household characteristics and region (ONS, 2011b).

[3]COICOP is one of the functional classifications in the System of National Accounts 1993, adapted for Europe as the European System of Accounts 1995. As well as being used for Household Final Consumption Expenditure (HHFCE), as published in Consumer Trends, it is also used for household budget surveys. These are adopted for the UK Living Costs and Food Survey, and international comparisons of Gross Domestic Product (ONS, 2009).

Data for the survey are collected through two channels. First, there are interviews with household members and second, household members are asked to maintain spending diaries for a fortnight. The interviews comprise two parts, a general "Household Questionnaire", which identifies the household's characteristics, such as size, age of members, employment status, etc.

The second part is the "Income Questionnaire" that follows straight on from the first questionnaire and collects details on the sources and amount of household income as well as which members of the household contribute to the total income. Both questionnaires are usually answered by the Household Reference Person (HRP). The HRP is defined in most instances as either the householder who "owns the household accommodation, or is legally responsible for the rent of the accommodation". When there are joint householders, the person with the higher wage or alternatively the eldest householder is chosen to be the HRP. Note that the HRP replaces the "Head of Household" concept (ONS, 2011b).

The spending diaries form the base of the information on household expenditure. These diaries are kept by every spender in the household who is 16 or over. Each household has, however, an assigned "Main Diary Keeper" (MDK). This is the person in the household who "is normally responsible for most of the food shopping". Thus the biggest share of the expenditure data for each household is collected through the information supplied by the MDK.

The expenditure data collected in the spending diaries are broadly limited to current expenditure on goods and services. Hence, savings and investment expenditures are excluded. Due to the nature of the questionnaires and the spending diaries, the information on household income and expenditure is in retail prices. Also note that the data collection process is done throughout the year to avoid any seasonal effects (ONS, 2011b).

The LCFS categorises persons aged 16 and over as either 'economically active' or as 'economically inactive'[4]. Furthermore the survey is disaggregated by regions in

[4]'Economically active' identifies persons who are: Employees at work, Employees temporarily away

the UK, identifying Scotland as a single region (ONS, 2011b)

4.4.2 UK Supply and Use Table - Household Final Consumption Expenditure

The UK Supply and Use Tables are part of the input-output framework of the European System of Accounts and they provide the basic building blocks for the Symmetric Input-Output Tables, such as the IxI table. The Supply and Use Table identify the production, income and expenditure measures of GDP. Hence, when combined and balanced, they provide a single measure of annual current price GDP, which integrates the components of gross value added, inputs and outputs, and final demands.

The Supply Table provides estimates of the output of a large number of differentiated products by each industry and the Use Table provides estimates of the inputs (of products) used by each industry to produce their own output. The data are presented in basic prices, which is a price unit that excludes any taxes but includes potential subsidies received by the producer. Note that this is the same price as the IxI and the SAM use. The tables cover the following aspects of the national accounts framework: 1. Goods and services account; 2. Production accounts by industry and sector; and 3. Generation of Income Account by industry and sector (Scottish Government, 2015b; Eurostat, 2008; ONS, 2006).

The Household Final Consumption Expenditure (HHFCE) is a key component of the Supply and Use Table, as it is 'the most important macroeconomic variable' on the expenditure side of the national accounts. The data for the HHFCE is mainly obtained through consumer expenditure surveys, such as the LCFS detailed above, and the HHFCE is also coded in the COICOP classification. The data are categorised into ten main purposes, which correspond, on aggregate, to the twelve product groups in the LCFS[5].

from work, Government supported training schemes, Self-employed, Unemployed or Unpaid family workers. 'Economically inactive' identifies persons who are: Retired or Unoccupied

[5]The ten main expenditure purposes are: 1. Food, beverages, and tobacco; 2. Clothing and footwear; 3. Housing, water, electricity, gas, and other fuels; 4. Furnishings, households equipment, and routine maintenance of the house; 5. Health; 6. Transport; 7. Leisure, entertainment, and culture; 8. Education; 9. Hotels, cafes, pubs, and restaurants; 10. Miscellaneous goods and services.

The construction of the HHFCE is structured as follows, first detailed data on consumption expenditure are collated and categorised into the ten main expenditure purposes, thus providing a 'use' breakdown. These data are subsequently matched to both 'commodity flows' and that of retail trade sales. Thus the HHFCE bridges household consumption expenditure data with data provided on a broader macroeconomic/industrial level (Eurostat, 2008).

4.4.3 Intra-Governmental Tax and Benefit Model

The Intra-Governmental Tax and Benefit Model (IGOTM) is a microsimulation model of the UK tax and benefit system, which is maintained by HM Treasury. The data used in this chapter are provided by and stems from the Scottish Government's variant of the IGOTM model for Scotland. IGOTM is generally used to estimate the impact of tax and benefit changes on household incomes. This chapter, however, uses the raw data on income and expenditure variables of Scottish households, which can be extracted by Household types or quintiles. For example, IGOTM captures most personal and indirect taxes, tax credits and benefits which makes it essential for the disaggregation of households as no other data source does this for Scotland (HMRC, 2012).

The input data for IGOTM comes from the Living Costs and Food Survey (see above) (ONS, 2011b) and the Family Resource Survey, both of which provide information on income, expenditure and important family characteristics (Department for Work and Pensions, 2015b). Note that static microsimulation models such as IGOTM lack the behavioural responses that a Computable General Equilibrium (CGE) model captures. For example, changes in the level of benefits of households does not change labour supply, whereas a change in this variable is typically modelled in a CGE model, such as AMOS. Nevertheless, the input data to IGOTM, which is what is used here, enables the disaggregation of the Household account in the SAM in a manner consistent with the data work on the 2009 SAM for Scotland (ONS, 2015).

4.4.4 Critical Analysis of the Data

First, a note on the type of Input-Output Table used here. There are two types of IO table, product-by-product (PxP) and industry-by-industry (IxI). The former provides details on the technological relations between products and homogeneous units of production. On an intermediate level, it gives the volume of products used to create the final product. Thus, it assumes the production of goods of a certain industry are made up of the same mix of intermediate inputs (Eurostat, 2008).

In contrast, IxI IO table details the interdependencies of industries for the production of their goods & services. These tables are closer to statistical sources and actual observations. Both tables have their use in economic analysis and it depends on the type of study, whether PxP or IxI is more suited. Generally, the latter are deemed better for the study of tax reforms and other fiscal interventions (Eurostat, 2008). Since the aim of this thesis is to provide an analysis of changes to the fiscal framework for Scotland as well as income tax simulations, the IxI table provides the more suitable database.

The bridging of the household consumption expenditure data (LCFS) to the spending on industry level (IxI) is based on several assumptions of data compatibility and accuracy of the survey data used here. The LCFS data are largely dependent on the input of the Household Reference Person, which might be a source of inaccuracy in failing to capture all income and expenditure flows to and from the household. Also, the diary process of noting down every expenditure for a fortnight is subject to the accuracy of the diary holder and thus might not capture all expenditures fully and accurately.

Furthermore, the sample size of the LCFS for the Scottish subset is small, but sufficient. Given the total of 11,482 households who participated in Great Britain, the Scottish household response rate is approximately 965 households for 2009 (this is calculated using the Scottish population share of 8.41% as used in the 2009 Scottish SAM.). Since this chapter splits these responses into sub-groups, i.e. seven Household types, 2008, 2009 and 2010 survey data are combined. This provides a bigger sample size around the base year (2009) and ensures more robust estimates for the highly disaggregated household data.

The HHFCE dataset provides a good estimate for converting the LCFS data to a more disaggregated product level. However, this does not match accurately with the industry-level data given in the IxI table, to which it is converted here. As stated above, the PxP and IxI Tables identify the interdependencies in an economy in distinct manners, which are not consistent with each other. Lastly, the data obtained through IGOTM are again based on a small sample size. Further, this chapter uses raw data from a 2013 calibrated model, as no other data are available. Therefore, the approach employed with the LCFS, that is building up the sample size through the use of data around the base year, is not possible here.

Additionally, the data in IGOTM are provided through several datasets and then converted for Scotland, which limits its accuracy in capturing actual income and expenditure data by Scottish households. Finally, the external data sources used for the disaggregation of the Household account are coded in COICOP, which is different to the SIC07 used in the IxI table and thus in the SAM. Therefore any data extracted from IGOTM and the LCFS needs to be mapped to the classification used in the SAM.

This section has detailed the data sources used in the disaggregation of the Household account by type in the 2009 Scottish SAM. There is no single data source, which enables this disaggregation and, as discussed above, there are apparent shortfalls in matching the data from the LCFS to the HHFCE and from IGOTM to the IxI table and the IncExp account.

The data sources and method employed here, however, match the different household consumption expenditure breakdowns as accurately as possible. The step from broad spending categories to the 104 industries in the SAM is done using shares, thus avoiding any inconsistencies in the totals of the various household accounts as well as national accounts data, hence using quality data sources.

4.5 Disaggregation

Section 4.3 outlined the disaggregation of the Household account in the SAM in broad terms. This section details the disaggregation. There are two distinct parts to disaggregating the Household account in the SAM. The first is disaggregating the Household consumption expenditure vector from the IxI table by 104 industries in Scotland. The second is disaggregating the Income and Expenditure (IncExp) account to identify seven individual Household accounts.

Recall that Table 4.3.1 and 4.3.2 provide references for the matrices/vectors and the various matrix computations detailed above. Table 4.3.1 lists key information for each of the matrices/vectors, for example, the source of the data and the units that the data are in. Table 4.3.2 details the matrix transformations that result in the disaggregation of the Household consumption expenditure.

4.5.1 Household Disaggregation of the Household consumption vector

The Household consumption vector in the SAM stems from the Scottish IxI IO table. It identifies a unified Household account for Scotland, which purchases goods & services classified by 104 industries. The goal for the disaggregation of the Household consumption expenditure vector, IxI_{HH}, which is 104×1, is to identify spending on Scottish industry output by Household type. The disaggregated vector is then transformed through matrix multiplication into a 104×7 matrix, which tracks the flows between 104 industries and 7 Household types.

The first part of the disaggregation is to obtain data that identify Household consumption spending by Household type. The LCFS identifies twelve spending categories from which Households purchase goods & services in a given year. These are: Food & non-alcoholic drinks; Alcoholic drink, Tobacco & narcotics; Clothing & footwear; Housing, fuel & power; Household goods & services; Health; Transport; Communication; Recreation & Culture; Education; Restaurants & Hotels; Other Goods & Services (ONS, 2011b). The survey provides a total for the annual expenditure by the seven Household types, specified above, on each of the 12 spending categories. Representing the data in matrix form,

$$K = \begin{bmatrix} k_{1,1} & \cdots & k_{1,7} \\ \vdots & \ddots & \vdots \\ k_{12,1} & \cdots & k_{12,7} \end{bmatrix} \tag{4.5.1}$$

where K is a 12×7 matrix. The jth row identifies one of the 12 spending categories and the ith column identifies one of the 7 Household types. Summing up all elements in a row, j gives the total spending on one category across all households. Conversely, the sum of all elements in a column, i, is equal to total spending by the corresponding Household type. Thus, the K matrix provides individual Household type consumption expenditure categorised by spending category. Table 9.5.1 gives the actual values for the K matrix in £million. It shows that Household Type 1 and 2 have the highest current expenditure on goods & services and that total Household expenditure is largest on 'Transport' and 'Recreation and Culture'.

The information contained in the K matrix identifies expenditure on 12 broad spending categories by Household type. These data are the first part in disaggregating the Household consumption vector from the IxI table. However, the 12 spending categories need to be matched to 104 industries in order to (fully) disaggregate the Household consumption vector. For this, a 'bridge'-matrix needs to be computed, as outlined in Section 4.3. The 'bridge'-matrix captures Industry-by-Spending Category flows, where each entry identifies the share of the basket of commodities (by industries) required to produce one unit of final demand by spending category. That is to say that the all columns (spending categories) sum up to one.

The HHFCE provides the data for the 'bridge'-matrix, but the data need to be transformed. The HHFCE is a 106×42 matrix identifying Household consumption expenditure by 106 product and 42 industries. Recall that the 'bridge'-matrix is a 104×12 matrix capturing the flows between industries and spending categories. Note that there is no Supply and Use table or HHFCE table for Scotland, thus this Section uses the UK Table.

As stated above, the 'bridge'-matrix identifies shares and not prices, i.e. £million. The data are not transformed for Scotland, due to the assumption that UK data capture the spending characteristic of Scottish Households as well. The HHFCE data are presented in a Product-by-Industry matrix,

$$L = \begin{bmatrix} l_{1,1} & \cdots & l_{1,42} \\ \vdots & \ddots & \vdots \\ l_{106,1} & \cdots & k_{106,42} \end{bmatrix} \tag{4.5.2}$$

where L is a 106×42 matrix. The jth row identifies the product type and the ith column the industry (see Table 9.5.2 for the 42 industry categories). Summing up all elements in a row identifies the total spending on a product by all Households and summing up all elements in a column gives the total spending by industry. As stated above, the aim is to create a 104×12 matrix, which identifies the 104 industries from the IxI table and the 12 spending categories from the LCFS. Hence, the data contained in the L matrix need to be transformed to capture Industry-by-Spending Category flows.

It is possible to match either the rows or the columns of the L matrix to the 104 industries from the IxI table. Disaggregating the 42 to 104 industries would require an exogenous data source, which would dilute the accuracy of the data. Matching the 106 product categories from the HHFCE to the 104 industry sectors from the IO is therefore more accurate and is what is done in this chapter. Transforming products to industry in an IO setting or vice versa is a commonly employed method, including by the official statistic authorities (see ONS (2011a) for example). Hence the 106 rows from the L matrix are aggregated to 104 rows.

The second part is to aggregate the 42 columns from the L matrix to 12, that is matching 42 industries to 12 spending categories. Although this is not an exact fit, it has the advantage of retaining the information contained in the 42 industry classification but in an aggregated way, without having to use additional exogenous data for the transformation.

Aggregating the 42 columns of the L matrix to 12 columns is done by multiplying the L matrix with the 'Aggregation matrix 1', A_1. This matrix is a self-constructed, binary matrix at 42×12 (see Table 4.3.1),

$$A_1 = \begin{bmatrix} a1_{1,1} & \cdots & a1_{1,12} \\ \vdots & \ddots & \vdots \\ a1_{42,1} & \cdots & a1_{42,12} \end{bmatrix} \tag{4.5.3}$$

The product of multiplying the L matrix with the A_1 matrix is,

$$L_A = \begin{bmatrix} la_{1,1} & \cdots & la_{1,12} \\ \vdots & \ddots & \vdots \\ la_{106,1} & \cdots & la_{106,12} \end{bmatrix} \tag{4.5.4}$$

where L_A is a 106×12 matrix. The rows remain the same as in the L matrix, i.e. the rows track the income by product type, but the columns are now aggregated from 42 industries to match the 12 industries. These 12 industries now match the spending categories identified in the rows of the K matrix and are labelled accordingly.

Table 9.5.3 shows the basket of commodities, classified in 'products,' required, to meet total Household final consumption expenditure by 12 spending categories. Displaying the matrix in a shortened version aims at giving the reader simply an overview of the method. Note that the last row is identified as product category 97 and not 106, which is due to some product categories being subdivided and hence some numbers are used multiple times. For example, category 10 is subdivided eight times (see Table 9.5.3), but the total row count is 106.

Table 9.5.3 shows the first and the last 15 rows of the actual values used in the disaggregation of the L_A matrix. For example, purchases from the first spending category, ‘Food and non-alcoholic drinks’, require a basket of commodities from product categories 1, 3, 8, 9, 10, 11, 12, 13 and 14[6] in order to produce the final products of that spending category. The total for the first spending category is £53,515m, which is the total for the UK. Conversely, all of the sales for product category 2, ‘Products of forestry, logging and related services’ go to spending category 4, ‘ Housing, fuel and power’, and 9, ‘Recreation and Culture’, for £24m and £138m.

As stated above, the 106 products from the L_A matrix are matched to a 104 industry classification from the IxI table. The conversion from products to industries does not offer a complete fit, but as noted above, it is a method regularly employed and the products generally match the industries well. When matching a product to an industry classification, all of the flows between a product and spending categories from the L_A matrix are retained and transferred to the transformed industry-by-spending category matrix.

For this transformation, the L_A matrix is pre-multiplied with the A_2 matrix (see Table 4.3.1), which is 104×106. The A_2 matrix is self-constructed and matches the 106 products to 104 industries.

$$A_2 = \begin{bmatrix} a2_{1,1} & \cdots & a2_{1,106} \\ \vdots & \ddots & \vdots \\ a2_{104,1} & \cdots & a2_{104,106} \end{bmatrix} \tag{4.5.5}$$

Following the conversion, the L_A matrix becomes,

[6] These categories are: 1. Products of agriculture, hunting and related services; 3. Fish and other fishing and aquaculture products, others; 8. Preserved meat and meat products; 9. Processed and preserved fish, fruit and vegetables 10.Vegetable and animal oils and fats; 11. Dairy products; 12. Grain mill products, starches and starch products; 13. Bakery and farinaceous products; 14. Other food products

$$M = \begin{bmatrix} m_{1,1} & \cdots & m_{1,12} \\ \vdots & \ddots & \vdots \\ m_{104,1} & \cdots & m_{104,12} \end{bmatrix} \tag{4.5.6}$$

where M is a 104×12 matrix and tracks the Household consumption expenditure flows by the 104 industries (as in the IxI) and by 12 spending categories. That is, the rows of the M matrix, j, identify industry income flowing from Households' purchases of goods & services, grouped into 12 spending categories. The columns, i, show the basket of commodities needed, classified in 104 industries, in order to produce the total Household demand by spending category. Note that the column totals are held constant when transforming the L_A matrix to the M matrix, since the column classification does not change in this step.

Table 9.5.4 presents an excerpt of the full M matrix in £million. Comparing Tables 9.5.3 and 9.5.4 reveals that the product categories from the L_A matrix generally match up well with the industries in the M matrix. For example, the HHFCE identifies "Products of agriculture, hunting and related services" and these are matched to "Agriculture" from the IxI classification, SIC07 (Scottish Government, 2013c), both at £9,324m total.

However, in some instances there are either more products (L_A matrix) than matching industries (M matrix) or less products (L_A matrix) than matching industries (M matrix). There are a total of 18 industries, which are not directly matched with one product. Conversely, 83% of industries match one product directly. In the first case, the products are simply aggregated up to the relevant industry, which matches the products most closely.

There are four industries, which are matched with two products and three industries are matched with three products. For example, the two products "Vegetable and animal oils and fats" (10.4) and "Dairy products" (10.5) (see Table 9.5.3) are aggregated into the the industry "Dairy products, oils & fats processing" (see Table 9.5.4).

The totals of the two products (of £757m and £7,392m) are unchanged when converting to the one industry (combined total of £8,149m), and the intermediate consumption is still captured by Spending Category 1 only, ‘ Food & non-alcoholic drinks’. That is to say that, although the row classifications have changed, the information on the basket of commodities required to produce the total output by spending category is retained.

When there are fewer products than industries, the product entries are disaggregated and matched to the relevant industries. There are eleven industries, which have less than one matching industry and these are computed as outlined below. These shares are computed by dividing the total final demand of each industry by the combined total final demand from the relevant industries, as given in the IxI table.

The largest element of the IxI table is a square 104×104 matrix tracking the flow of funds between all industries in Scotland,

$$IxI = \begin{bmatrix} x_{1,1} & \cdots & x_{1,104} \\ \vdots & \ddots & \vdots \\ x_{104,1} & \cdots & x_{104,104} \end{bmatrix} \qquad (4.5.7)$$

where the sum of a row identifies the total income of an industry,j, derived from selling its goods & services to all industries, i, as intermediate inputs. Conversely, the columns, i, identify the expenditure of the ith industry on products purchased from other industries, j, as intermediate inputs for the production of the ith industry’s products. As stated above, in some cases there are fewer products in the L_A matrix than matching industries in the M matrix, i.e. the IxI table.

For example, the product “Alcoholic beverages” (11.01-6) in the L_A matrix (see Table 9.5.3) does not have a single corresponding industry. The IxI table and thus the M matrix identify both the “Spirits & wines” (17) and the “Beer & malt” (18) industries, however. In this instance, two shares, $\sigma_{1,i}$ and $\sigma_{2,i}$ are computed. Note that the number of shares is flexible depending on how many corresponding industries there are. Using the example above, the share for the “Spirits & wines” industry, $\sigma_{1,i}$, is,

$$\sigma_{1,i} = \frac{\sum_{i=1}^{104} x_{1,i}}{\sum_{i=1}^{104} x_{1,i} + \sum_{i=1}^{104} x_{2,i}} \tag{4.5.8}$$

where x is the final demand entry of the relevant industry. Here $x_{1,i}$ refers to the final demand of the "Spirits & wines" industry and $x_{2,i}$ captures the final demand of the "Beer & malt" industry. This means that where expenditure on an alcoholic beverage change by ΔA this is translated in the IO analysis into a $\sigma, \Delta A$ on "Spirits & wines" and $(1 - \sigma)\Delta A$ on beer. The share for the "Beer & malt" industry here, $\sigma_{2,i}$, simply is then,

$$\sigma_{2,i} = 1 - \sigma_{1,i} \tag{4.5.9}$$

The corresponding row entries in the L^A matrix, θ, are then multiplied by the shares for the two industries, $\sigma_{1,i}$ and $\sigma_{2,i}$,

$$\theta_{j,i} \times \sigma_{1,i} = \kappa_{1,i} \tag{4.5.10}$$

$$\theta_{j,i} \times \sigma_{2,i} = \kappa_{2,i} \tag{4.5.11}$$

where κ is a 1×12 vector, which identifies the total output of the jth industry by the ith Spending Category in the L_A matrix.

Looking at the data for the above example in Table 9.5.3, the "Alcoholic beverages" product has one entry under Spending Category 2, 'Alcoholic drink, tobacco & narcotics' of £8,706m. Hence, this is also the total for this product. The disaggregated product entries are then transferred to the matching M matrix row entries. That is the initial entries for one product are now matched to the corresponding two industry entries. Recall that both the L_A matrix as well as the M matrix have the same column identifiers and thus only the row entries need to be disaggregated. For the example above, the shares are calculated as follows,

$$\sigma_{1,i} = \left[\frac{3,189}{3,189 + 178}\right] = 0.95 \tag{4.5.12}$$

where $\sigma_{1,i}$ is the share for the "Spirits & wines" industry and the share for the "Beer & malt" industry, $\sigma_{2,i}$ is,

$$\sigma_{2,i} = 1 - 0.95 = 0.05 \tag{4.5.13}$$

Following the method outlined above, the row entry for the "Spirits & wines" industry in the M matrix is,

$$8,706 \times 0.95 = 8,246 \tag{4.5.14}$$

hence the row entry for the "Beer & malt" industry is,

$$8,706 \times 0.05 = 460 \tag{4.5.15}$$

The M matrix has the format needed for the 'bridge'-matrix (104×12), but the entries are in £million rather than shares. Thus, the M matrix needs to be converted into a matrix identifying Household expenditure by shares. Recall that the 'bridge'-matrix has to be multiplied with the individual columns of the K matrix, which identify Household type spending on 12 spending categories. In order to disaggregate this information to Household spending by 104 industries, the 'bridge' matrix needs to capture the shares of Household consumption expenditure by Spending category, i.e. column totals equal 1.

For this, the M matrix is pre-multiplied with the A_3 matrix (see Table 4.3.1), which is a self-constructed 104×104 matrix. The A_3 matrix is a diagonal matrix, where the elements are the inverse of the corresponding row totals from the M matrix,

$$A_3 = \begin{bmatrix} a3_{1,1} & \cdots & a3_{1,104} \\ \vdots & \ddots & \vdots \\ a3_{104,1} & \cdots & a3_{104,104} \end{bmatrix} \tag{4.5.16}$$

This matrix multiplication effectively divides each individual column entry of the M by the corresponding column sum and yields,

$$B = \begin{bmatrix} b_{1,1} & \cdots & b_{1,12} \\ \vdots & \ddots & \vdots \\ b_{104,1} & \cdots & b_{104,12} \end{bmatrix} \tag{4.5.17}$$

where B is a 104×12 matrix. The rows identify the 104 industries from the IxI table and the columns identify the 12 spending categories. Each scalar in the B matrix captures the shares of the jth industry's basket of commodities for the production of the ith spending category's goods & services. Note that the columns of the B matrix sum up to 1.

A visual inspection of the 'bridge'-matrix shows that the basket of commodities needed to produce a unit of final output per industry is the same as in the IxI table. For example, Household purchases from the "Alcoholic drink, tobacco & narcotics"

Spending Category (the second column in the B matrix) are made up of commodities from the following industries: “Spirits & wines”, “Beer & malt”, “Tobacco” and “Pharmaceuticals” (these are industries 17, 18, 20 and 32 in Table 9.5.5).

In order to identify Household type spending by the 104 industries from the IxI table, each of the column vectors of the K matrix is multiplied with the B matrix. For the first Household type this is,

$$K_{j,1} \times B_{j,i} = \begin{bmatrix} k_{1,1} \\ \vdots \\ k_{12,1} \end{bmatrix} \times \begin{bmatrix} b_{1,1} & \cdots & b_{1,12} \\ \vdots & \ddots & \vdots \\ b_{104,1} & \cdots & b_{104,12} \end{bmatrix} \tag{4.5.18}$$

which produces,

$$hh_1 = \begin{bmatrix} hh1_{1,1} \\ \vdots \\ hh1_{104,1} \end{bmatrix} \tag{4.5.19}$$

where hh_1 is a 104×1 vector that tracks the Household consumption expenditure by Household type 1 across 104 industries. This matrix computation is performed for all Household types, i.e. there are seven hh_i vectors at 104×1. Note that the values of the hh_i vectors are in £m but on a UK level. This is because the data in the K matrix is real expenditure data for the UK.

Summing up all seven hh_i vectors produces,

$$\sum_{i=1}^{7} hh_i = hh_T \tag{4.5.20}$$

where hh_T is a 104×7 matrix. The rows correspond to the 104 industries from the IxI table and the columns identify the seven Household types. Each entry gives the jth

industry's share of intermediate inputs required to meet the ith Household's demand for current goods & services. Table 9.5.6 presents the first and the last 15 industries' actual data for the hh matrix. The hh_T contains the same data as the K matrix, but the 12 spending categories are disaggregated to 104 industries here. This is captured in equations 4 and 5 in Table 4.3.2.

As stated above, the values in the hh_T matrix are the disaggregated data from the K matrix and hence these are UK level. Although the hh_T matrix does provide disaggregated Household information by 104 industries, these figures do not match the IxI table Household consumption expenditure. Therefore, the disaggregated Household information in the hh_T needs to be matched to the control totals from the IxI table.

The hh_T needs to be transformed to capture each Household type's share of consumption by industry. That is to say that total industry consumption (of 100%) is divided between the seven Household types in the transformed hh_T matrix.

The A_4 matrix is a self-constructed 104×104 matrix (see Table 4.3.1). The A_4 matrix is a diagonal matrix, where the elements are the inverse of the corresponding row totals from the hh_T matrix,

$$A_4 = \begin{bmatrix} a4_{1,1} & \cdots & a4_{1,104} \\ \vdots & \ddots & \vdots \\ a4_{104,1} & \cdots & a4_{104,104} \end{bmatrix} \tag{4.5.21}$$

Pre-multiplying the hh_T by the A_4 matrix effectively divides each entry in the hh_T by the corresponding row total. This produces,

$$hh_F = \begin{bmatrix} hhF_{1,1} & \cdots & hhF_{1,12} \\ \vdots & \ddots & \vdots \\ hhF_{104,1} & \cdots & hhF_{104,12} \end{bmatrix} \tag{4.5.22}$$

where hh_F is a 104×7 matrix. The jth row identifies each Household type's share of the total Household consumption expenditure of the jth industry. The total of each row j is 1. The ith column is the share of each Household type's consumption expenditure by industries.

Table 9.5.7 shows the actual values for the hh_F matrix. The bottom row shows the average share for Household consumption expenditure by Household type. It shows that the two 'working' Households (1 and 2) are responsible for more than half of the total Household consumption (31% and 24%, respectively).

Note that there are some rows in Table 9.5.7, which have initially no entry. For example, industries 7. Oil & gas extraction, metal ores and 9. Mining Support. Missing row vectors are imputed by using the average of all row vectors, touched upon above,

$$\overline{hh_i} = \frac{1}{104} \sum_{j=1}^{104} hh_{j,i} \tag{4.5.23}$$

The last step in the disaggregation of the Household consumption vector is to multiply the control total with the hh_F matrix. The Household consumption vector is transformed into a 104×104 for matrix algebra purposes, which is a diagonal matrix. Each entry is the corresponding row entry from the control vector. In matrix form this is,

$$IxI_{HH} = \begin{bmatrix} IxI_{1,1} & \cdots & IxI_{1,104} \\ \vdots & \ddots & \vdots \\ IxI_{104,1} & \cdots & IxI_{104,104} \end{bmatrix} \tag{4.5.24}$$

Multiplying the IxI_{HH} matrix with the hh_F matrix produces,

$$HH = \begin{bmatrix} hh_{1,1} & \cdots & hh_{1,7} \\ \vdots & \ddots & \vdots \\ hh_{104,1} & \cdots & hh_{104,7} \end{bmatrix} \tag{4.5.25}$$

where the HH matrix is the final 104×7 matrix. It is the disaggregated Household consumption expenditure, which is consistent with the IxI control total. This disaggregates the Household account in the IxI by Household type, which is also captured under "IO Expenditure" in the IncExp account.

Table 9.5.8 is the disaggregated Household Account in the IxI table by 104 industries. The last column, "Total" is the Household account's "Total Final Consumption Expenditure" from the IxI table. The corresponding rows give the computed 'Total Final Consumption Expenditure' by Household type. Summing up the row entries from all seven Households gives the corresponding total. Thus, the method applied here results in a disaggregated Household account in the IxI table and consequently in the SAM that is consistent with the aggregated account.

4.5.2 Household Disaggregation of the Income and Expenditure Account

The second part in disaggregating the Household account in the SAM is through identifying the seven separate IncExp Household accounts. Table 4.5.1 shows the Household account in the IncExp account from the (aggregated) 2009 SAM for Scotland (see chapter 2). Each of these entries is used as a control total after the individual households are calculated. The IncExp account is disaggregated by, first estimating the IncExp account for each Household type. These are then transformed into shares, where each entry across Household accounts sums up to 1. For example, summing up the total income figure for all Household accounts (cell 1 for each Household in Table 9.5.11) equals 1. These shares are then multiplied by the control total from Table 4.5.1, in order to produce the disaggregated IncExp account.

Table 4.5.1: Households in the Income-Expenditure Accounts for Scotland (in £million)

HOUSEHOLDS			
1. **Income**	**107,877**	10. **Expenditure**	**107,877**
2. Income from Employment	63,561	11. IO Expenditure	74,669
3. Profit Income (OVA)	5,289	12. Payments to Corporations	6,401
4. Income from Corporations	15,103	13. Payments to Government	21,379
5. Income from Government	19,835	14. Transfers to RUK	238
6. Transfers from RUK	1,853	15. Transfers to ROW	119
7. Transfers from ROW	2,237	16. Payments to Capital (Savings)	5,070

The data for the disaggregation of the IncExp account for Households come from two (Scottish) sources, the Scottish Government's variant of the Intra-Governmental Tax and Benefit Model (IGOTM) and from the Living Cost and Food Survey (LCFS) (ONS, 2015, 2011b). This chapter benefited from restricted access to the Scottish Government's IGOTM data, which was provided in a way consistent with the entries shown in Table 4.5.1. All of the Income data, that is cells 2 to 7 are provided by this dataset for all seven Household types. Note that the total income (cell 1) is simply the sum of cells 2 to 7. Furthermore, the IGOTM data also disaggregate "Payments to Government" (cell 13 in Table 4.5.1) from the expenditure side.

The remaining expenditure side entries are disaggregated as follows. The "IO Expenditure" entry (cell 11) is disaggregated using the method discussed in Section 4.5.1, with cell 11 in in Table 9.5.11 capturing each Household's total only. Next, "Payments to Corporations", "Transfers to ROW" and "Payments to Capital" (cells 12, 15 and 16) are disaggregated using data extracted from the LCFS. The survey contains variables, which match these expenditure items by the seven Household types.

The survey does not provide an estimate for "Transfers to RUK" (cell 14), however, which is to be expected since the LCFS is a UK-wide survey with a regional identifier to extract Scottish data from it, i.e. it is not a Scottish survey. This entry is disaggregated using the assumptions that the shares for "Transfers to ROW" provide a sufficient estimate to identify each Household type's expenditure share on flows to the ROW as well. Note that this mirrors the assumption in the original construction of the IncExp accounts (see chapter 2). Finally, the “Expenditure” entry (cell 10) is the sum of all the other expenditure entries, these are cells 11-16.

Table 9.5.9 presents the estimated (/disaggregated) IncExp account by Households. Recall that the seven Household types are: 1) Working without children, 2) Working with children, 3) Non-working without children, 4) Non-working with children, 5) Pensioners, 6) Multiple tax units without children and 7) Multiple tax units with children. The disaggregated Household sector in the IncExp account (see Table 9.5.9) mirrors the layout of the aggregated IncExp account. Note that the full IncExp account identifies the income and expenditure flows for other SAM accounts as well, for example the Government, Corporate, Capital and External account.

The data in Table 9.5.9 are sufficient to disaggregate the Household account in the IncExp account, however, as it also captures the entries flowing between the other accounts in the full IncExp account. For example, Households receive income from the Government (“Income from Government”), which is recorded as “Payments to Households” under the Government’s IncExp account (see chapter 2 section 2.4 for a detailed analysis of the full IncExp accounts in the 2009 Scottish SAM).

The Household total income figures in Table 9.5.9 show that there is variation in the income and expenditure level between the Household types. This difference can be explained through, first, the Household type characteristics. and second, by looking at the size of the population in each Household type. First, Households 1 and 2 have higher income levels than Households 3 and 4, since the former two are ‘working’ and the latter two are ‘non-working’. Also, the data used here show that Households in aggregate without children (1,3 and 6) earn more than Households with (children 2,4 and 7).

Secondly, there are likely to be variations in the population size of the different Household types. These are not accounted for here as just actual values are reported. Hence, one Household with similar ‘characteristics’ might have only half the number of Households in it and thus the figures are skewed.

Generally, the estimated IncExp account (Table 9.5.9), provides better estimates for the income side than for expenditures. The sources of Household income seem, on aggregate, appropriate for the various Household types. Households 1, 2, 6 and 7 receive the majority of their income from wages, whilst pensioners (5) fund their consumption expenditure through income flows from the Government and Corporate accounts. Note that "Income from Corporations" (cell 4) includes private pension payments.

Household 3 and 4 are 'non-working' and consequently, Household 3 receives around 96% of its income from the Government and Corporate account (the latter includes redundancy payments). Household 4, however, receives 63% of its income from wage income and only 34% from the Government. This seems counter-intuitive, but could be due to the head of household being unemployed, i.e. 'non-working' and wage income from other Household members flowing to the Household. Household type 4 is a Household with children, which might necessitate the extra income generation, but the estimated income results for this Household have to viewed with caution.

The estimates for the expenditure entries in Table 9.5.9, do not provide full coverage. The "IO Expenditure" (cell 11) is wholly disaggregated, i.e. summing up all entries across Households yields the control total of £74,669m from the base SAM (this was disaggregated in section 4.5.2). The estimated "Payments to Government" also provide sufficient detail, but the remaining entries do not. Overall, the data presented in Table 9.5.9 provide the base for the disaggregation of the Household sector in the IncExp Accounts. But, the estimated IncExp account does not match the IncExp account from the 2009 SAM.

Table 9.5.10 gives a comparison between the 'SAM Household Account Total' and the 'Estimated Household Account Total', i.e. the one discussed above. Note that "Payments to Corporations" are a balancing item in the original IncExp account. Also, the data sources used here, do not capture savings and investments, which are captured by "Payments to Capital" (see section 4.4 for details on the data sources).

Although the estimated IncExp account does not fully match the control totals of the IncExp account from the base SAM, most sources of income (apart from OVA income) and some expenditure items match up well. The percentages shown next to the figures in £million are the share of the entry of the respective total (that is of £107,877m for the SAM and £93,063m for the Estimate). For both, the SAM and the estimated/disaggregated Household account, wage income is the biggest share of total income (at 59% and 64%).

The second and third largest shares are "Income from Government"(at 14% and 11%) and "Income from Corporations"(at 18% and 20%), respectively. On the expenditure side, "IO Expenditure" is the same on aggregate (see section above), but the percentages differ (69 % for the SAM compared to 80%for the Estimated account) due to the variation in the total. "Payments to Government" make up the second highest share at 20% for both.

Table 9.5.10 further illustrates the 'Variation' between the SAM and the Estimated account (these are the estimated entries subtracted from the control totals). It shows that the income side is underestimated. In particular, "Profit Income (OVA)" and lesser so "Income from Corporations" show significant variations when comparing the estimated figures to the SAM control figures (£-4,760m and £-5,254m from a total 'Variation' of £-14,814m) . As noted above, "Payments to Corporations" and "Payments to Capital" are not captured by the estimated account and hence these entries are missing in comparison to the SAM entries. Furthermore, the estimates for "Transfers to RUK" and "Transfers to ROW" do not provide enough 'detail' to be used for the disaggregation and therefore have to be imputed.

Individual Household type shares are produced for the disaggregated IncExp, in order to match the information from the estimated Household IncExp account with the aggregated totals. Table 9.5.11 shows the computed shares, which are derived by dividing each Household Type's estimated income, $\mu_j^{y,k}$ and expenditure $\mu_j^{e,k}$ entry by the corresponding total, M_j^Y and M_j^E respectively, for all Households. Note that the μ^y entries correspond to the income and the μ^e entries to the expenditure figures for the individual Households in Table 9.5.9. The M_j^Y and M_j^E values are the relevant totals shown in the previous section in Table 9.5.9. The shares for the income side hence are,

$$\eta_j^{y,k} = \frac{\mu_j^{y,k}}{M_j^Y} \tag{4.5.26}$$

and for expenditures,

$$\eta_j^{e,k} = \frac{\mu_j^{e,k}}{M_j^E} \tag{4.5.27}$$

where eta_j is a scalar identifying the share of a Household's total income (y) or share of total expenditure (e). M is a scalar identifying the total income or expenditure across households and k identifies the Household type, for example Household 1 ('Working without kids'). These shares are produced for each entry per Household type and combined yield,

$$H^1 = \begin{bmatrix} \eta_1^{y,1} & \eta_1^{e,1} \\ \vdots & \vdots \\ \eta_7^{y,1} & \eta_7^{e,1} \end{bmatrix} \tag{4.5.28}$$

where H^1 is a 7×2 matrix, which identifies the Household Type 1's shares of the disaggregated IncExp account (for that Household). A H^k matrix is produced for each Household type and the combined matrices are the 'Shares Income-Expenditure Accounts' in Table 9.5.11).

The shares for each Household are then multiplied by the relevant control total, i.e. the corresponding IncExp entry from the 2009 SAM for Scotland (Table 4.5.1). This produces the final disaggregated Household IncExp account, see Table 9.5.12. The individual entries shares of the corresponding Households total broadly match those of the 'Estimated IncExp Account' in Table 9.5.9. However, there are some variations, as some entries are either inflated in the final accounts, due to the estimated figures being too low (see income side). Also, some entries had to be imputed by using the share data from Table 9.5.11 and multiplying it with the control totals (Table 4.5.1), for example "Payments to Capital" as discussed above.

Collapsing the disaggregated Household account to one, yields the same entries as the original IncExp account,

$$\Lambda = \sum_{i=1}^{7} h_i \times \Lambda \tag{4.5.29}$$

where: $\sum_{i=1}^{7} h_i = 1$. Thus, multiplying the cell entry with each of the Household shares; h_i and summing these up produces the original IncExp account entry, Λ. For example, summing up all the "Income from Employment" entries for all seven Household accounts in Table 9.5.12 yields the total £63,561m, which is equal to the control total from Table 4.5.1 (and the figure in the base SAM).

4.5.3 Household Disaggregated SAM for Scotland

Table 4.5.2 is the Household type disaggregated 2009 SAM for Scotland (Household SAM). It contains all the information and entries as in Table 4.2.2, but with seven Household sectors. That is to say that the Household SAM tracks the same flows between Households and the other sectors in the SAM, as the base SAM from chapter 2. The disaggregated IxI entries from section 4.5.1 are identified as totals for each Household in the Household consumption expenditure on the "Activities" sector. The remaining Household entries (both rows and columns) flow into the SAM from the disaggregated IncExp account from section 4.5.2.

The Household SAM allows for a more detailed analysis of both the income as well as the expenditure flows. For example, Household saving, which are the expenditure flows to the "Capital" sector, as well as details on wage income, which is the Household income from "Labour". Note that Household expenditure on the "Corporations" sector remains the balancing item, with the total matching the (aggregate) control total of the base SAM, however.

As stated above, the disaggregated SAM uses the Household entries as control totals. Hence, summing up all Households' expenditure on the "Activities" sector produces the same value as in the base SAM (£15,567m + £11,986m + £6,897m + £810m + £6,267m + £6,267m + £2,007m = £49,802m). An example from the Household income side is summing up all of the income from "Labour", which again produces the base SAM total, i.e. matches the control total (£26,643m + £21,026m + £7m + £947m + £1,009m + £10,280m + £3,648m = £63,561m). The Household disaggregated SAM tracks the flows of both income to and expenditures from Households in more detail and therefore enables more accurate analysis as well as (SAM) simulations of possible shocks to the Scottish economy.

The Household SAM is of itself a major contribution to the existing SAM-based modelling approach for Scotland. Furthermore, it is a useful tool, specifically for a more detailed analysis of the flow of funds in the Scottish economy than is possible with the (aggregated) 2009 SAM. The Household SAM can also be used as the basis for a Household disaggregated SAM model. This is partly what is done in chapter 6, however with a combined Household and Government account disaggregated SAM. Additionally, the disaggregation of the Household consumption expenditure vector in section 4.5.1 disaggregates the Scottish IO Tables by Household type. This could be employed for more detailed IO modelling by itself. Note that section 4.7 details the Combined SAM.

This section discussed the method employed to disaggregate the Household account in the SAM. There are two distinctive parts to the disaggregation and both are successfully disaggregated using a bottom-up approach. Using the Household entries from the aggregated SAM as control totals ensures consistency across the different stages of Household disaggregation.

The method discussed above allows for a detailed disaggregation of the Household account whilst remaining statistically robust. As such, this method improves on previous attempts to disaggregated the Household account, and in particular disaggregating by Type has not been done in recent years. The next section combines

Table 4.5.2: Household Disaggregated 2009 SAM for Scotland, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Household 1	6. Household 2	7. Household 3	8. Household 4	9. Household 5	10. Household 6	11. Household 7	12. Corporations	13. Government	14. Taxes	15. External	Total
1. Activities	63,607	-	13,981	-	15,567	11,986	6,897	810	6,267	6,267	2,007	-	29,486	-	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	2,497	1,384	331	109	19	444	287	24,828	119	-	-10,087	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38,441
5. Household 1	-	26,643	-	1,698	-	-	-	-	-	-	-	5,103	1,220	-	1,542	36,206
6. Household 2	-	21,026	-	644	-	-	-	-	-	-	-	3,053	3,126	-	985	28,834
7. Household 3	-	7	-	718	-	-	-	-	-	-	-	2,773	6,926	-	239	10,664
8. Household 4	-	947	-	-	-	-	-	-	-	-	-	116	507	-	35	1,604
9. Household 5	-	1,009	-	1,710	-	-	-	-	-	-	-	2,147	5,794	-	606	11,266
10. Household 6	-	10,280	-	430	-	-	-	-	-	-	-	1,410	1,673	-	520	14,314
11. Household 7	-	3,648	-	88	-	-	-	-	-	-	-	501	589	-	163	4,989
12. Corporations	-	-	-	29,456	3,047	2,043	150	10	24	856	271	-	5,722	-	11,928	53,507
13. Government	-	-	-	3,697	7,135	7,195	256	302	1,781	3,333	1,376	5,248	-	13,165	20,041	63,530
14. Taxes	4,779	-	1,495	-	2,046	1,764	305	30	948	1,152	323	-	-	-	322	13,165
15. External	40,532	-	4,455	-	5,914	4,462	2,725	343	2,227	2,262	725	8,328	8,368	-	10,470	90,808
Total	210,920	63,561	19,930	38,441	36,206	28,834	10,664	1,604	11,266	14,314	4,989	53,507	63,530	13,165	90,808	661,739

the disaggregated Household account produced in this chapter with the Government disaggregated SAM from chapter 3.

4.6 Linking the Disaggregated Household and Government Accounts

The 2009 SAM for Scotland (base SAM) is disaggregated by Households above (see section 4.5). It is also, separately, disaggregated by Government in chapter 3. This section combines the two disaggregated SAMs and produces a SAM, which captures three Government, three Tax account and seven Household (type) accounts (this SAM is henceforth referred to as the 'Combined SAM'). This extended database provides the framework for more detailed SAM modelling (see chapter 6) and more detailed CGE modelling (see chapters 7 and 8).

Linking the two disaggregated SAMs together does not require additional exogenous data, but some re-calibration of some entries in the Household account. This is due to the Government disaggregated SAM (Government SAM) treating the Government and the Tax accounts differently than the Household disaggregated SAM (Household SAM) does. Recall that the Household SAM from section 4.5 treats the public sector as a unified Government and a unified Tax account, like the base SAM constructed in chapter 2.

First, this section provides an overview of the Government disaggregated SAM from chapter 3 as a means of recollection for the reader. This highlights, in particular, the different treatment of the Government and the Tax account in contrast to how the Household SAM treats these sectors. For a detailed discussion on the Government SAM refer to chapter 3. Second, the method of linking the two disaggregated SAMs is described. Third, the Combined SAM is computed and analysed.

4.6.1 The Government Disaggregated SAM

Table 4.6.1 is the Government SAM from chapter 3. The Government and Tax accounts are disaggregated to capture all three Governments operating in Scotland. These are the UK Government, the Scottish Government and the Local Government, as well as the corresponding Tax accounts. Note that the Household account is unified here. The "Total" of the Government SAM is larger (at £723,502m) than the Household SAM (at £661,739m), because it captures inter-governmental transfers. Most other entries are the same as in the in the Household SAM. Where this is not the case, the difference is discussed below.

The Government SAM identifies public sector income and expenditure by the three Government sectors operating in Scotland. Public sector expenditures on "Activities", "Capital", "Households", "Corporations" and the "External" sector are, on aggregate, equal to the Household SAM. Table 4.6.1 shows that the UK Government pays a 'block grant' to the Scottish Government of £25,303m and the Scottish Government pays the Local Government, i.e. Local Authorities, £10,644m. Including these transfer payments inflates the total Government account from the initial £63,530m in the Household SAM to £99,476m.

The total income flows from the "OVA" and from the "External" sector to the Government remain the same, on aggregate, as in the Household SAM. The aforementioned inter-governmental transfers are also recorded on the income side. That is to say that, for example, the 'block grant' from the UK Government to Scotland is recorded as both an expenditure for the UK Government, but also as an income for the Scottish Government.

The tax flows are captured differently here. In the Household SAM some tax payments from both the Household and from the Corporate sector are captured as direct payments from the respective sector to the Government sector. The remaining direct and indirect taxes, such as VAT and Aggregates Levy are captured as payments to the Tax account in the Household SAM.

Table 4.6.1: Government Disaggregated 2009 SAM for Scotland, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Households	6. Corporations	7. UK Government	8. Scottish Government	9. Local Government	10. UK Tax	11. Scottish Tax	12. Local Tax	13. External	Total
1. Activities	63,607	-	13,981	-	49,802	-	5,924	13,372	10,190	-	-	-	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	5,070	25,007	89	5	25	-	-	-	-10,267	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	-	-	-	-	38,441
5. Households	-	63,561	-	5,289	-	15,103	13,519	-	6,316	-	-	-	4,090	107,877
6. Corporations	-	-	-	29,456	7,031	-	2,660	3,062	-	-	-	-	11,298	53,507
7. UK Government	-	-	-	529	-	-	-	-	-	35,221	-	-	20,112	55,862
8. Scottish Government	-	-	-	1,780	-	-	25,303	-	-	-	-	-	-	27,082
9. Local Government	-	-	-	1,388	-	-	-	10,644	-	-	-	3,761	738	16,531
10. UK Tax	4,779	-	1,495	-	25,356	3,269	-	-	-	-	-	-	322	35,221
11. Scottish Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12. Local Tax	-	-	-	-	1,961	1,801	-	-	-	-	-	-	-	3,761
13. External	40,532	-	4,455	-	18,657	8,328	8,367	-	-	-	-	-	10,470	90,808
Total	210,920	63,561	19,930	38,441	107,877	53,507	55,862	27,082	16,531	35,221	-	3,761	90,808	723,502

The Government SAM, however, records the flows of all taxes directly to the relevant Tax account. That is to say, taxes are paid to the Tax account of the Government, which is assigned the collection of the taxes. For example, VAT and income tax are paid by the respective sectors to the UK Tax account. These changes to the treatment of taxes, allow for devolved taxes to be captured in the Government SAM, which is not possible in the Household SAM.

For example, Council Tax and the Non-Domestic Rate are devolved to the Local Government under the Scotland Act 1998 (The UK Parliament, 1998). As reported in Table 4.6.1 with Households paying £1,961m to the “Local Tax” account and Corporations paying £1,801m to the “Local Tax” account. The income from each Tax account then flows back as income to the corresponding Government sector. Therefore, the income side of the Government account includes now all appropriate taxes as one, for example, £3,761m of Local Tax to the Local Government.

The Tax accounts now capture both direct tax payments, which flow straight to the Government sector in the Household SAM as well as indirect tax payments. These are captured under “Taxes on Expenditure” in the Household SAM. The expenditures of the tax accounts are the payments of the collected taxes to the relevant Government account. For example, the UK Tax account receives £35,221m as total income, which it then transfers to the UK Government (see Table 4.6.1).

Capturing the inter-governmental transfer payments and modifying the treatment of taxes, enables more detailed modelling of potential changes to the fiscal framework in Scotland. For example, the devolution of taxes under the Scotland Act 2012 or the current Scotland Bill (The UK Parliament, 2012, 2015). These changes to the Scottish fiscal framework are incorporated into the combined Household and Government SAM model in chapter 6.

4.6.2 Method

The Combined SAM identifies three Government and three Tax accounts as well as seven Household (type) accounts. The first step is to determine whether the Government or the Household SAM provides the framework for the Combined SAM. The Government SAM is used as the control total for the Combined SAM. This is because, as outlined above, the Government SAM alters the treatment of the Government and the Tax accounts significantly from how they are treated in the Household SAM.

Adding the additional data contained in the Household SAM to the Government SAM is straightforward and requires only some combined entries to be re-calibrated. Most of the disaggregated Household accounts' entries are simply added to the Government SAM, by adding the corresponding rows and columns. However, the entries which capture the flow of funds between Households and the Government and Tax accounts need to be computed. There are three distinct parts to combining the two SAMs.

First, the flow of funds from Households to Corporations is the balancing item in all versions of the SAM. In the Household SAM, the value for this is calculated at £6,401m. In the Government SAM, however, it rises to £7,031m, as explained in Section 3.5.2. Note that this re-balancing of the Household account results in altering the individual Household accounts' totals (in comparison to the Household SAM), whilst holding the combined Household total constant at £107,877m.

Second, both direct and indirect tax payments from Households to the Tax accounts are disaggregated by Households. This is done by using the same shares that are employed to disaggregate tax payments in the Household SAM. The data for this are from IGOTM. Recall that these tax payments are captured both as direct payments from Households to the Government as well as payments to the "Taxes on Expenditure" account in the Household SAM.

Table 4.6.1 shows that Household make payments of £25,356m to the UK Tax account and of £1,961m to the Local Tax account (these are both direct and indirect taxes). Note that these figures from the Government SAM are used as the control totals for the Combined SAM. The IGOTM shares are then multiplied with the relevant control total in order to compute tax payments disaggregated by both Tax account and Households.

Note that the Government SAM reflects the fiscal framework for Scotland under the Scotland Act 1998. Here only the Council Tax is devolved to Scotland (The UK Parliament, 1998). That tax is paid to the Local Authorities, hence this is captured as flows of funds from Households to the Local Tax account (£1,961m in Table 4.6.1). The remaining taxes, both direct and indirect, paid by Households all flow to the UK Tax account (£25,356m in Table 4.6.1).

Third, payments from the Government to Households, i.e. welfare/benefit payments are disaggregated for the Combined SAM. The Government SAM identifies that £13,519m of welfare payments flow from the UK Government to Households. A further £6,316m flow from the Local Government to Households (see Table 4.6.1). The same method as with tax payments above is employed in order to identify welfare payments by both Government and Household.

The IGOTM data used in the Household SAM disaggregates welfare payments by Household type. The Government SAM control totals for welfare spending are multiplied with the "Income from Government" shares from Table 9.5.11. This disaggregates welfare spending by both the Household and Government account. Note that the same shares are used for the UK Government payments and for the Local Government payments. The Scottish Government is not assigned any welfare payments here, since this is not part of the devolution settlement under the Scotland Act 1998 (The UK Parliament, 1998).

The method outlined above uses the Government SAM as control totals. The corresponding shares used in the construction of the Household SAM are multiplied with the tax and welfare entries in the SAM. The method uses the same data that is employed in building the Government and Household SAM, which ensures internal consistency between the different stages of disaggregation.

4.7 Combined SAM Analysis

The Combined SAM provides great detail on the flow of funds between the private and public sectors in the Scottish economy. It combines the income and expenditure flows by seven Household types from the Household SAM with the disaggregated Government and Tax accounts from the Government SAM. Hence, the Combined SAM inhibits the level of detail of both the Household and of the Government SAM in one system. This is a unique level of detail for a Scottish SAM.

The Combined SAM fulfils the data requirements for this thesis to study both the fiscal framework for Scotland under different stages of fiscal devolution (see chapter 6) as well as the impact of tax shocks across Households (see chapter 8).

Section 4.7.1 discusses the Combined SAM, which includes analysing the flow of funds information contained in it. Section 4.7.2 looks at some of the underlying statistics of the data employed in the SAM, with particular emphasis on the population data of the Household types. The focus of this section is on the entries that combine the information of the Household and of the Government SAM.

4.7.1 The Combined Household and Government Disaggregated SAM

Table 4.7.1 is the Combined Household and Government Disaggregated 2009 SAM for Scotland. It expands on both the Household SAM and on the Government SAM. It identifies income and expenditure flows for seven Household type accounts, three Government accounts and three Tax accounts in one SAM framework. It is consistent, on aggregate, with the Government SAM, which was used as a control total for linking the Government and the Household SAM.

Furthermore, it is consistent with the methods employed to build the Household SAM as well as with the methods used for the construction of the Government SAM. That is to say, that although the Government SAM provides the control totals also for the aggregated Household account, the way the Household account is disaggregated is consistent with the method employed for the Household SAM.

The Combined SAM's total is £723,502m, that is the the same as for the Government SAM which was used as the control total (see Tables 4.6.1 and 4.7.1, respectively). The individual account totals shown in Table 4.7.1 are also equal to those in

Table 4.7.1: Government and Household Disaggregated SAM for Scotland, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Household 1	6. Household 2	7. Household 3	8. Household 4	9. Household 5	10. Household 6	11. Household 7	12. Corporations	13. UK Government	14. Scottish Government	15. Local Government	16. UK Tax	17. Scottish Tax	18. Local Tax	19. External	Total
1. Activities	63,607	-	13,981	-	15,567	11,986	6,897	810	6,267	6,267	2,007	-	5,924	13,372	10,190	-	-	-	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	2,497	1,384	331	109	19	444	287	25,007	89	5	25	-	-	-	-10,267	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38,441
5. Household 1	-	26,643	-	1,698	-	-	-	-	-	-	-	5,192	832	-	388	-	-	-	1,542	36,296
6. Household 2	-	21,026	-	644	-	-	-	-	-	-	-	3,042	2,131	-	995	-	-	-	985	28,823
7. Household 3	-	7	-	718	-	-	-	-	-	-	-	2,780	4,721	-	2,205	-	-	-	239	10,671
8. Household 4	-	947	-	-	-	-	-	-	-	-	-	108	346	-	161	-	-	-	35	1,596
9. Household 5	-	1,009	-	1,710	-	-	-	-	-	-	-	2,097	3,949	-	1,845	-	-	-	606	11,216
10. Household 6	-	10,280	-	430	-	-	-	-	-	-	-	1,396	1,140	-	533	-	-	-	520	14,300
11. Household 7	-	3,648	-	88	-	-	-	-	-	-	-	487	401	-	187	-	-	-	163	4,975
12. Corporations	-	-	-	29,456	3,347	2,244	165	11	27	940	298	-	2,660	3,062	-	-	-	-	11,298	53,507
13. UK Government	-	-	-	529	-	-	-	-	-	-	-	-	-	-	-	35,221	-	-	20,112	55,862
14. Scottish Government	-	-	-	1,780	-	-	-	-	-	-	-	-	25,303	-	-	-	-	-	-	27,082
15. Local Government	-	-	-	1,388	-	-	-	-	-	-	-	-	-	10,644	-	-	-	3,761	738	16,531
16. UK Tax	4,779	-	1,495	-	8,316	8,087	530	296	2,513	4,081	1,532	3,269	-	-	-	-	-	-	322	35,221
17. Scottish Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18. Local Tax	-	-	-	-	654	660	24	28	163	306	126	1,801	-	-	-	-	-	-	-	3,761
19. External	40,532	-	4,455	-	5,914	4,462	2,725	343	2,227	2,262	725	8,328	8,367	-	-	-	-	-	10,470	90,808
Total	210,920	63,561	19,930	38,441	36,296	28,823	10,671	1,596	11,216	14,300	4,975	53,507	55,862	27,082	16,531	35,221	-	3,761	90,808	723,502

the Government SAM. The aggregated Household account total at £107,877m is the same as in both the Government and the Household SAM.

Table 4.7.1 identifies the flows from Government to Households and from Households to the Tax account in greater detail than any previous SAM for Scotland. The Combined SAM captures the Government disaggregated welfare flows from the public sector to Households. These flows are disaggregated here by Government and the seven Households.

The total amount of transfer payments by the UK Government is £13,519m and the Local Government makes transfer payments to Households of £6,316m. The Scottish Government does not make any welfare payments here. However, different stages of fiscal devolution are modelled in chapter 6, including welfare payments from Scotland.

Note that the total amount of transfer payments differs between the Government accounts, but the proportions received by Households of the total welfare spending are constant. That is to say that, for example Household 3 is the highest recipient of welfare by all Government accounts and Household 4 receives the smallest amount of transfer payments.

The figures in Table 4.7.1 show that, for example Household type 1 receives £832m from the UK Government and Household 2 receives £2,131m. Recall that Household 1 and 2 are both 'working' Households, but Household 1 is 'without children' whereas Household 2 is 'with children'. Hence these figures indicate that Households with children receive, as expected, a higher benefit package.

The transfers from the UK Government to Household 3 are £4,721m and to Household 4 are £346m. Recall that Household 3 is 'non-working without children' and Household type 4 is 'non-working with children'. This might seem counter-intuitive at first, since Households with children are subject to higher welfare benefits than Households with the same broad characteristics but without children are (for example through 'child benefit' (Department for Work and Pensions, 2015a)). However, these differences might be due to the classifications of the Household types. This is discussed in detail in section 4.7.2.

The remaining UK Government to Households payments are for Household 5, 'Pensioners', and for Household 6 and 7, 'Multiple Tax Units without children' and 'Multiple Tax Units with children', respectively. Pensioners receive £3,949m, which is the second highest welfare payment. This figure is made up predominantly of state pension payments and other retirement benefits (Department for Work and Pensions, 2011a). Household 6 receives £1,140m and Household 7 £401m. The latter Household types include a wide variety of Households with different characteristics. Hence, it is difficult to analyse the exact benefit framework that is underlying these payments.

The Local Government also makes welfare payments to Households as noted above. These are not discussed in detail here, since, although smaller in total volume, the Local Government payments are equal in proportion to those made by the UK Government to Households. Hence the underlying data characteristics mentioned above, i.e. Household type classifications, also affect the numbers here.

Additional to the more detailed flows from Government to Households, the Combined SAM also captures tax payments at a disaggregated level. Table 4.7.1 identifies both direct and indirect tax payments by seven Household types to three Tax accounts (UK, Scottish and Local). Since the Combined SAM reflects the fiscal arrangements for Scotland of 2009, Households are paying most of their taxes to the UK Government and some to the Local Government.

Table 4.6.1 shows the total of taxes flowing from Households to the UK Government at £25,356m and to the Local Government at £1,961m. The latter is Council Tax, which is collected by Local Authorities in Scotland (The UK Parliament, 1998). All remaining taxes paid by Households flow to the UK Government through the UK Tax account in Table 4.6.1. Note that the Scottish Government does not receive any taxes here. However, the Scottish Government does receive Household tax payments under further stages of fiscal devolution, for example, under the Scotland Act 2012 (The UK Parliament, 2012) . This is modelled in chapter 6.

Households 1 and 2 pay the highest amount of taxes to the UK Government with £8,316m and £8,087m, respectively. Recall that these are the two 'working' Households and hence income tax payments as well as national insurance payments will be highest for these Household types. In contrast, Households 3 and 4 pay £530m and £296m each. These are the 'non-working' Households, hence the difference in the tax payments is well founded (see ONS (2012) for further details).

Household 5, 'Pensioners', pay £2,513m in taxes to the UK Tax account. Household 6 and 7 pay £4,081m and £1,532m, respectively. The latter two Household types are the 'multiple tax units', which are difficult to classify based on Household characteristics. However, these Household accounts include 'working' Households, which are subject to the same tax liabilities as Households 1 and 2, for example. The total volume of tax payments by Household type in the Combined SAM are also subject to the impact of the classification for each Household account. This will be discussed in section 4.7.2.

As noted above, Households also pay the Local Taxes, which is the Council tax only here. Although smaller in total, the distribution across Households is the same as for the UK Tax payments. Therefore, these payments are not discussed in detail here.

The Combined SAM offers a unique level of detail for the flow of funds in Scotland. The SAM has 'full' industry disaggregation with 104 sectors, seven Household accounts (by type), three Government accounts and three Tax accounts. The Combined SAM identifies welfare and tax payments, in particular, at a highly disaggregate level, as discussed above. These data enable researchers to model changes to the fiscal framework in greater and more accurate detail (see chapter 6). Furthermore, the SAM is the building block for a more disaggregate CGE model, which incorporates both a disaggregated Household account and a disaggregated Government account (see chapter 8).

4.7.2 Tax and Welfare Flows Analysis for the Combined SAM

As noted above, the transfers between the Household and the public sector in the Combined SAM are affected by underlying data characteristics such as the classification of Household types. This section discusses the entries between Households and the Government and Tax accounts in detail through the use of some summary statistics. Understanding the flow of funds between these sectors is vital for interpreting the results in any modelling work, for example the SAM modelling in chapter 6.

Recall that there are three groupings of Household types: 1 & 2 are 'working', 3 & 4 are 'non-working' and 6 & 7 are 'multiple tax units'. Note Household type 5 captures all Households classified as 'Pensioners', hence there is no comparative type. Highlighting the difference between Households with similar characteristics, e.g. the groupings above or whether Households are with or without children, aides the reader's understanding of the accuracy of the Household type classifications, discussed below.

Table 4.7.2 reports the totals of tax payments and of welfare receipts by Household type. The second line under 'Total Tax Payments' as well as under 'Total Welfare Receipts' is the proportion of each Household's tax expenditure/ welfare income of the total. These data illustrate that Households 1 and 2 ('working') have the highest tax liabilities with around 65% of the total. In contrast, Households 3 and 4's tax payments make up a combined 3% of the total.

Household 5's tax liability is around 10% of the total and Households 6 and 7's is of a combined 22%. Overall, the data show that Households with children (Households 2, 4 and 7) pay less tax than those in the same 'grouping' but without children (Households 1, 3 and 6). The differences between the two 'working' and the two 'non-working' Households is at just 1 percentage point, whereas Household 6 pays 10 percentage points more tax than Household 7.

Table 4.7.2 also reports figures for tax payments that are 'Final Demand Weighted'. These figures are computed by multiplying each Household's tax payment with the corresponding 'Final Demand Share' for each Household These shares are reported in the last row in Table 4.7.2.

Weighing the tax payments by the Final Demand Share produces figures that reflect the tax liability by Households' purchasing power. This method aides in comparing the tax liability across the different Household groupings. Note that Households are

Table 4.7.2: Households and Public Sector Transfers, 2009 basic prices (£million)

	HH 1	HH 2	HH 3	HH 4	HH 5	HH 6	HH 7	Total
Total Tax Payments	8,970	8,747	554	323	2,676	4,387	1,658	27,317
	33%	32%	2%	1%	10%	16%	6%	
Final Demand Weighted	8,539	6,575	3,783	444	3,437	3,437	1,101	
Variation	432	2,173	- 3,229	- 121	- 761	950	557	
Total Welfare Receipts	1,220	3,126	6,926	507	5,794	1,673	589	19,835
	6%	16%	35%	3%	29%	8%	3%	
Final Demand Total	15,567	11,986	6,897	810	6,267	6,267	2,007	
Final Demand Share	31%	24%	14%	2%	13%	13%	4%	

subject to different tax liabilities and benefit receipts if, for example, children are part of the Household. This is not taken into account when applying the Final Demand weight.

Table 4.7.2 identifies, for example, that Households 1 and 2 have very similar tax liabilities of £8,970m and £8,747m, respectively. In contrast, their Final Demand Totals are £15,567m for Household 1 and £11,986m for Household 2. Applying the Final Demand weight to the tax payments produces a figure for Household 1 of £8,539m and for Household 2 of £6,575m. Hence, the Final Demand Weighted tax payments are both adjusted downwards by £432m for Household 1 and £2,173m for Household 2 (these figures are reported under 'Variation' in Table 4.7.2).

These figures suggest that Household's 2 actual tax burden is proportionally higher than Household 1's. In particular, if taking into consideration that Household 2 is the 'working' Household with children. The actual tax payment figures and the Final Demand weighted figures are reproduced in Figure 4.7.1. In general, the 'working' and 'non-working' Households' actual tax liabilities are close in terms of value.

Figure 4.7.1: Household Tax Payments Comparison

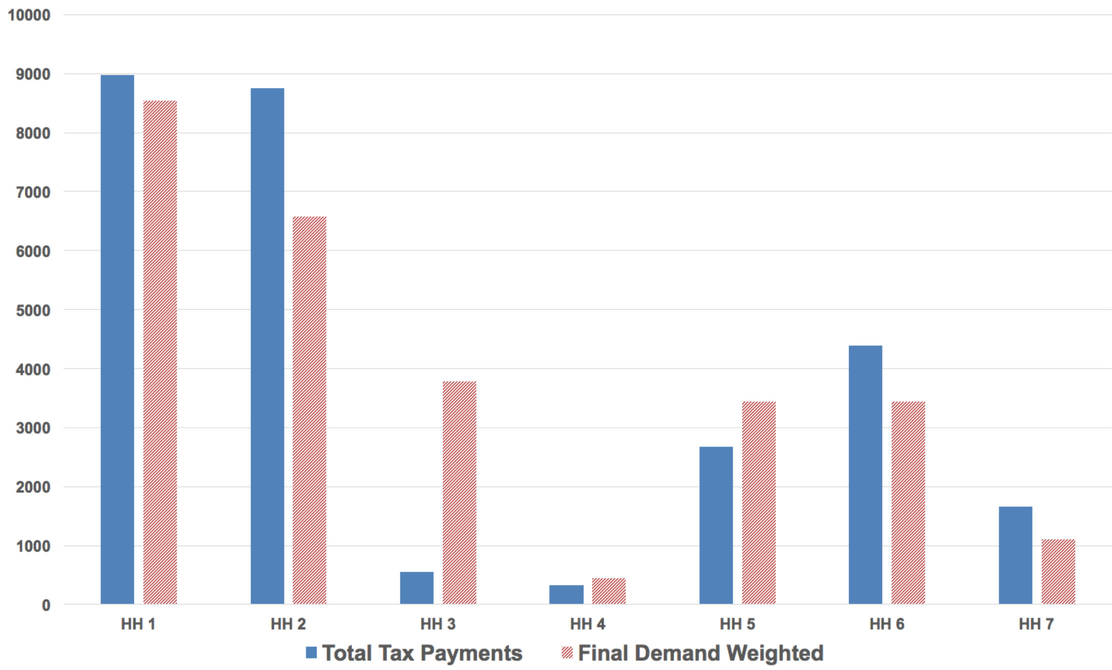


Figure 4.7.1 shows that there are some significant variations when the weighting is applied, in particularly for Households 2 and 3. It illustrates that the weighting of the figures results in a more even distribution of tax liabilities overall. This suggests that Household tax payments are not reflective of some Households' purchasing power. Note that the Household types are grouped by characteristics and not by population size. That is to say that the different Household groups can differ significantly in how many individual Households are included in each type. Due to the various data sources used in disaggregating the Household account, there is no accurate population estimate for each type, however.

Table 4.7.2 also reports the Total Welfare Receipts by Households and their respective shares. Note that no weighting for the Final Demand Total is applied to these figures. Across the different Household groupings, the two 'non-working' Households (3 and 4) receive the highest share of welfare receipts with a combined total of 38%. Next, 'Pensioners' (Household 5) receive 29%. The two 'working' Households (1 and 2) receive 22% in total and Households 6 and 7 receive a combined 11%.

The general distribution of welfare receipts seems sensible. However the welfare payments to Household 4 seem counter-intuitive. Households 3 and 4 are both 'non-working', and Household 4 is 'with children'. Household 3 receives 35% of all benefits, whereas Household 4 receives only 3%. However, the actual tax and welfare figures are not weighted for the population size of each Household type. That is to say that Household type 3 might include a larger share of the total population than Household 4.

Overall, the data in Table 4.7.2 aligns with the tax and welfare flows in Scotland observed in other official publications Department for Work and Pensions (2011a, 2015b). In general, working Households pay most of Household tax and those who are not working, pay the smallest amount. Also, non-working and pensioner Households receive the highest amount of welfare. As highlighted above, the actual figures do not take account of population size.

4.8 Conclusion

This chapter disaggregated the 2009 SAM for Scotland by seven Household types. The method of disaggregation employs, where possible, publicly available data and is replicable for other years and potentially other regions/countries. The disaggregation offers a 'full' industry breakdown (104 industries).

Furthermore, this chapter combined the Government and the Household SAM to produce a SAM, which is disaggregated by seven Household types and three Government and three Tax accounts. This is a unique level of disaggregation, which enables more detailed and accurate studies of the flow of funds in Scotland.

The Combined SAM provides the framework for a more detailed SAM model. For example, the impact of an exogenous demand shock under different stages of fiscal devolution (see chapter 6). Furthermore, the Combined SAM can be employed for a disaggregated CGE model that simulates the distributional impact of fiscal policies, such as a hike in income taxes (see chapter 8).

Chapter 5

Type II Multiplier Analysis

5.1 Introduction

Input-Output (IO) multiplier are widely used in order to simulate the impact of exogenous shocks to an economy. Most commonly demand shocks are modelled using IO Type I and Type II multipliers. Type I multipliers capture the linkage effects between industries with the household sector being treated as an exogenous expenditure sector. Type II multiplier aim at incorporating the impact on household consumption following the initial demand shock.

This chapter compares methods for calculating IO Type II multipliers. These are formulations of the standard Leontief demand-driven IO model which attempt to endogenise at least a part of household consumption. This is done essentially through a two-step process. First, a link is made between income generated in production and household income. Second, the endogenous change in household income then stimulates corresponding changes in household consumption.

There are two basic IO Type II multiplier methods that are available in the literature. This difference does not appear to be explicitly acknowledged or understood in the current literature. The choice of the Type II method has a marked effect on the multiplier value. This lack of homogeneity in deriving the Type II multiplier is also problematic when multiplier values are compared across different economies. The discussion of these different methods also raises methodological issues such as the treatment of non-wage income.

In this discussion the standard IO assumptions that hold in production are assumed to be extended to the generation of household income and expenditure. These assumptions are that there are no supply constraints and that there are fixed coefficients in the linear production and consumption functions. This implies that all responses to changes in demand occur through changes in output, with no changes in prices, and that these responses are linear, with average and marginal values being identical.

This chapter sets out to contrast the two principle methods for deriving Type II multipliers and to highlight the difference in computation and interpretation between them. Section 5.2 summarises the underlying issues when endogenising household expenditure for the Type II multipliers, section 5.3 outlines the different Type II multipliers in detail and section 5.4 provides an introduction to Social Accounting Matrix multiplier. Section 5.5 analytically compares the Multiplier Values, section 5.6 outlines the data used, 5.7 details the calculations and 5.8 analyses the results. Section 5.9 discusses the implications of the findings and concludes.

5.2 Endogenising Households in Type II Multipliers

Input-Output (IO) multipliers are widely used in order to simulate the impact of exogenous shocks to an economy, see for example Allan et al. (2007); P. McGregor et al. (2008); Wiedmann et al. (2007). Most commonly demand shocks are modelled using IO Type I and Type II multipliers, for example Fraser of Allander Institute (2014).

For an increase in final demand, in one sector, the Type I multiplier incorporate two distinct output effects. The direct effect is the increase in production required in that sector to satisfy the change in final demand. The Type I multiplier also incorporates the expansionary effect on the output of intermediate sectors, and how these sectors will in turn increase their demand for their own intermediate inputs, and so on. The activity that is generated by the sum of these demands for intermediate inputs is the indirect effect. The indirect effect thereby identifies the interdependencies of the various sectors to satisfy a final demand increase in one sector (Miller & Blair, 2009).

These multiplier effects occur because sectors buy / sell intermediate inputs to one another. Therefore an increase in sales in one sector increases output in others, generating a linear relationship between final demand and output. IO analysis demonstrates that all output can be attributed to final demand, since all intermediate demand is endogenised, and that multipliers show how a change in final demand results in the change in vector of outputs. The sum of these changes gives the value of the respective output multiplier (Miller & Blair, 2009).

Type I multiplier treat household consumption as an exogenously determined final demand category. Type II multiplier aim at also capturing the impact on household consumption following the initial demand shock. This is done by endogenising household expenditure in the model. That is to say, households are now treated as an income sector.

By endogenising households, the Type II multiplier shows three levels of effect: the direct- and indirect effect (as seen in the Type I multiplier) and the induced effect. This effect shows induced changes in household consumption (Miller & Blair, 2009). This change is due to the impact that the initial demand shock has on the income (wages and other income sources) for households and their change in spending compared to the base scenario. This approach is similar to that taken in the Keynesian multiplier where changes in output lead to changes in household income which in turn changes household expenditure (Raa, 2006).

IO tables have GDP determined in production which in turn is a primary source of household income. The Type II multiplier therefore attempts to link household consumption to income generated in production. The different methods used to endogenise household expenditure in the Type II multiplier focus on wages but use different methods to link wages to household expenditure. A secondary issue that must be acknowledged is that there are other income sources to households, such as Other Value Added (OVA).

A literature review reveals that Miller and Blair (1985) and Batey (1985) adopt alternative methods in calculating the Type II multiplier. These two methods are henceforth referred to as $Miller\&Blair$ and $Batey1$ respectively. The aim of both methods is to endogenise households by using information that is contained within the IO tables (the data used to compute the multipliers).

The Type II $Miller\&Blair$ uses the total of the "Compensation of Employee" (wages) as the denominator for the technical coefficients of the household sector. Thereby this method endogenises all of household consumption by linking it to wages. Yet, this method does not acknowledge that there are income flows (such as OVA), and thereby does not take into account expenditures driven by exogenous income. This method thereby tends to inflate multipliers (Miller & Blair, 1985).

The benefit, however, of using this method is that the data required to compute the Type II multipliers are available within the IO tables. This method would be correct in situations where there are no additional flows of income to households other than wages.

The $Batey1$ multiplier uses the total household expenditure as given in the IO table as the denominator. This method tries to counter the shortcomings of $Miller\&Blair$ by attempting to endogenise only that part of household consumption that is driven by wages which are linked to production. Yet, this method does not explicitly link transfers and other income sources generated in production to households. Thereby, the multipliers derived by this method may be 'too small' (Batey, 1985). Again, the benefit from using this method is that the data required to compute the Type II multiplier are available within the IO tables.

It is, however, anticipated that both $Miller\&Blair$ and $Batey1$ are not adequate in endogenising household expenditure flows, as IO tables, by design, do not capture all income and expenditure flows to households. $Batey1$ recognises this there are no explicit links within the IO data to capture the implied flows of funds. Moreover, the size of the multipliers is expected to vary significantly between these two models. Both methods have a weakness in appropriately endogenising factors of income and in link these to household consumption.

Given these shortcomings a third Type II model is used, which includes all known income flows to households from a source external, but compatible, to the IO tables. This method uses data from a Social Accounting Matrix (SAM) which captures all household income and expenditure flows in a explicit way. That is to say, it identifies 'all' income flows between production and domestic institutions (including households).

The SAM is an extension to the IO tables and incorporates these fully. Thereby the derived multipliers stem from comparable data. The third Type II model, henceforth referred to as $Batey2$, uses the total expenditure of the household sector from the SAM.

$Batey2$ is similar to $Batey1$ in that it does not treat all of household expenditure as endogenous but it includes income flows in addition to wages. Thereby, $Batey2$ is more inclusive in linking income to household expenditure. In order to measure which model has the closest approximation, a SAM multiplier is also computed.

The SAM multiplier offers the most inclusive study of the multipliers. As well as endogenising the household sector, the SAM multiplier also endogenises the corporate sector. The advantages of the SAM are that it fully identifies the sources of household income. It therefore has more scope in completely identifying linkages between production and income sources.

The SAM multiplier is used as a benchmark as it automatically includes the Compensation of Employees and household coefficients. The inter-industry flows and the Income from Compensation of Employees entries are the same for the IO and the SAM multiplier calculations. The variation of the multiplier values for the methods is due in part to the different totals used for endogenising the household sector. Thus the assumption is that the multipliers closest in value to the SAM multipliers are the most inclusive Type II multipliers. The detailed derivation of the different multipliers is given in the following section.

5.3 IO Multiplier

IO tables allow for the computation of various types of multipliers, including income, employment and output multipliers. The focus here is on the latter. The output multiplier is the most basic multiplier. Other multipliers, such as the employment multiplier, are built on the framework of the output multiplier. Therefore, both Type I and Type II income and employment multiplier, for example, can be analysed following the same procedure. Type II multipliers are extensions of Type I multiplier.

Section 5.3.1 outlines the derivation of the Type I multiplier. Section 5.3.2 derives the generic Type II. Section 5.3.3 details the $Miller\&Blair$ model. Building upon this, the following sections (5.3.4 and 5.3.5) outline $Batey1$ and $Batey2$.

5.3.1 Type I

The Type I multiplier quantifies the 'knock-on' effects throughout the economy of a change in final demand. It incorporates the direct and the indirect effect associated with the production for final demand (Miller & Blair, 2009). The data needed for the computation of Type I multiplier are the inter-industry flows documented in the IO tables, the relevant column totals as well as the "Total Output" for each industry. The derivation of the Type I multiplier is outlined below. A more detailed description of the Type I multiplier is presented in Appendix 5. The Type I multiplier is the framework on which all other IO multipliers, including the Type II output multiplier in this chapter, are based.

The Type I, as well as, the Type II multiplier in section 5.3.2 and the SAM multiplier in section 5.4 are based on Leontief production functions (Miller & Blair, 2009). An underlying assumption here is that quantities and thus technical input coefficients are fixed.

Practically this translates into assuming fixed prices for multipliers derived from the IO framework. That is prices for intermediate and final goods as well as the proportions of inputs needed for production remain constant and do not change following an exogenous shock to the IO or SAM system. This implies that only outputs of production factors adjust to clear markets whilst prices remain fixed. Furthermore the supply of non-produced inputs is assumed to be completely elastic at the existing price.

All IO multiplier are based on the Leontief Inverse (Leontief, 1986). Equation 5.3.1 details the first step in its derivation for an economy with n production sectors. The column totals of which are the output multiplier for the respective industry. The A-matrix is a $n \times n$-matrix of the technical coefficients, derived by dividing each sector column entry by its relevant column total. The x is a $n \times 1$-matrix of the total output of each sector i. f is a $n \times 1$-matrix and this is the Final Demand total of each sector, respectively.

$$Ax + f = x \tag{5.3.1}$$

Equation 5.3.2 shows the intermediate step in order to derive the equation for the total output of each sector x. Subtracting Ax from both sides of 5.3.1 gives

$$f = [I - A]x \tag{5.3.2}$$

Pre-multiplying both sides of 5.3.2 by $[I - A]^{-1}$ produces the familiar:

$$[I - A]^{-1} f = x \tag{5.3.3}$$

The total output of each sector x is given by Equation 5.3.3, which also shows the Leontief Inverse explicitly, $[I - A]^{-1}$. Equation 5.3.3 means that a unit increase in final demand for output i will generate increases in output in the jth industry that can be found as the jth element of the ith column of the $[I - A]^{-1}$. Summing the elements of column j gives the Type I multiplier for sector j, M_j^I. This is the total output across all sectors associated with a unit increase in exogenous demand for the output of sector j. If there are n sectors it is given as:

$$M_j^I = \sum_{i=1}^{n} a_{i,j} \tag{5.3.4}$$

Note that equation 5.3.3 can be interpreted as an accounting identity, in that any initial set of IO accounts can be manipulated in this way so that the actual vector of outputs is attributed to actual final demand. Imposing all the relevant assumptions results in equation 5.3.3 being interpreted as a model in which changes in final demand will drive, in a linear and deterministic manner, total output.

5.3.2 Type II Output Multiplier

The Type II output multiplier extends the Type I output multiplier by linking household consumption to income generated in production. In the Type I model, household consumption demand is included in (exogenous) final demand. Type II multipliers seek to endogenise some or all of the household consumption. As noted earlier, this should be in principle linked to all income that is generated in production. In practice both Type II IO approaches link household consumption to wage income.

This task presents two central problems, both relating to the limited information available in the IO accounts. The first is that it is not possible to track fully all the income that is generated in production which goes, either directly or indirectly, to households. The second is that with the data given in the IO accounts, accurate household coefficients cannot be calculated.

Type II multiplier incorporate the induced changes in household consumption whilst retaining the direct and indirect effects, as outlined for the Type I multiplier (Miller & Blair, 2009). This induced change is a result of the impact of the demand shock on household income (both wages and other income sources) and thus their (induced) change in spending compared to the base scenario. Note that it is consistent with Keynesian multiplier analysis, which is driven solely by consumption demand (Raa, 2006).

To begin, although household income should be linked to all factor income that is generated in production, the conventional IO Type II approaches tie endogenous household consumption solely to wage income. The total wages, W, generated in production are straightforward to calculate. They are given as:

$$W = wx \tag{5.3.5}$$

In equation 5.3.5 w is the $1xn$ vector of wage coefficients, where the ith element is the wage payment in sector i divided by the total output of that sector. In the Type II multiplier, labour demand is therefore generated in the same way as the demand for any other intermediate input.

The key aspect of the Type II multiplier is that the household consumption demand vector given in the IO accounts, c, is divided into two $n \times 1$ vectors representing endogenous, c_N^Z, and exogenous, c_X^Z , household consumption expenditures. In principle, endogenous household consumption expenditure is expenditure funded by income generated in production, whereas exogenous household expenditure is financed through savings, transfers (pensions, welfare payments, etc.). Each of the three multiplier methods, identified by the superscript Z, does this breakdown in a different way, but in all:

These, together with the matrix of technical coefficients A, do not vary across different Type II IO methods. However, the h^Z , the $n \times 1$ vector of household coefficients, does differ across the different approaches and this affects what is taken to be exogenous final demands. Therefore where equation 5.3.4 is taken as an accounting identity, the different methods will have different values for the level of (exogenous) final demand.

$$c = c_N^Z + c_X^Z \tag{5.3.6}$$

In the Type II IO context, the ith element of the c_N^Z vector is equal to the appropriate consumption coefficient, ϕ_N^Z, times what is taken to be the endogenous household income, Y_N^Z . Therefore:

$$c_N^Z = \phi_N^Z + Y_N^Z \tag{5.3.7}$$

where ϕ_N^Z is the $nx1$ vector of endogenous household consumption coefficients. Combining equations 5.3.2, 5.3.5, 5.3.6 and 5.3.7 and presenting in matrix form gives:

$$B^Z j^Z + f^Z = j^Z \tag{5.3.8}$$

where B^Z is an $(n+2) \times (n+2)$ matrix, and where f^Z and j^Z are $n+2$ column vectors, given as

$$B^z = \begin{bmatrix} A & 0 & \phi_N^Z \\ w & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}, f^z = \begin{bmatrix} f - c_N^Z \\ 0 \\ 0 \end{bmatrix} \text{ and } j^z = \begin{bmatrix} x \\ W \\ Y_N^Z \end{bmatrix} \tag{5.3.9}$$

Using the familiar matrix inversion, the Type II accounting identity that corresponds to equation 5.3.3 in the Type I formulation:

$$[I - B^Z]^{-1} f^z = j^z \tag{5.3.10}$$

The matrices and vectors A, w and c do not vary across different IO Type II methods. However the ϕ_N^Z vector of endogenous household coefficients does and this will also imply variations across multiplier methods in the endogenous final household consumption demand vector, cN^Z.

As with the Type I multipliers, if $\beta_{i,j}$ is the coefficient in the ith row and jth column, the multiplier value for sector j is the sum of the first n elements of the jth row. That is to say:

$$M_j^Z = \sum_{i=1}^{n} \beta_{i,j} \tag{5.3.11}$$

Again, this is the impact on total output of a unit change in the exogenous final demand for the output of sector j.

5.3.3 Type II - Miller & Blair

Miller and Blair endogenise all household consumption. That is to say, $c_N^{M+B} = c$ and total household income, Y, consists solely of wages, so that $Y = W$. The ith element of the endogenous household consumption vector, ϕ_N^{M+B} , is therefore calculated as the ith element of the total domestic household consumption vector, c_i, divided by the total wage payment, W, so that:

$$\phi_N^{M+B} = \left[\frac{c}{W}\right] \tag{5.3.12}$$

Also implicit in this approach is that when equation 5.3.4 is used as an accounting identity, the exogenous final demand vector includes no household consumption demand (Miller & Blair, 1985).

A major benefit of using the $Miller\&Blair$ multiplier is that the data needed for the computation of the multiplier are all contained in the IO tables. However, as discussed above, using the total of household wage income for endogenising the household sector excludes other income sources from being internalised in the model. Furthermore, this total results in an inflated multiplier.

The primary problem for the $Miller\&Blair$ method is that typically only around 60% of all household income comes from wages (as detailed in chapter 2), yet the whole of household expenditure is determined by wage income in this method. This means that typically the sum of the coefficients in the household consumption vector, c_i, is greater than one. Moreover, perhaps more critically, some elements of household consumption, such as pensions and some government transfers, are conventionally treated as being exogenous, independent of income generated in current production.

This issue is 'fudged' in the example given in Miller and Blair (1985) where the sum of household consumption is made to arbitrarily equal the total wage payment. This would be correct in a situation in which there is no flow of OVA or other transfer payments to household income. Or if other transfer payments were linked either directly or indirectly to wages.

One example that would make the $Miller\&Blair$ approach defensible would be if transfer payments to households would be proportionate to the population and the population would be proportionate to employment. This is a fairly restrictive assumption placed on the economy and one that does not correspond to any empirical evidence.

As discussed later, perhaps even more critical is the fact that there are elements of household consumption, such as pensions and some government transfers, that are not dependent on income generated in current production. Therefore it is expected that the $Miller\&Blair$ approach overestimates the true Type II multiplier values.

5.3.4 Type II - Batey 1

In the approach outlined in Batey (1985) the Type II multiplier captures the household consumption that comes through changes in wage income alone. In this case, the vector of household coefficients, $\phi_N^{B_1}$, is constructed by dividing the entries in the household consumption column in the IO accounts by total household consumption, C. This implies that the ith element of the vector of coefficients equals:

$$\phi_{N,i}^{B_1} = \left[\frac{c_i}{C}\right] \tag{5.3.13}$$

A benefit of the $Batey1$ multiplier approach is that is can be computed using data contained in the IO tables alone. However, a drawback to this approach is the obverse of the problem facing the $Miller\&Blair$ method. $Miller\&Blair$ is criticized above for assuming that all income to households comes from wages.

However, a criticism of $Batey1$ is that there are also sources of income generated in production, apart from wages, that make their way into household income. Income enters the household account directly from OVA and also indirectly through the elements of corporate income that are distributed to households. Therefore endogenising household expenditure by tying it strictly to the consumption directly funded by wage income will give a multiplier that is too big.

5.3.5 Type II - Batey 2

An alternative approach retains the spirit of $Batey1$ but uses external data to endogenise the household expenditure. It is labelled $Batey2$. In this case, the vector of household coefficients, $\phi_N^{B_2}$, is constructed by dividing the entries in the household consumption column in the IO accounts by a more comprehensive total for household consumption than is used for $Batey1$ (here the household total from the SAM is used), Y. This implies that the ith element of the vector of coefficients equals:

$$\phi_{N,i}^{B_2} = \left[\frac{c_i}{Y}\right] \tag{5.3.14}$$

Using the household total from the SAM for the derivation of this Type II multiplier addresses the lack of additional sources of household income that $Miller\&Blair$ and $Batey1$ encounter. However, there are four main problems in this case. The first is that, as with $Batey1$, the $Batey2$ method does not incorporate non-wage household income generated in current production. Secondly, it ignores all the household income not spent on domestic and imported goods and services. Therefore it does not take into account some taxes, savings and other transfers.

A third problem is that the total household income, Y, is not a figure that is given in the IO accounts. It needs to come from some other source. A fourth problem is that with this method it is not possible to determine directly the exogenous and endogenous household consumption from the IO accounts. This means that one cannot use equation 5.3.4 as a consistency to check to see whether the model replicates base when applying the base value final demands. This is because the base level final demands are unknown.

In order to better endogenise household consumption a more complete set of national accounts is needed. This framework is provided by using the SAM and the more inclusive SAM multiplier instead of the IO multiplier.

5.4 SAM Multiplier

All of the Type II output multipliers discussed in section 5.3 are unable to map fully total income flowing to households. The SAM contains a more comprehensive set of accounts than the IO tables and therefore, the SAM multiplier captures all income flows to households. This includes household income stemming from the external sector. The SAM multiplier endogenises both the household and the corporate sector.

Therefore, the direct link between household income and OVA, as well as, the indirect flow of OVA through corporations to households is endogenised in the SAM multiplier. Thereby the previously discussed shortcomings of the Type II multipliers are taken into account. Traditionally, the government, capital, and external sector are treated as exogenous in the model (Round, 2003). Note that chapter 6 develops a SAM multiplier with a partially endogenised government sector, however.

The IxI table used to compute the Type II multipliers is fully incorporated in the SAM. Additionally, other external data sources are used to extend the IO database to include the above-mentioned extensions in the SAM. Thereby the SAM uses a more comprehensive dataset and thus relies on additional assumptions than the Type I or Type II output multiplier.

Note that the basic assumption of fixed prices still holds. Thus, the modelled demand shock on the economy does not affect prices, but it is assumed that there is excess capacity and unemployment, which absorb the shock (Thorbecke, 2000). Therefore, any job gains or losses are treated as permanent and instantaneous.

In the SAM multiplier, total OVA, Π, is determined in exactly the same way as wages in the Type II IO:

$$\Pi = \pi x \tag{5.4.1}$$

where π is an $n \times 1$ vector whose ith value is the OVA in the ith sector divided by the total output of that sector. A share of value added, ρY goes directly to households and a share ρR goes to corporations. Subsequently a share of corporate income, rY, is transferred to households. This means that in the SAM multiplier, corporate, R, and household income, Y, are given as:

$$R = \rho^R \Pi + T^R \tag{5.4.2}$$

$$Y = W + \rho^Y \Pi + r^Y R + T^Y \tag{5.4.3}$$

where T^R and T^Y are exogenous transfers to the corporate and household sector from the government and external sectors. Finally for household expenditure the appropriate coefficients are the $Batey2$ values. Combining equations 5.3.3,5.3.5,5.3.12,5.3.13, 5.4.2 and 5.4.3 and expressing this in matrix form produces:

$$S \begin{bmatrix} x \\ v \end{bmatrix} + \begin{bmatrix} f - c \\ f_v \end{bmatrix} = \begin{bmatrix} x \\ v \end{bmatrix} \tag{5.4.4}$$

where the S is the $(n+4) \times (n+4)$ matrix:

$$S = \begin{vmatrix} A & 0 & 0 & \phi_N^{B_1} & 0 \\ w & 0 & 0 & 0 & 0 \\ \pi & 0 & 0 & 0 & 0 \\ 0 & 1 & \rho^Y & 0 & r^Y \\ 0 & 0 & \rho^R & 0 & 0 \end{vmatrix} \tag{5.4.5}$$

where f_V is the 4×1 vector of exogenous income transfers and v is the 4×1 vector of factor and institutional incomes, so that:

$$f_V = \begin{bmatrix} 0 \\ 0 \\ T^Y \\ Y^R \end{bmatrix}, v = \begin{bmatrix} W \\ \Pi \\ Y \\ R \end{bmatrix} \tag{5.4.6}$$

Through the standard matrix inversion:

$$[I - S]^{-1} \begin{bmatrix} f - c \\ f_V \end{bmatrix} = \begin{bmatrix} x \\ v \end{bmatrix} \tag{5.4.7}$$

The multiplier outlined here endogenises both the household and the corporate sector. Therefore, the direct link between household income and OVA, as well as the flow of OVA through corporations to households is endogenised in the SAM multiplier. As mentioned previously, government, capital, and external sector are traditionally treated as exogenous in the model (Round, 2003).

Again if the element in the ith row and the jth column of the SAM inverse is represented as $_{i,j}$ then the SAM multiplier value for sector j , M_j^S , is the sum of the first n elements j

$$M_j^S = \sum_{i=1}^{n} \sigma_{i,j} \tag{5.4.8}$$

Thereby measuring the system-wide change in total output generated by a unit increase in exogenous final demand for the output of sector j.

Equation 5.4.7 identifies the characteristics of the SAM multiplier model. Expenditure in the government, capital and external accounts are wholly exogenous. Expenditures in all other accounts are endogenous. All wage and profits income generated in production go to domestic households.

Household and corporate expenditures are endogenised but in both cases there are exogenous transfers from government and the external sector, together with endogenous income indirectly from production. This means that all changes to wages and OVA generated in production, which is indirectly linked to households, are allocated to households in a way that is consistent with the standard demand-driven IO approach.

The SAM multiplier analysis is subject to the limitations imposed by the underlying IO framework, which are, inter alia, the fixed price assumption and permanent labour market adjustments, as outlined above. Furthermore, income elasticities of demand are assumed to equal 1. Thus, the impact of an increase in household income on the demand for luxury goods is understated whilst the model overstates the impact on demand for necessities (Golan et al., 2000). Nevertheless, SAM multiplier analysis overcomes the IO Type II limitations with regards to mapping household income flows comprehensively.

5.5 Analytical Comparison of Multiplier Values

If the SAM framework is accepted as the most appropriate way to endogenise household consumption in a manner consistent with the Input-Output approach, none of the standard IO Type II multiplier methods are correct. Equations 5.5.1 and 5.5.2 adjust the B^Z and S matrices shown in Equations 5.3.8 and 5.4.4 so that their structures are harmonised in order to better identify the differences.

$$\overline{B}^{Z} = \begin{vmatrix} A & 0 & 0 & \phi_N^{B_1} \\ w & 0 & 0 & 0 \\ \pi & 0 & 0 & 0 \\ 0 & \kappa^{Z} & 0 & 0 \end{vmatrix} \tag{5.5.1}$$

where $\kappa^{B1} = \frac{Y}{C}$, $\kappa^{B2} = 1$ and $\kappa^{M+B} = \frac{Y}{W}$.

There is an argument for endogenising other elements of these disaggregated accounts. In the present context, it is sometimes argued that endogenising transfers, particularly those linked to population and employment status, increases the accuracy with which household consumption is modelled (Batey, 1985; Batey & Madden, 1983; Batey & Weeks, 1989).

$$\bar{S} = \begin{vmatrix} A & 0 & 0 & \phi_N^{B_1} \\ w & 0 & 0 & 0 \\ \pi & 0 & 0 & 0 \\ 0 & 1 & \rho^{Y} + \rho^{R} r^{Y} & 0 \end{vmatrix} \tag{5.5.2}$$

Each of the four rows and columns in the $\overline{B}^{Z}$ and $\overline{S}$ matrices represent receipts and expenditures of the industries, labour, OVA and household accounts. Note that the first three rows of these matrices are identical. They use the same A matrix and w, π and c_N^{B2} vectors of coefficients. The two matrices differ solely in the fourth row which identifies the sources of income entering the household account.

In the $\overline{B}^{Z}$ matrix one adjustment is the addition of the OVA account. However, its impact is trivial. Although the OVA generated in production can be identified, the destination of OVA expenditure is unknown in the IO accounts. Therefore the OVA column, column three in $\overline{B}^{Z}$, only has zero elements. The second change is more interesting.

In Equation 5.3.8 the different Type II multiplier formulations are identified by their different household consumption coefficients. However, it is straightforward to show that this can be translated to a differences in the level of wage income transferred to households, combined with the household consumption coefficients used in $Batey2$ and the SAM multipliers.

The consumption coefficient $\phi_{N,i}^{B_1}$ is defined in equation 5.3.13 and $\phi_{N,i}^{B_2}$ in equation 5.3.14. Using these equations, the coefficients $\phi_{N,i}^{B_2}$ can be expressed as:

$$\phi_{N,i}^{B_1} = \frac{c_i}{C} = \frac{c_i}{Y} \cdot \frac{Y}{C} = \phi_{N,i}^{B_2} \kappa^{B_1} \quad (5.5.3)$$

where $\kappa^{B1} = \frac{Y}{C}$. Applying a similar procedure to equations 5.3.12 and 5.3.13:

$$\phi_{N,i}^{M+B} = \phi_{N,i}^{B_1} \kappa^{M+B} \quad (5.5.4)$$

where $\kappa^{M+B} = \frac{Y}{W}$.

Equations 5.5.3 and 5.5.4 show that the $Miller\&Blair$ and $Batey1$ household consumption coefficients are simply scalar multiples of the $Batey2$ coefficients, which are the coefficients also used in the SAM multipliers. The different Type II IO multipliers can therefore solely be represented by differences in the relationship between the change in wage income and the subsequent change in effective household income.

Given that, in the Scottish data, $Y > C > W$, the relative values of values of κ^Z for Scotland are $\kappa^{M+B} > \kappa^{B1} > \kappa^{B2}1$. Note that this implies the seemingly illogical position that in the $Batey2$ and $Miller\&Blair$ multiplier measures, more than 100% of the wage income is assumed to be transferred to household income. However, as has been remarked already, in the B^Z matrix there is no transfer of OVA to household income.

Therefore some overweighting of wage income could be justified on this basis. These observations have a number of implications. Begin with the IO Type II multipliers. For each industry, their values can be ranked in the same order as their κ^Z values. That is to say, for Scotland for any industrial sector, i; $M_i^{M+B} > M_i^{B1} > M_i^{B2}$. However, a comparison between the IO Type II and the SAM multiplier values is a little more complex.

The $Batey2$ multiplier value is always lower than the SAM multiplier: for any sector, i, $M_i^S > M_i^{B2}$. This is apparent from a comparison of the $\overline{B}^{B1}$and the $\overline{S}$ matrices given in equations 5.5.1 and 5.5.2. The only difference in the two matrices is the additional elements in the SAM matrix, $\overline{S}$, linking household income positively to OVA.

On the other hand, the value of the $Miller\&Blair$ multiplier will generally higher than the corresponding SAM value. The sum of the M_i^{M+B} values, weighted by their associated final demands, is greater than the corresponding weighted sum of the SAM multipliers.

This is because in the accounting identity (equation 5.3.8) the $Miller\&Blair$ multiplier endogenises all household income through directly linking all household income linearly to wage payments. But, in general, there are exogenous elements in household income, so that $T^Y$is positive in equation (5.4.4. This means that the $Miller\&Blair$ method typically overcompensates for not directly including the link between household income and OVA generated in production.

However, this does not mean that M_i^{M+B} is necessarily greater than M_i^S for all industries. If an industry is very capital intensive and if a significant share of OVA is transferred to household income, the SAM multiplier can be higher than $Miller\&Blair$ for particular individual industries.

Clearly the $Batey1$ multiplier takes an intermediate position, between the $Batey2$ and $Miller\&Blair$ figures. Its value relative to the SAM multiplier is wholly data dependent. The $Batey1$ average multiplier value and the value for individual sectors could be higher or lower than the corresponding SAM values, depending on the extent to which the impact of wages on household income under- or over-compensates for the missing income from OVA. This in itself might reflect the level of OVA income retained in the local economy.

5.6 Data

The data used to compute the IO and SAM multipliers are the 2009 Scottish IxI table (Scottish Government, 2013a) and the 2009 Scottish SAM, respectively. Both the IO tables and the SAM are outlined in detail in chapter 2 but a summary is presented here. It should be noted from the start that the 2009 SAM is based on the 2009 Scottish IO tables. Thereby multipliers for both IO and SAM are consistent.

The IxI table used here is for the calendar year 2009 and is sourced from the Scottish Government (2013a). Table 5.6.1 is an aggregate version of the 2009 IxI table for Scotland. Focusing on the first row and column, the row gives the expenditure on Scottish goods/services, whilst the column details the cost breakdown of the Scottish production sectors.

The IO tables define the production cost entries in the column as: intermediates, labour costs, OVA, Government and intermediate Imports from the Rest of UK (RUK), and the Rest of the World (ROW). The production income entries are defined as: Capital, household expenditure on Scottish goods/services, Government, and exports to the RUK and ROW.

The first row total of £210,920m in the aggregated IxI table 5.6.1 gives the total turnover of all production and service activity in the Scottish economy (total aggregate demand of gross outputs). It is labelled as 'Activities'. This includes private, public and voluntary sector production activity. This total can be broken down to show the interactions between individual sectors in more detail. The disaggregate version of the IxI table details these interactions at full 104 industry level.

The IxI table 5.6.1 show the destination of industry output, for example primary manufacturing products. The columns of the IxI table show purchases made by industries and final demand from each Scottish industry's output arising from both principal production and intermediate demand. Conversely, the rows provide a breakdown of industry receipts by origin.

Note that the sum of all final demands across all sectors is equal to the sum of all value added (Scottish Government, 2011a). The aggregate IxI table shows that Total Final Demand equals Total output at basic prices within the Activities account. That is, all expenditures are balanced by receipts within the Activities account (£210,920m - £210,920m = 0).

Table 5.6.1: Aggregated Industry-by-Industry Table, 2009 basic prices (£million)

	1. Activities	2. Households	3. Government	4. Capital	5. RUK	6. ROW	Total
1 Activities	63,607	49,802	29,486	13,981	36,879	17,166	210,920
2. Labour	63,561	-	-	-	-	-	63,561
3. Other Value Added	38,441	-	-	-	-	-	38,441
4. Government	4,779	6,568	-	1,495	193	129	13,165
5. RUK	30,274	13,875	-	3,358	4,362	2,890	54,759
6. ROW	10,258	4,424	-	1,097	3,057	161	18,997
Total	210,920	74,669	29,486	19,930	44,491	20,346	

Source: Scottish Government (2013a)

IO tables do not attempt to link the elements of Value Added (wages and OVA) with the elements of Final Demand (consumers, government, and investment). This is in contrast to a SAM where the “missing" data on transfers between these accounts is recorded.

Table 5.6.2 depicts an aggregate version of the SAM that is derived by combining the IO Industry-by-Industry (IxI) table and the Income and Expenditure Accounts (details on this account can be found in chapter 2). For illustrative purposes the disaggregation within accounts has been suppressed, as in Table 5.6.1. For example. the 104 industries contained in the SAM are aggregated to one industry (Activities).

However, it must be emphasised that for modelling purposes a much more detailed SAM is used. The aggregated 2009 SAM for Scotland is a square matrix with 9 column and 9 corresponding row accounts. This aggregated SAM contains the following main accounts: Activities, Labour, OVA (Profits), Households, Corporations, Government, Capital, RUK, and ROW.

The row and column entries in the SAM are considered to be receipts and expenditures receptively. The rows in the SAM show income sources for each Account in detail. For example, the household account shows that total household income is £107,877m, of which £63,561m (58 percent) comes from Labour income.

Conversely, the columns in the SAM depict the expenditures of each account in detail. Again, total household expenditure is £107,877m, of which £49,802m (46 percent) are payments to domestic productive Activities i.e. household consumption on goods/services produced in Scotland.

The first row and the first column of the SAM include all the aggregated information from the IxI table, and thus balance. That is the £210,920m from the IxI table (see Table 5.6.1) are fully incorporated. Thus, IO tables provide key macroeconomic variables (GDP and total wage income) as well a breakdown of flows between Scottish industries.

The IxI table 5.6.1 gives a breakdown of total household (£74,669m) consumption on Activities (domestic goods/services), Government and Imports. However, the IxI table does not detail other forms of expenditure, and more importantly, no explicit sources of household income. In contrast, the SAM in Table 5.6.2 provides a more detailed breakdown of household expenditure on savings, corporations, taxes, and imports. Total household expenditure is thereby estimated to be £107,877m.

In comparison to the SAM, the IxI table only captures 69 percent of total household expenditure. The SAM also presents a detailed breakdown of household income by Labour, OVA, Corporations, Government and ROW. The SAM thereby contains additional sources of household income that are not captured in the IxI table.

Table 5.6.2: Aggregated 2009 Scottish SAM, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Other Value Added	4. Households	5. Corporations	6. Government	7. Capital	8. RUK	9. ROW	Total
1. Activities	63,607	-	-	49,802	-	29,486	13,981	36,879	17,166	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	63,561
3. Other Value Added	38,441	-	-	-	-	-	-	-	-	38,441
4. Households	-	63,561	5,289	-	15,103	19,835	-	1,853	2,237	107,877
5. Corporations	-	-	29,456	6,401	-	5,722	-	5,964	5,964	53,507
6. Government	4,779	-	3,697	27,947	5,248	13,165	1,495	20,234	129	76,694
7. Capital	-	-	-	5,070	24,828	119	-	- 5,217	- 4,871	19,930
8. RUK	30,274	-	-	14,113	3,768	8,368	3,358	4,362	2,890	67,133
9. ROW	10,258	-	-	4,544	4,560	-	1,097	3,057	161	23,676
Total	210,920	63,561	38,441	107,877	53,507	76,694	19,930	67,133	23,676	

The additional information contained in the SAM, compared to the IO tables, can be used to extend and improve the multiplier modelling capacity to include the behaviour of the non-production part of the economy. In particular, the more explicit link between activity and household income should improve the Type II multiplier.

5.7 Multiplier Calculations

The following two Sections discuss the computations of the three Type II multiplier methods and the SAM Multiplier using the 2009 Scottish IxI table and SAM. First, this section discusses the derivation of the multipliers. Second, section 5.8 analyses the computations using descriptive analysis.

5.7.1 Miller & Blair

The $Miller\&Blair$ method derived in section 5.3.3 uses the total of wages from employment received by household, W. That is the "Total Intermediate Demand" of the "Compensation of employees" row in the IxI table (see Table 5.6.1), at £63,561m. Thereby, the data used to endogenise the household sector are, first, the "Income from Employment" row which gives the data on wage income from employment. And second, the "Households" column containing the entries of household expenditure on industry output.

$$h_k^{M+B} = \left[\frac{H_k}{W}\right] \qquad Where: \quad W = £63,561m \tag{5.7.1}$$

5.7.2 Batey 1

The $Batey1$ method derived in section 5.3.4 internalises exogenous household income alongside wage income in the model. Here the total used for endogenising the household sector is the total of household expenditure from the IO tables, C^H. This is the total household expenditure scalar given at £74,669m in Table 5.6.1.

$$h_k^{B_1} = \left[\frac{H_k}{C^H}\right] \qquad Where: \ C^H = £74,669m \tag{5.7.2}$$

5.7.3 Batey 2

The $Batey2$ method derived in section 5.3.5 uses a more comprehensive household Total, Y^H. This figure is derived by summing up the "Final Consumption Expenditure" of households and that of Non-Profit Organisations Serving households (NPISHs). Then the household expenditure on goods & services of the following sectors are added to the household Total: ROW, RUK, Corporate, Government and Capital. This figure amounts to £107,877m.

$$h_k^{B_2} = \left[\frac{H_k}{Y^H}\right] \qquad Where: \ Y^H = £107,877m \tag{5.7.3}$$

Note that there is an alternative figure in use, which follows the same theoretical foundation as the approach outlined here. This method uses the combined Compensation of Employees at £63,561m from the IxI table (Scottish Government, 2013a) and all 'Unearned Income' at £46,835m (Scottish Government, 2013e). The total for this method is £110,396m. This is the figure used for the official Scottish Government Leontief Inverse calculations.

5.7.4 SAM Multiplier

Equation 5.7.4 illustrates the calculation for the SAM multiplier. The inter-industry matrix of technical coefficients is given as S. Note that the household Total, h^{B2}, shown in equation 5.7.5 is the one used in $Batey2$. This figure amounts to £107,877m.

$$[I - S]^{-1} \left[\frac{F_x^S}{F_v^S}\right] = \left[\frac{x}{v}\right] \tag{5.7.4}$$

$$S = \begin{vmatrix} A & 0 & 0 & h^{B2} & 0 \\ w & 0 & 0 & 0 & 0 \\ \pi & 0 & 0 & 0 & 0 \\ 0 & 1 & \pi^h & 0 & c^h \\ 0 & 0 & \pi^c & h^c & 0 \end{vmatrix}$$

$$Where:$$

$$h^{B2} = £107,877m.$$

5.8 Descriptive Analysis

If the SAM multiplier value is accepted as the most appropriate method for endogenising household consumption in a manner consistent with the IO approach, then none of the standard Type II IO multiplier methods is ‘correct’. IO does not identify key income flows from production into (total) household income, therefore in attempting to endogenise household consumption there is, almost inevitably, some inaccuracy.

Table 9.6.1 in Appendix 5 provides a full breakdown of the Type I, the Type II ($Miller\&Blair$, $Batey1$, and, $Batey2$) and the SAM multiplier derived for 102 sectors of the 2009 Scottish IxI table and the 2009 Scottish SAM (sector 7, Oil & Gas Extraction, Metal Ores, and sector 20, Tobacco, do not contain data and are thereby omitted from the initial 104 sectors).

Appendix 5 shows the mean, the minimum and the maximum values for each of the multipliers detailed in 9.6.1. The Type I multiplier shows the lowest values. This is to be expected, since this multiplier is computed using only the inter-industry flow data from the IxI table.

The mean values for the $Miller\&Blair$, $Batey1$ and $Batey2$ variants of the IO Type II multipliers are 2.156, 2.017 and 1.810 respectively. This implies that the indirect and induced activity calculated using the $Miller\&Blair$ multiplier formulation is just less than 20% higher than the corresponding activity calculated using the $Batey1$ measure. Thus it clearly matters which formulation is used.

Table 5.8.1: Multiplier Summary Statistics

		Type II			
	Type I	Miller & Blair	Batey1	Batey2	SAM
Mean	1.465	2.156	2.017	1.810	1.910
Min	1.000	1.220	1.206	1.186	1.321
Max	2.780	3.343	3.230	3.061	3.214

The mean SAM multiplier lies within the range of mean IO Type II values. The $Batey2$ value is systematically below the SAM multiplier and the $Batey1$ and $Miller\&Blair$ approaches systematically higher. The $Batey1$ approach gives the Type II IO mean that is closest to the SAM multiplier. The minimum and maximum multiplier values also reflect these analytics.

When comparing the multipliers, there are some clear results. One is that for any sector the $Batey2$ multiplier, the multiplier reported by the Scottish Government, must always lie below the SAM multiplier value. This is because the household coefficients are the same for the two measures but the SAM multiplier incorporates that part of profits income that indirectly enters household income. Also if household income, household consumption and total wages can be ranked so that $Y^H > C^H > W$, then for any sector k; $M_k^{M+B} > M_k^{B_1} > M_k^{B_2}$. However, which is closest to the SAM multiplier is an empirical issue.

This hierarchy is also largely observed at individual sector level. It is always the case that the three IO values are in the same order, and when including the SAM multiplier, $Batey2$ always takes the lowest of all the multipliers. However, the position of the SAM multiplier value varies at sector level and is not always between $Batey1$ and $Batey2$. The $Miller\&Blair$ multiplier is below that of the SAM for sectors 27.Coke, petroleum & petrochemicals, 75. Real estate, and 76. Imputed rent.

The $Batey1$ multiplier is below that of the SAM in sectors: 1. Agriculture, 4. Fishing, 5. Aquaculture, 9. Mining Support, 17. Spirits & wines, 18. Beer & malt, 27. Coke, petroleum & petrochemicals, 47. Electricity, 49. Water and sewerage, 75. Real estate, and 76. Imputed rent. These are industries with high ratios of OVA to wages. This is because income from profits, which plays no role in any of the IO type II multipliers, is an important element of the SAM multiplier.

Figure 5.8.1 gives the difference between the SAM and the Type II multipliers. The horizontal axis here can be interpreted to represent the SAM multiplier value and thus the closer the lines are to this axis, the better the fit. This graph shows that the $Batey2$ method using the more comprehensive household figure gives the closest fit to the SAM multiplier.

The graph also depicts that this method varies less in value compared to $Miller\&Blair$ and $Batey1$, because the coefficients are the same. The $Miller\&Blair$ method shows the overall biggest differences to the SAM. This confirms that endogenising the household sector using a more comprehensive figure (external to the IO table) results in the closest fit.

Furthermore, figure 5.8.1 highlights that the difference between the methods varies substantially between the sectors. The methods using the $Batey2$ for endogenising the household sector show some variation compared to the SAM. However, there are some very pronounced spikes observable for the $Miller\&Blair$ and the $Batey1$ methods.

The three biggest differences are for sectors 93. Education, 89. Security & Investigation, and 96. Social Work. The multipliers for these sectors show large variation in comparison to the SAM multiplier. These differences seem to be due to a small gap between the values for Gross Value Added and Total Output.

Figure 5.8.1: Difference between the SAM and the Type II Multipliers

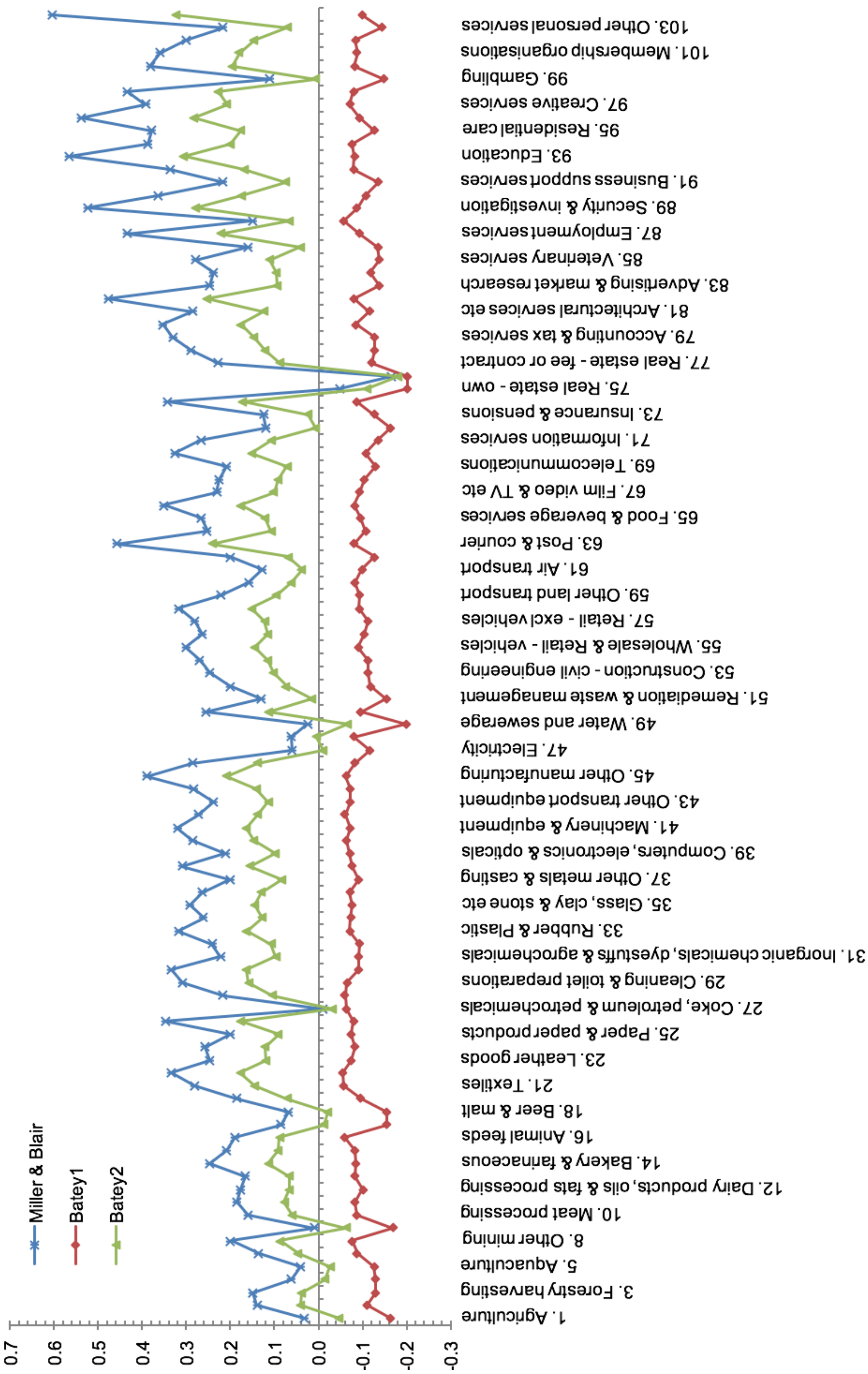


Table 5.8.2 shows various error-computations of the three IO methods. This allows for detailed measurements of the differences between the methods compared to a benchmark, here the SAM multiplier. The error-measurements are the Root Mean Squared Error (RMSE) and the Mean Absolute Error (MAE). The smallest value indicates the best fit with respect to the SAM multiplier.

Table 5.8.2: Error Statistics

	Miller & Blair	Batey1	Batey2
RMSE	0.201	0.099	0.077
MAE	0.131	0.062	0.054

All measurements show that endogenising the household sector using the SAM household total figure, $Batey2$, results in the closest fit. This method does not differ much in the error values. Also note that the methods shown can be classified into two groups. Both $Miller\&Blair$ and the $Batey1$ use purely data from the IO tables, $Batey2$ uses more comprehensive household expenditure figures which are not found purely in IO tables.

The values in Table 5.8.2 also confirm that the $Miller\&Blair$ method results in the least close fit compared to the SAM multiplier. In comparison, $Batey1$, which endogenises household expenditure using the IxI household expenditure total, results in a closer fit. The RMSE for the $Miller\&Blair$ method is given at 0.201 and the RMSE for $Batey1$ at 0.099.

The results show that if IO multipliers are computed using only the Scottish IO tables, then $Batey1$ method results in more accurate computations as opposed to the $Miller\&Blair$ method. The overall smallest error values are computed by using the $Batey2$ method which uses the household total from the SAM. However, all three methods are not 'correct' as the IO table does not identify key income flows from production into (total) household income, therefore in attempting to endogenise household consumption there is, almost inevitably, some inaccuracy.

5.9 Discussion and Conclusion

There is complete agreement about the method used to calculate IO Type I multipliers. These measure the direct and indirect output effects from a unit expansion in exogenous final demand in a particular sector. They incorporate the change in activity associated with the production of the intermediate goods that contribute directly or indirectly to the production of final demand.

Type II multipliers identify the direct and indirect effects. However, they also incorporate the impact of increased household income and subsequent consumption expenditure that accompanies any change in output. These are known as induced effects. Although this is a very common procedure, a number of different methods have been adopted in the literature.

A literature review has shown that the variation in methods is not widely recognised. This is potentially problematic for the interpretation of Type II multipliers, their use in modelling demand-side disturbances and the value for comparing the structural characteristics of different economies. Second, it would be valuable to standardise the Type II procedure, which requires choosing amongst the different formulations.

The first question is whether empirically this is a serious problem. The Scottish results suggest that it is. The range of Type II multiplier mean values is almost 40% of the most accurate measurement of additional multiplier effect. The second question is: which method is preferable? If the SAM multipliers embody the most complete linking of income generated in production and the subsequent distribution to households.

For Scotland the mean value using the $Batey2$ method is closest to the mean SAM value and has the smallest mean error, even though the method systematically underestimates the SAM multiplier values. However, this method has the disadvantage that it requires information on household income that is typically not available from the IO accounts themselves.

This indicates that when using IO tables data exclusively the $Batey1$ multiplier will provide the 'best' estimates. When incorporating data external to IO tables for the computation of the Type II multiplier, the $Batey2$ provides the closest fit.

Despite some of the models coming close to SAM multipliers, it must be acknowledged that all three Type II methods have a fundamental weakness; they all explicitly endogenise wages, and link household expenditure to these. A SAM multiplier incorporates income from OVA into household income in a way completely consistent with the standard demand-driven IO approach. It is therefore the only wholly satisfactory means of endogenising household consumption in the application of such an approach.

Chapter 6

Degrees of Fiscal Devolution - A SAM Modelling Approach

6.1 Introduction

This chapter develops SAM-based models of the Scottish economy under varying fiscal frameworks. The models are then used to quantify the effect of external demand shocks on the Scottish economy. Chapter 4 describes the construction of a SAM for Scotland that is disaggregated by seven Household types, by three Government sectors and by three Tax accounts[1].

Chapter 5 analyses the IO Type II output multiplier in detail with reference to different methods of multiplier construction currently in use in the literature. The conclusion reached in that discussion is that the SAM multiplier is superior to the IO multiplier (see chapter 5 for a more detailed discussion). This chapter employs both the highly disaggregated SAM and an extended SAM multiplier in order to study fiscal devolution in Scotland.

Scotland is currently undergoing significant changes to its fiscal framework in terms of the devolution of both greater public spending but especially tax revenue raising. First, the Scotland Act 2012 (The UK Parliament, 2012) is about to be fully implemented. The biggest fiscal change will be the introduction of the new Scottish income

[1] Recall, the Household types are: 1. Working without Children, 2. Working with Children, 3. Non-working without Children, 4. Non-working with Children, 5. Pensioners, 6. Multiple Tax-Units without Children and 7. Multiple Tax-Units with Children. The Government accounts are: 1. The UK Government in Scotland, 2. The Scottish Government and 3. The Local Government. The Tac accounts are: 1. UK Taxes, 2. Scottish Taxes and 3. Local Taxes.

tax regime coming into effect in April of 2016. This is accompanied by the devolution of a number of other taxes and an adjustment to the Block Grant. These changes are captured under “Scotland Act 2012” in this chapter.

Second, the changes proposed by the Smith Commission (The Smith Commission, 2014) have largely informed the current Scotland Bill (The UK Parliament, 2015). The new legislation will lead to further devolution of fiscal powers (both income and expenditure) from the UK Government to the Scottish (and possibly Local) Government. These changes are captured under “Scotland Bill” in this chapter. Third, further fiscal devolution from the UK to Scotland is likely in the future. This could result in full fiscal autonomy for Scotland, with no direct UK Government involvement in Scottish fiscal affairs. These changes are captured under “Fiscal Devolution” in this chapter.

It is vital for policy-makers both in Scotland as well as the rest of the UK to be aware of the implications of these changes to the Scottish fiscal framework. Additionally, economists and economic commentators need an increasing pool of academic studies which can help answer some of the questions relating to the ways in which greater fiscal autonomy for Scotland will affect the performance of the economy. This chapter aims to provide a tool to aid the economic analysis of the Scottish economy under both varying levels of fiscal devolution as well as under different (external) shocks.

This chapter is structured as follows. Section 6.2 outlines the changes to the fiscal framework for Scotland in more detail. Section 6.3 discusses the setup of the four variants of the SAM, which are used to calculate the SAM output multipliers. The four SAMs reflect the different degrees of fiscal devolution modelled outlined in section 6.2.

Section 6.4 extends the standard SAM multiplier model through partially endogenising the Government sector. Four models are then derived, each calibrated on one of the four SAMs from section 6.3. Section 6.5 models two separate exogenous demand shocks with each of the four models. Section 6.6 discusses the results in a wider economic perspective and section 6.7 concludes.

6.2 Degrees of Fiscal Devolution for Scotland

This section outlines four degrees of fiscal devolution for Scotland. The focus is on the devolution of taxes and Government spending as well as the adjustments to the block grant resulting from the rise in Scottish self-directed revenue. These four degrees are reflected in the SAMs in section 6.3.

6.2.1 Scotland Act 1998

The Scotland Act 1998 devolved the power to add 3p on the base rate of income tax to the Scottish Parliament. This power, the “Scottish Variable Rate”, was never used, however. Hence the income tax rates in Scotland remained the same as in the rest of the UK. Furthermore, the Scotland Act 1998 fully devolved Council tax and the Non-Domestic rates, which are both assigned to the Local Government in Scotland. Also, the Scotland Act 1998 confirmed the revenue support for Scotland, the ‘block grant’, which is an annual payment form the UK Government to the Scottish Government (The UK Parliament, 1998, 2012). The 2009 SAM for Scotland reflects this stage of fiscal devolution for Scotland.

6.2.2 Scotland Act 2012

The Scotland Act 2012 grants the Scottish Government more fiscal responsibility through the full devolution of some taxes and, in particular, through the partial devolution of income tax paid in Scotland. The new “Scottish Rate of Income Tax” (SRIT) comes into effect in April 2016. 10p in the pound will be taken off each income tax rate in Scotland and Scotland is allowed to set an additional tax, up to 20p in the £. In effect, this means that the Scottish Government can vary the UK income tax rate of up to 10p (+/-) in the pound and bear the revenue implications. That is to say that the Scottish Government can either benefit or detriment from higher or lower revenue receipts following a change to the Scottish income tax rates (the block grant will not be adjusted as a result of a ‘Scottish rate resolution’) (The UK Parliament, 2012).

If Scotland were to set a SRIT of 10p, this would result in the same income tax rates set for the UK. Setting either lower or higher levels implies varying the Scottish rate compared to the UK base. The Scottish Government announced that the SRIT is set at 10p for the 2016-17 fiscal year, i.e. the rate of income tax paid in Scotland remains unchanged compared to the RUK. Additionally, the Scotland Act 2012 fully devolved the Landfill Tax and the Stamp Duty Land Tax to Scotland (The UK Parliament, 2012).

The Scotland Act 2012 grants limited borrowing facilities to the Scottish Government, which were to reflect the greater fiscal authority following the introduction of the SRIT. These borrowing facilities include inter alia, borrowing for current and capital expenditure. Borrowing for capital expenditure is limited at a total of £2.2bn at any given time. Borrowing for current expenditure is predominantly put in place to cover shortfalls in forecasted revenue from devolved taxes as well as from expected revenue under a Scottish rate resolution (The UK Parliament, 2012).

6.2.3 Smith Commission & Scotland Bill 2015-16

The third degree of fiscal devolution for Scotland outlined here is the proposals made by the Smith Commission, which have been introduced as a new Scotland Bill in the UK Parliament (The Smith Commission, 2014; HM Government, 2015). In the vote on independence on 18th September 2014 the electorate in Scotland decided to remain part of the UK. However, all three major UK political parties[2] had proposed more devolution of powers to the Scottish Parliament and to the Scottish Government (The BBC, 2014). The Smith Commission[3] was formed immediately after the referendum with the remit to produce a set of proposals, which reflect the views of the representative parties and the electorate.

The Scotland Bill 2015-16 sets out that the Scottish Parliament has no limits on the income tax bands, rates or thresholds, but the personal allowances are still to be set by the UK Parliament. Second, all income tax receipts on wage income collected

[2]The parties are the Conservatives, Labour and the Liberal Democrats.
[3]Named after Lord Smith of Kelvin who oversaw the commission (The Smith Commission, 2014).

in Scotland are to be received by the Scottish Government. Third, HMRC remains responsible for collecting Scottish income taxes (The Smith Commission, 2014).

The Smith Commission's proposals on the devolution of tax and welfare powers is part of the Scotland Bill 2015-16 (The UK Parliament, 2015). However, the adjustments to the fiscal framework, e.g. the decrease in grant money to Scotland due to the increase in direct tax income, are not part of the Bill. However, the Smith Commission did provide guidance on the budget adjustments. These proposals as well as the academic work by Bell, D. and Eiser, D. and Phillips, D. (2015) inform the adjustments outlined below.

The Smith Commission recommends increasing the borrowing capacities to reflect the extended fiscal autonomy of Scotland resulting from its proposals. Scotland would be able to borrow both for current spending as well as for capital investment. However, the UK Government is to remain the potential 'lender of last resort' and to oversee automatic stabilisers in case of an economic shock. The Smith Commission proposes that the Scottish Government's budget is to benefit or bear the fiscal cost of the impact of its own policy decisions. Note that the current version of the Scotland Bill 2015-16 extends the borrowing facilities to approximately £4.75bn from £2.7bn in the Scotland Act 2012 (The UK Parliament, 2012, 2015).

The transfer of fiscal powers is subject to a 'no detriment' clause, which tries to capture any adverse tax receipt effects by differential tax regimes between Scotland and RUK [4]. Furthermore, the proposals note that where either the UK or the Scottish Government make policy decisions that affect the tax receipts or expenditure of the other, the decision-making government will either reimburse the other, if there is an additional cost, or receive a transfer from the other if there is a saving (The Smith Commission, 2014).

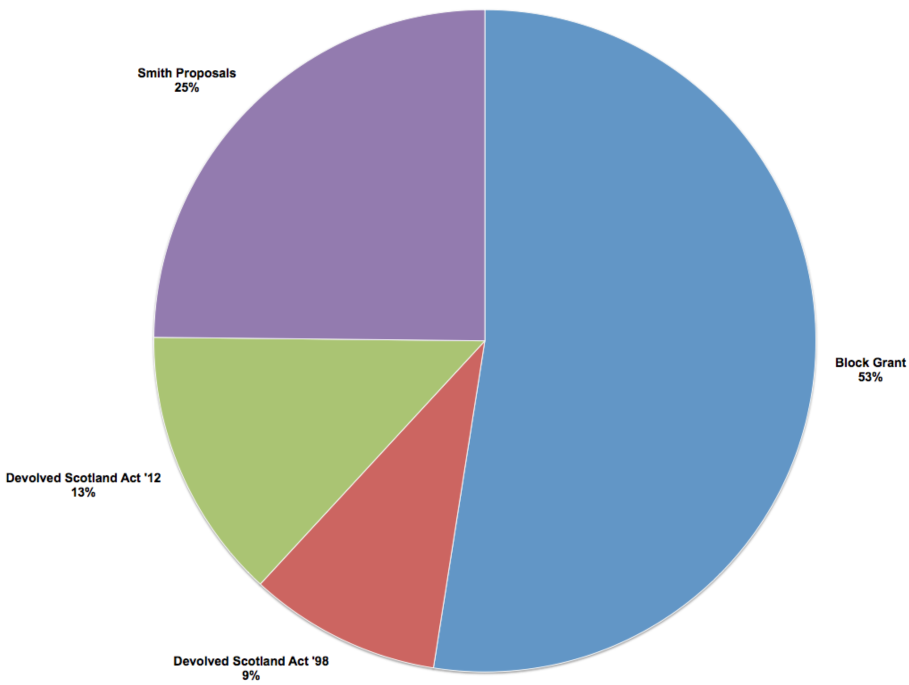
[4]This clause is not laid out in very clear terms in the Commissions report, however. Also, its interpretation, as represented in the current Scotland Bill, has resulted in some debate amongst Scottish economic commentators, see Cuthbert, J. and Cuthbert, M. (2015)

6.2.4 Fiscal Devolution

Apart from the changes discussed above, there is also the possibility of further fiscal devolution after the current Scotland Bill is in effect. Scotland has seen its fiscal autonomy increase since the Scotland Act 1998, and the current political landscape seems to favour continual debates in favour of more fiscal powers for Scotland. In order to set a benchmark for a potential future state of some version of 'full fiscal autonomy', the "Fiscal Devolution" scenario modelled below assigns all Central government income and expenditure to the Scottish Government.

Figure 6.2.1 illustrates the move to more self-directed revenue for Scotland using estimated revenue figures for 2014. Approximately 9% of the total Scottish budget was devolved to Scotland through the Scotland Act 1998. The Scotland Act 2012 enhances this share by an additional 13% and thus brings the total of self-directed revenue to around 22% (Scottish Government, 2013b; The Smith Commission, 2014).

Figure 6.2.1: Devolution of the Scottish Budget



Further fiscal devolution is likely, as key amongst the Smith Commission's proposals is the devolution of more fiscal powers to Scotland. The proposals aim at enhancing the scope of self-directed revenue in Scotland and give the Scottish Parliament the ability to replace some UK-wide taxes with new Scottish taxes. Thus, nearly half of the Scottish budget could be in the control of the Scottish Government, as the block grant would shrink to approximately 53% post-Smith (see Figure 6.2.1) (The Smith Commission, 2014). Note that under the "Fiscal Devolution" setting, all of the Scottish budget is devolved to Scotland.

Bell and Eiser (2015) argue that the changes proposed under the Scotland Bill would transfer significant fiscal powers to Scotland. Indeed, Scotland would have a high degree of fiscal autonomy in Europe.

6.3 SAM Setup

The SAM Model computed and employed later in this chapter (Sections 6.5 and 6.6) is build on the combined Government- and Household SAM (Combined SAM) outlined in chapter 4. Recall that this SAM identifies three Government sectors, the UK Government in Scotland, the Scottish Government and the Local Government, three Tax accounts, the UK, Scottish and Local Tax account, as well as seven Household Types.

Table 6.3.1 shows an aggregated version of the SAM with the full Government-, Tax- and Household account disaggregation. The disaggregation identifies, inter alia, the transfers both to-and from the seven Household sectors as well as for the three Government sectors[5]. Recall that the SAM does not take into account the continental shelf, i.e. no revenue from North Sea oil is captured in public accounts.

Table 6.3.1 shows the flows of direct and indirect taxes to the Tax accounts, which in turn are received by the corresponding Government account. Payments from the public sector to the private sector, as for example welfare payments to Households, are captured in the Combined SAM. Furthermore, inter-governmental transfers, such

[5]For a more detailed discussion on Table 6.3.1 please refer to chapter 4.

Table 6.3.1: Aggregated 2009 SAM for Scotland, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Household 1	6. Household 2	7. Household 3	8. Household 4	9. Household 5	10. Household 6	11. Household 7	12. Corporations	13. UK Government	14. Scottish Government	15. Local Government	16. UK Tax	17. Scottish Tax	18. Local Tax	19. External	Total
1. Activities	63,607	-	13,981	-	15,567	11,986	6,897	810	6,267	6,267	2,007	-	5,924	13,372	10,190	-	-	-	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	2,497	1,384	331	109	19	444	287	25,007	89	5	25	-	-	-	- 10,267	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38,441
6. Household 1	-	26,643	-	1,698	-	-	-	-	-	-	-	5,192	832	-	388	-	-	-	1,542	36,296
7. Household 2	-	21,026	-	644	-	-	-	-	-	-	-	3,042	2,131	-	995	-	-	-	985	28,823
8. Household 3	-	7	-	718	-	-	-	-	-	-	-	2,780	4,721	-	2,205	-	-	-	239	10,671
9. Household 4	-	947	-	0	-	-	-	-	-	-	-	108	346	-	161	-	-	-	35	1,596
10. Household 5	-	1,009	-	1,710	-	-	-	-	-	-	-	2,097	3,949	-	1,845	-	-	-	606	11,216
11. Household 6	-	10,280	-	430	-	-	-	-	-	-	-	1,396	1,140	-	533	-	-	-	520	14,300
12. Household 7	-	3,648	-	88	-	-	-	-	-	-	-	487	401	-	187	-	-	-	163	4,975
13. Corporations	-	-	-	29,456	3,347	2,244	165	11	27	940	298	-	2,660	3,062	-	-	-	-	11,298	53,507
14. UK Government	-	-	-	529	-	-	-	-	-	-	-	-	-	-	-	35,221	-	-	20,112	55,862
15. Scottish Government	-	-	-	1,780	-	-	-	-	-	-	-	-	25,303	-	-	-	-	-	-	27,082
16. Local Government	-	-	-	1,388	-	-	-	-	-	-	-	-	-	10,644	-	-	-	3,761	738	16,531
17. UK Tax	4,779	-	1,495	-	8,316	8,087	530	296	2,513	4,081	1,532	3,269	-	-	-	-	-	-	322	35,221
18. Scottish Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19. Local Tax	-	-	-	-	654	660	24	28	163	306	126	1,801	-	-	-	-	-	-	-	3,761
17. External	40,532	-	4,455	-	5,914	4,462	2,725	343	2,227	2,262	725	8,328	8,367	-	-	-	-	-	10,470	90,808
Total	210,920	63,561	19,930	38,441	36,296	28,823	10,671	1,596	11,216	14,300	4,975	53,507	55,862	27,082	16,531	35,221	-	3,761	90,808	723,502

as the block grant paid from the UK to the Scottish Government (£25,303m in Table 6.3.1), are captured in the Combined SAM.

Identifying these flows of funds are essential for the SAM to capture indirect taxes as well as direct tax payments by both Households and Corporations to the Government account as well as welfare and business support payments from the public to the private sector. Furthermore, the Government-to-Government entries in the SAM identify the grant payments as of 2009 from both the UK Government to the Scottish Government as well as from the Scottish- to the Local Government.

This chapter simulates different degrees of fiscal devolution in the SAM by changing public spending and income in Scotland from the UK- to the Scottish Government, whilst holding the Local Government account constant. Note that the changes to the fiscal framework for Scotland alter the totals of the Government account, reflected by a more autonomous Scottish Government and a reduction in direct expenditure in Scotland by the UK Government. The total of the combined Government and Tax accounts balance throughout.

Modelling different levels of fiscal devolution for Scotland requires a shift in income and expenditure from the UK- to the Scottish Government account in the SAM. Note that the increase in fiscal autonomy is solely transferred to the Scottish Government, with the Local Government remaining fixed. It is possible that the Local Government will also receive more fiscal autonomy during the devolution of fiscal powers, but these are not accurately foreseeable.

Thus the focus is on taxes and welfare payments shifting from the UK Government to the Scottish Government only. Note that this is reflected in the SAM by shifts between the two Government accounts as well as the UK and Scottish Tax accounts. Tables 6.3.2, 6.3.3, 6.3.4 and 6.3.5 below illustrate how the SAM is adjusted to reflect the transfer of fiscal responsibility from the UK to Scotland. These tables reflect the four degrees of fiscal devolution outlined above, respectively.

BASE

First, the "BASE" SAM (see Table 6.3.2) is an aggregated version of the SAM above (Table 6.3.1), which shows the level of fiscal devolution in Scotland in 2009 under the fiscal settlement of the Scotland Act 1998 (The UK Parliament, 1998). Here, the Household Account has been collapsed to one again for ease of comparison with the following Tables. The focus of this section is to highlight the entries in the SAM that change between the versions presented below. For a full analysis of how the Government account is disaggregated in the SAM, please refer to chapter 3. The balancing item for all Government sectors is their expenditure on the "Capital" account.

All other entries are either derived from the IxI table or they are based on official UK national statistics (see chapter 2, section 2.4.1). The nature of a balancing item is that it absorbs the variation between the income and the expenditure for one sector in order for the total to balance. There is slight deviation between the balancing items for the different Government sectors in the SAMs below.

As outlined in chapter 3, the Total for the disaggregated Government account differs from the total in the (aggregated) 2009 SAM for Scotland in chapter 2. The disaggregated account incorporates the Government-to-Government transfer payments, namely the "Block Grant" from the UK Government to the Scottish Government as well as the grants paid from the Scottish- to the Local Government in Scotland. That is to say that if the intra-governmental transfers were taken out of the SAM, the Government and Tax accounts would total that of the initial SAM.

The UK Government total is £55,862m, the Scottish Government total is £27,082m, the Local Government total is £16,531m for the Local Government, the UK Tax total is £35,221m and the Local Tax total is £3,761m. There are no tax payments to the Scottish Government here, as the devolved taxes flow to the Local Government. Thus, the UK Government is the largest of the three Government sectors in terms of direct and indirect income as well as expenditure.

Below is an analysis of the Government and Tax accounts in the "BASE" SAM in more detail. Note that the Local Government account is held constant for the other

Table 6.3.2: Aggregated 2009 SAM for Scotland - **BASE**, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Households	6. Corporations	7. UK Government	8. Scottish Government	9. Local Government	10. UK Tax	11. Scottish Tax	12. Local Tax	13. External	Total
1. Activities	63,607	-	13,981	-	49,802	-	5,924	13,372	10,190	-	-	-	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	5,070	25,007	89	5	25	-	-	-	- 10,267	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	-	-	-	-	38,441
5. Households	-	63,561	-	5,289	-	15,103	13,519	-	6,316	-	-	-	4,090	107,877
6. Corporations	-	-	-	29,456	7,031	-	2,660	3,062	-	-	-	-	11,298	53,507
7. UK Government	-	-	-	529	-	-	-	-	-	35,221	-	-	20,112	55,862
8. Scot Government	-	-	-	1,780	-	-	25,303	-	-	-	-	-	-	27,082
9. Loc Government	-	-	-	1,388	-	-	-	10,644	-	-	-	3,761	738	16,531
10. UK Tax	4,779	-	1,495	-	25,356	3,269	-	-	-	-	-	-	322	35,221
11. Scottish Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12. Local Tax	-	-	-	-	1,961	1,801	-	-	-	-	-	-	-	3,761
13. External	40,532	-	4,455	-	18,657	8,328	8,367	-	-	-	-	-	10,470	90,808
Total	210,920	63,561	19,930	38,441	107,877	53,507	55,862	27,082	16,531	35,221	-	3,761	90,808	723,502

three SAMs below, and will therefore not be detailed subsequently. All Government sectors purchase goods & services from Scottish industries, this is identified by the Government expenditures on "Activities" in Table 6.3.2.

The Scottish Government spends most on local industry products at £13,372m, which is followed by £10,190m spend by the Local Government and £5,924m by the UK Government. The payments to the "Capital" account, are reported as £89m, £5m and £25m, for the UK Government, the Scottish Government and the Local Government, respectively.

The UK Government and the Local Government make payments to Households. These are mainly social security payments as well as dividend payments from public companies from the UK Government at £13,519m. The Local Government predominantly makes payments to Households through housing benefits, here this figure is £6,316m.

The balancing items for the UK Government and the Scottish Government account are their payments to the Corporate sector, as outlined in chapter 4, section 4.6. These are £2,660m for the UK Government and £3,062m for the Scottish Government. The last payments by the Government sectors recorded in the "BASE" SAM are the Block Grant from the UK to Scotland at £25,303m and the grant payment by the Scottish Government to the Local Government at £10,644m.

The UK Government payment to the External sector of £8,367m is the "Non-identifiable spending", which the UK Government does on behalf of Scotland. Thus these are UK Government expenditures, which are not covered as direct spending in Scotland but are made on behalf of the whole of the UK. For example, spending on "Defence" falls under this category and Scotland is apportioned a population-share based figure. The External sectors payments to the Local Government are also some UK-wide funding streams to Local Authorities, which are not identified as direct spending.

Each of the three Governments identified in the SAM earns income from OVA, £529m for the UK, £1,780m for Scotland and £1,388m for Local (see chapter 4, section

4.6 for further details on these entries). The grant payments are already covered above. The next income recorded in Table 6.3.2 are the tax incomes. UK Taxes identifies UK-wide taxes, which are set by the UK Parliament and collected in Scotland, but flowing straight back to the UK Government[6].

These are £35,221m for the UK Government, whilst Local Taxes yield £3,761m for the Local Government. Thus the total for the Tax accounts is £38,982m. Note that the tax total is held constant for all SAMs below. The Local Tax account is made up of the "Non-Domestic Rate" and the "Council Tax" which were devolved to the Local Authorities in Scotland under the Scotland Act 1998 (The UK Parliament, 1998).

The transfer from the External sector to the UK Government of £20,112m is a balancing item for the UK Government account. It reflects (and is close in value to) the revenue support that Scotland receives from the UK, however (see chapter 3, section 3.5.2). The transfer to the Local Government of £738m from the External sector, is the balancing item for the Local Government account.

The Activities account pays indirect taxes mainly in form of VAT to the UK Government, which is at £4,779m (see UK Tax row) in the "BASE" SAM. The Capital account pays the UK Tax account most of the capital gains tax collected at £1,495m for 2009. The remaining capital gains payments are made by Households, who also pay income tax, inheritance tax, social security contributions and taxes on products (mainly VAT) to the UK Tax account, with the total at £25,356m.

Households also pay council tax to the Local Tax account of £1,961m. Corporations tax flows from corporations to the UK Tax account at £3,269m and the Non-Domestic rate payments are £1,801m. The External sector pays £322m (mainly VAT) to the UK Tax account.

[6]These taxes are: Aggregates levy; Agriculture levies; Air passenger duty; Alcohol duties; Betting, gaming and lottery duties; Capital Gains Tax; Channel 4 funding; Climate change levy; Fossil fuel levy; Gas levy; Hydro benefit tax; Hydrocarbon oils duty; Income Tax; Inheritance Tax; Insurance premium tax; Landfill tax; Lottery fund; Protective duty on imports; Renewable obligation certificates; Social Security Contributions; Stamp duties; Strategic Rail Authority rail franchise premia; Sugar levy; Tobacco duty (Scottish Government, 2011a)

Scotland Act 2012

Table 6.3.3 shows an aggregated SAM for Scotland under the fiscal framework of the Scotland Act 2012 (The UK Parliament, 2012). The SAM total is smaller compared to Table 6.3.2, which captures the reduction in the UK Government account (£55,862m to £51,130m), whilst the other two Government accounts are held constant. Note that the Scottish Government total does not change here, since the increase in tax revenue is offset by a decrease in the 'block grant' payment from the UK Government. The total of the Tax account remains unchanged, since there is only an internal shift from some UK taxes to Scottish taxes. The changes from the "BASE" SAM to the "Scotland Act 2012" (as well as the subsequent changes in Tables 6.3.4 and 6.3.5) are implemented using the following structure.

First, all direct and indirect tax changes are implemented, i.e. the relevant UK Government and Tax accounts' income and expenditure items are transferred to the Scottish Government and Tax accounts. The largest item of fiscal transfer to Scotland is the partial devolution of the income tax, known as the "Scottish Rate of Income Tax" (SRIT). Using calendar year 2009 figures for the estimate, the adjustment is £4,347m of income tax paid by Households to the Scottish Government.

The other tax changes are the full devolution of the Landfill Tax (£83m) and the Stamp Duty Land Tax (£303m). These taxes are captured in the Tax account and the total adjustment is £385m[7], which is captured under "Scottish Tax" in Table 6.3.3 (Scottish Government, 2013b). All of the Landfill Tax is identified as a tax paid by industry in the IxI table. However, Stamp Duty is paid by both Corporations and Households. The share of the latter is £134m, which is added to Households' payment to the Scottish Tax account at £4,480m. The total of the Scottish Tax account is £4,732m

The remaining share of the Stamp Duty tax as well as all of the Landfill Tax are captured under industries' tax expenditure, here in the "Activities" account, at £252m. Note that in the full SAM, the Landfill Tax and Stamp Duty Tax are disaggregated from all sectors individually using a share of total tax payments for all sectors. The UK Tax

[7] Note that these figures are subject to rounding due to presentation purposes here.

Table 6.3.3: Aggregated 2009 SAM for Scotland - **Scotland Act 2012**, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Households	6. Corporations	7. UK Government	8. Scottish Government	9. Local Government	10. UK Tax	11. Scottish Tax	12. Local Tax	13. External	Total
1. Activities	63,607	-	13,981	-	49,802	-	5,924	13,372	10,190	-	-	-	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	5,070	25,007	89	5	25	-	-	-	- 10,267	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	-	-	-	-	38,441
5. Households	-	63,561	-	5,289	-	15,103	13,519	-	6,316	-	-	-	4,090	107,877
6. Corporations	-	-	-	29,456	7,031	-	2,660	3,062	-	-	-	-	11,298	53,507
7. UK Government	-	-	-	529	-	-	-	-	-	30,489	-	-	20,112	51,130
8. Scottish Government	-	-	-	1,780	-	-	20,571	-	-	-	4,732	-	-	27,082
9. Local Government	-	-	-	1,388	-	-	-	10,644	-	-	-	3,761	738	16,531
10. UK Tax	4,528	-	1,495	-	20,876	3,269	-	-	-	-	-	-	322	30,489
11. Scottish Tax	252	-	-	-	4,480	-	-	-	-	-	-	-	-	4,732
12. Local Tax	-	-	-	-	1,961	1,801	-	-	-	-	-	-	-	3,761
13. External	40,532	-	4,455	-	18,657	8,328	8,367	-	-	-	-	-	10,470	90,808
Total	210,920	63,561	19,930	38,441	107,877	53,507	51,130	27,082	16,531	30,489	4,732	3,761	90,808	718,770

account decreases reflecting the devolution of these taxes to Scotland and thus the total now is £30,489m.

The devolution of the taxes above to Scotland is also reflected in the adjustment of the Block Grant, as stated in the Scotland Act 2012 (The UK Parliament, 2012). This is at £20,571m down from £25,303m in the "BASE" SAM. Recall that the Local Government and the Local Tax account are held constant, thus there is no change in the grant to the Local Government.

Scotland Bill

Table 6.3.4 shows the Scottish SAM under the changes proposed under the Smith Commission and currently being formalised under a "Scotland Bill" in the UK Parliament (The Smith Commission, 2014; The UK Parliament, 2015). The devolution of taxes as well as welfare payments from the UK to Scotland alongside the adjustment of the Block Grant outlined below result in the following changes to the public sectors totals.

The UK Government total decreases from £51,130m under the "Scotland Act 2012" (shown in Table 6.3.3) to £43,962m under the "Scotland Bill" (shown in Table 6.3.4). The Scottish Government total remains largely unchanged with the total for this sector increasing slightly to £27,319m. Note that the increase here is due to the adjustment in the grant payments from the UK Government to the Scottish Government in order to cover the devolution of some welfare spending (The UK Parliament, 2015).

The UK Tax and Scottish Tax account capture the full and partial devolution of direct and indirect taxes, with the total between the two accounts remaining constant, however. The UK Tax account reduces from £30,489m to £23,321m, whilst the Scottish Tax account increases from £4,732m to £11,900m.

The tax changes in the Scotland Bill include the full devolution of income tax as well as the Air Passenger Duty and the Aggregates Levy. Furthermore, the first 10p of VAT collected in Scotland are to be devolved to the Scottish Government as well

Table 6.3.4: Aggregated 2009 SAM for Scotland - **Scotland Bill**, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Households	6. Corporations	7. UK Government	8. Scottish Government	9. Local Government	10. UK Tax	11. Scottish Tax	12. Local Tax	13. External	Total
1. Activities	63,607	-	13,981	-	49,802	-	5,924	13,372	10,190	-	-	-	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	5,070	25,007	89	5	25	-	-	-	- 10,267	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	-	-	-	-	38,441
5. Households	-	63,561	-	5,289	-	15,103	13,282	237	6,316	-	-	-	4,090	107,877
6. Corporations	-	-	-	29,456	7,031	-	2,660	3,062	-	-	-	-	11,298	53,507
7. UK Government	-	-	-	529	-	-	-	-	-	23,321	-	-	20,112	43,962
8. Scottish Government	-	-	-	1,780	-	-	13,640	-	-	-	11,900	-	-	27,319
9. Local Government	-	-	-	1,388	-	-	-	10,644	-	-	-	3,761	738	16,531
10. UK Tax	3,738	-	1,495	-	14,509	3,269	-	-	-	-	-	-	311	23,321
11. Scottish Tax	1,042	-	-	-	10,847	-	-	-	-	-	-	-	11	11,900
12. Local Tax	-	-	-	-	1,961	1,801	-	-	-	-	-	-	-	3,761
13. External	40,532	-	4,455	-	18,657	8,328	8,367	-	-	-	-	-	10,470	90,808
Total	210,920	63,561	19,930	38,441	107,877	53,507	43,962	27,319	16,531	23,321	11,900	3,761	90,808	711,839

as 2.5p of the 5p reduced rate. Thus the assumption here is 50% of VAT revenue is flowing directly to Scotland and the remainder is attributed to the UK Government. These changes are captured in adjustments to the Government as well as the Tax accounts in the "Scotland Bill" SAM.

The data for the devolution of the VAT comes from the Scottish Government and is not publicly available. The devolution of the Air Passenger Duty is captured by both the Household and the Tourist account. This is done using a share of the total tax payments as identified in the IxI table. The Aggregates Levy is paid by the Mining industries and thus, is devolved to the Scottish Tax account from these sectors.

The devolution of Household taxes to Scotland results in the Scottish Tax account increasing its revenue from Households to £10,847m, whilst that of the UK Tax account falls to £14,509m. The devolution of the taxes paid by industries leads to the Scottish Tax account increasing its income from the "Activities" sector to £1,042m, whilst the UK Tax account decreases here to £3,738m. The devolution of part of VAT results in the External sector paying £11m in taxes to the Scottish Tax account.

The devolution of the above taxes is accompanied by a reduction of the Block Grant, as outlined by both the Smith Commission and the current Scotland Bill. The total of the grant payment from the UK to Scotland decreases from £20,571m (under the "Scotland Act 2012"), to £13,640m.

The Scotland Bill also devolves some welfare payments. A share of the benefits, which are currently proposed to be devolved to Scotland[8], against all benefit payments is calculated and a population share for Scotland applied. This share is 1,75% and this is applied to the UK Government payments to Households. Hence, the Scottish Government pays £237m in benefits to Households, with the UK Government paying the remainder of £13,282m(The UK Parliament, 2015; Department for Work and Pensions, 2011a, 2011b).

[8]These benefits are: Attendance Allowance, Carer's Allowance, Disability Living Allowance, Personal Independence Payment, Industrial Injuries Disablement Allowance, Severe Disablement Allowance, Cold Weather Payment, Funeral Payment, Sure Start Maternity Grant, Winter Fuel Payment and Discretionary Housing Payments.

Fiscal Devolution

Table 6.3.5 shows the Scottish SAM under full “Fiscal Devolution”. Here, all remaining income and expenditure entries from the UK Government identified in the “Scotland Bill” SAM are now devolved to the Scottish Government. The UK Government is essentially taken out of the SAM under this framework. The Scottish Government and Tax accounts increase to a total of £57,642m and £35,221m, respectively.

The aggregate effect is that the SAM total decreases to £698,199m. All tax receipts and expenditure for the Scottish Government are now the combined figures of the UK- and Scottish Governments from the “Scotland Bill” SAM. All row and column entries that identified UK Government income and expenditure in Table 6.3.4 are now aggregated with the corresponding Scottish Government cells. The same is applied to the UK Tax account and Scottish Tax account.

Note that the Scottish Government account now captures the spending on the External sector of £8,367m. This is the “Non-identifiable” spending that the UK does on behalf of Scotland.

Also, the Scottish Government now reports the transfer payment from the External sector of £20,112m. This was previously assigned to the UK Government and reflects the shortfall in Scottish tax revenues versus public sector expenditure in Scotland.

It has to be stressed that the “Fiscal Devolution” SAM offers a potential, although more hypothetical fiscal arrangement for Scotland. This is because it is unlikely that there would be no UK Government purchases from Scottish industries at all. More importantly, the transfers between the Scottish Government and the External account, outlined above, would most likely be subject to adjustments.

Table 6.3.5: Aggregated 2009 SAM for Scotland - **Fiscal Devolution**, 2009 basic prices (£million)

	1. Activities	2. Labour	3. Capital	4. Other Value Added	5. Households	6. Corporations	7. UK Government	8. Scottish Government	9. Local Government	10. UK Tax	11. Scottish Tax	12. Local Tax	13. External	Total
1. Activities	63,607	-	13,981	-	49,802	-	-	19,296	10,190	-	-	-	54,045	210,920
2. Labour	63,561	-	-	-	-	-	-	-	-	-	-	-	-	63,561
3. Capital	-	-	-	-	5,070	25,007	-	94	25	-	-	-	- 10,267	19,930
4. Other Value Added	38,441	-	-	-	-	-	-	-	-	-	-	-	-	38,441
5. Households	-	63,561	-	5,289	-	15,103	-	13,519	6,316	-	-	-	4,090	107,877
6. Corporations	-	-	-	29,456	7,031	-	-	5,722	-	-	-	-	11,298	53,507
7. UK Government	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8. Scottish Government	-	-	-	2,309	-	-	-	-	-	-	35,221	-	20,112	57,642
9. Local Government	-	-	-	1,388	-	-	-	10,644	-	-	-	3,761	738	16,531
10. UK Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11. Scottish Tax	4,779	-	1,495	-	25,356	3,269	-	-	-	-	-	-	322	35,221
12. Local Tax	-	-	-	-	1,961	1,801	-	-	-	-	-	-	-	3,761
13. External	40,532	-	4,455	-	18,657	8,328	-	8,367	-	-	-	-	10,470	90,808
Total	210,920	63,561	19,930	38,441	107,877	53,507	-	57,642	16,531	-	35,221	3,761	90,808	698,199

6.4 Modelling Different Levels of Fiscal Devolution

Section 6.3 calculated Scottish SAMs intended to reflect different levels of fiscal autonomy for Scotland. This section utilises these SAMs for calibrating SAM models which are employed to analyse the effects of two different exogenous demand shocks on the Scottish economy under varying levels of fiscal devolution (this is done in section 6.5).

Computing the multiplier with an endogenous and disaggregated Government account enables the study of how the different levels of fiscal devolution are likely to affect the response of the Scottish economy to impact responses to both internal and external shocks. Section 6.4.1 derives the SAM Multipliers with an endogenous Government sector. Section 6.4.2 calculates the different SAM multipliers, which reflect various level of disaggregation and of degrees of fiscal autonomy.

6.4.1 SAM Multiplier - Endogenising Government

The “Standard” SAM multiplier accounts for both the direct and indirect effects on the system following an exogenous shock as well as capturing the induced effects on factor and household incomes. Furthermore, the SAM multiplier as a Keynesian income-expenditure multiplier, also captures the changes in expenditures on industry outputs following the aforementioned household consumption effects (Round, 2003; Adelman & Robinson, 1986).

The SAM multiplier analysis is subject to the limitations imposed by the underlying IO framework, which are, inter alia, the fixed price assumption, immediate labour market adjustments and excess capacity. Thus the implicit assumption is that prices do not react to changes in the economic conditions following an exogenous demand shock, which eliminates any substitution and competitiveness effects.

A key assumption for the SAM model is passive supply, i.e. no price changes and thus no incentive to substitute inputs following an exogenous shock to the system. Thus, the model assumes that there is spare labour and resources available at all times to adjust according to changes in the demand for products.

Furthermore, income elasticities of demand are assumed to equal 1. Thus, the impact of an increase in household income on the demand for luxury goods is understated whilst the model overstates the impact on demand for necessities. However, as argued in chapter 5, the SAM multiplier model still allows for detailed and accurate modelling of the direct and indirect effects that an exogenous shock has on a regions or on a country's economy Golan et al. (2000); Round (2003).

As noted in chapter 5, the Government, Capital and External Accounts are customarily treated as exogenous in SAM multiplier analysis (Round, 2003). However, in order to study the effects of fiscal devolution on Scotland, part of the Government sector needs to be endogenised. Therefore the Scottish and Local Government are endogenised here, to reflect increasing degrees of fiscal autonomy in the different SAM models. Note that endogenising part of the Government sector in the Scottish context is a unique contribution of this chapter. The part of the SAM model, which captures the endogenised Government part, are wholly derived in this chapter.

Including part of the Government account results in the SAM multiplier also capturing those direct and indirect flows of corporate as well as household income and of Other Value Added (OVA) to and from the Government sector. Additionally, Scottish and Local Government spending becomes endogenous. The derivation of the SAM multiplier with an endogenous Government sector below is an extension of the computation in chapter 5.

The SAMs used for this model are aggregated to 25 industry sectors with full Household and Government sector disaggregation. Note also that the basic assumption of fixed prices still holds. Thus, the modelled demand shock does not affect prices, but it is assumed that there is excess capacity and unemployment, which absorb the shock (Thorbecke, 2000). Therefore, any job gains or losses are treated as permanent and instantaneous as was outlined in chapter 5.

The derivation below borrows from chapter 5 and therefore not all equations are repeated here. More detail is given in chapter 5, Sections 4 and 5. The model outlined below still retains some parts of the Government sector as exogenous (the UK Government) and some parts are endogenised (Scottish and Local Government). Thus, the model description below focuses on the additional endogenised Government component. Recall, in the SAM multiplier, total other value added, Π, is given by:

$$\Pi = \pi x \tag{6.4.1}$$

where π is an $n \times 1$ vector whose ith value is the other value added in the ith sector divided by the total output of that sector. A share of value added, ρ^Y goes directly to households, a share ρ^R goes to corporations and a share ρ^G flows directly to the part of Government that is endogenised here. Ψ^Y, Ψ^R and Ψ^G are endogenous transfers to the Household, Corporate and Government sectors, respectively.

T^Y, T^R and T^G are exogenous transfers to the Household, Corporate and Government sector from the external sector as well as from the part of the Government account that is held exogenous. Subsequently a share of corporate income, rY, is transferred to households. Also, the (endogenised) Government sector receives tax income from both the Household sector, τ^Y, and from the Corporate sector, τ^R. This means that in the SAM multiplier Household, Y, Corporate, R, and Government ,G are given as:

$$R = \rho^R \Pi + \Psi^R + T^R \tag{6.4.2}$$

$$Y = W + \rho^Y \Pi + r^Y R + \Psi^Y + T^Y \tag{6.4.3}$$

$$G = \rho^G \Pi + \tau^Y + \tau^R + \Psi^G + T^G \tag{6.4.4}$$

Combining equations 5.3.3, 5.3.5, 5.3.12 and 5.3.13 from chapter 5 with 6.4.2, 6.4.3 and 6.4.4 and expressing this in matrix form produces:

$$S\begin{bmatrix} x \\ v \end{bmatrix} + \begin{bmatrix} f - c \\ f_v \end{bmatrix} = \begin{bmatrix} x \\ v \end{bmatrix} \tag{6.4.5}$$

where the S is now a $(n+5) \times (n+5)$ matrix:

$$S = \begin{vmatrix} A & 0 & 0 & \phi_N & 0 & \delta \\ w & 0 & 0 & 0 & 0 & 0 \\ \pi & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & \rho^Y & 0 & r^Y & \Psi^Y \\ 0 & 0 & \rho^R & 0 & 0 & \Psi^R \\ 0 & 0 & \rho^G & \tau^Y & \tau^R & \Psi^G \end{vmatrix} \tag{6.4.6}$$

The entries in the first four rows and columns of the S-matrix are identical to those in Equation 5.4.5 in the previous chapter. However, the bottom row and right column are added and represent the partly endogenised Government sector. Note that investment and the external sector as well as that part of the Government account which identifies the UK Government in Scotland is held as exogenous.

where f_V is the 5×1 vector of exogenous income transfers and v is the 5×1 vector of factor and institutional incomes, so that:

$$f_V = \begin{bmatrix} 0 \\ 0 \\ T^Y \\ Y^R \\ 0 \end{bmatrix}, v = \begin{bmatrix} W \\ \Pi \\ Y \\ R \\ \Psi \end{bmatrix} \tag{6.4.7}$$

Through standard matrix inversion:

$$[I - S]^{-1} \begin{bmatrix} f - c \\ f_V \end{bmatrix} = \begin{bmatrix} x \\ v \end{bmatrix} \tag{6.4.8}$$

The multiplier outlined here endogenises the Household, Corporate and part of the Government sectors. Therefore, the direct link between Household income and OVA, as well as the flow of OVA through Corporations and the Scottish Government and Local Government to Households is endogenised in the SAM multiplier, as is part of government expenditure (Scottish Government and Local Government expenditure).

In contrast to the "Standard" SAM multiplier, tax- and welfare payments to- and from the Scottish Government and Local Government are now endogenised, whereas these are traditionally treated as exogenous to the model. Note that part of the total payments remains exogenous in this model, since the UK Government sector remains exogenous.

Again if the element in the ith row and the jth column of the SAM inverse is represented with the subscript i, j then the SAM multiplier value for sector j , M_j^S , is the sum of the first n elements j

$$M_j^S = \sum_{i=1}^{n} \sigma_{i,j} \tag{6.4.9}$$

Thereby measuring the system-wide change in total output generated by a unit increase in exogenous final demand for the output of sector j.

Equation 6.4.7 identifies the characteristics of this SAM multiplier model with endogenous Government. Expenditure in the Capital and External accounts are wholly exogenous as well as part of the Government account (UK Government here). Expenditures in all other accounts are endogenous.

All wage and parts of profits income generated in production go to domestic Households. Household, Corporate as well as Scottish and Local Government expenditures are endogenised but in all cases there are exogenous transfers from the External and the UK Government sector, together with endogenous income indirectly from production and some Government transfers.

An important issue here is that the model operates so that exogenous expenditures drive endogenous ones. A key issue is therefore what is counted as exogenous and what is endogenous. Endogenising part of the Government sector in the SAM model counters a criticism of this type of model, where changes in the system do not have an impact on the components that are treated as exogenous but are in fact endogenous under some fiscal arrangement. Since the domestic Government sector in Scotland is of importance to the whole economy (e.g. the public sector is the single largest employer in the country), demand shocks ought to have direct and indirect effects on the domestic Government sector.

6.4.2 SAM Multiplier - Calculation

Section 6.4.1 developed a SAM multiplier model with a partially endogenised Government account, here the Scottish and Local Government. Using the method outlined above, this section computes 4 SAM multipliers. Each of these multipliers is based on one of the 4 SAMs from section 6.3. That is to say that the first multiplier captures the Scottish economy under the “BASE” setting, the second multiplier under the “Scotland Act 2012” setting, the third multiplier under the “Scotland Bill” setting and the fourth multiplier under the “Fiscal Devolution” setting.

Table 6.4.1 shows the multiplier values associated with the four SAM models, which are based on a 25 industry aggregation[9]. The table displays the multiplier value for each of the 25 industry SAM multiplier, as well as the totals, the average and weighted average. Note that the weighted average is calculated by computing each industry's share of the total exogenous demand from the SAM (see Table 9.7.2). This share is then multiplied by each multiplier. The 'weighted average' figure at the bottom of Table 6.4.1 is the sum of all industries' weighted averages.

The different multipliers are based on SAMs capturing increasing stages of fiscal devolution. Hence, the multiplier values are assumed to increase accordingly (left to right in Table 6.4.1). This is the case for all multipliers, apart from the 'Agricutlure' multiplier for the "Scotland Bill" and the "Fiscal Devolution" setting. This is due to the subsidy payments, i.e. endogenising a negative tax payment here, for the "Agriculture" sector. These were carried by the UK Government in the other settings of the SAM, but they are transferred to the Scottish Government under "Fiscal Devolution".

The averages of the multipliers are increasing with higher degrees of fiscal autonomy for Scotland. The averages are 1.942 for the "BASE", 1.999 for the "Scotland Act 2012", 2.093 for the "Scotland Bill" and 2.334 for the "Fiscal Devolution" setting. Equally, the weighted averages increase from 1.970 to 2.027 to 2.123 to 2.364 for each setting, respectively.

The differences between the averages are: 0.057 ("BASE" to "Scotland Act 2012"), 0.094 ("Scotland Act 2012" to "Scotland Bill") and 0.241 ("Scotland Bill" to "Fiscal Devolution"). The differences between the weighted averages are: 0.057, 0.096 and 0.241 for the same settings as above, respectively. Hence, the difference in the weighted averages between the "BASE" and "'Scotland Bill" setting is: 0.153 and between the "BASE" and "Fiscal Devolution" case is: 0.394.

The average and weighted average multiplier values for the "BASE" and the "Scotland Act 2012" show that the impact of moving to the latter setting seems comparatively small. Recall that the largest change from the "BASE" to the "Scotland Act 2012"

[9]Table 9.7 is the aggregation matrix, which details how the initial 104 industries are aggregated to 25 industries for the model.

Table 6.4.1: Partially Government Endogenised SAM Multiplier - Overview

	Base	Scotland Act 2012	Scotland Bill	Fiscal Devolution
1. Agriculture, forestry and fishing	2.073	2.103	2.176	2.101
2. Mining	1.955	2.002	2.089	2.306
3. Food, drink and tobacco	1.975	2.024	2.103	2.301
4. Textile, leather, wood and paper	2.033	2.088	2.172	2.396
5. Chemicals	1.431	1.455	1.492	1.617
6. Rubber, plastic, cement and iron	1.969	2.029	2.119	2.394
7. Computer, electrical and transport equip.	1.951	2.006	2.093	2.315
8. Electricity, gas and water	2.149	2.195	2.268	2.503
9. Construction	2.201	2.261	2.356	2.597
10. Wholesale and retail	1.955	2.022	2.123	2.423
11. Land transport	1.963	2.024	2.116	2.410
12. Water transport	2.022	2.071	2.142	2.409
13. Air Transport	1.849	1.900	1.970	2.276
14. Post and support transport services	2.032	2.097	2.202	2.463
15. Accommodation	1.872	1.937	2.033	2.360
16. Food & beverage services	1.874	1.940	2.034	2.389
17. Telecommunication	1.914	1.976	2.073	2.336
18. Computer and information services	1.840	1.909	2.020	2.294
19. Financial services	1.969	2.027	2.131	2.408
20. Real estate	1.727	1.766	1.831	2.016
21. Professional services	1.938	2.005	2.112	2.378
22. Research and development	2.086	2.157	2.286	2.412
23. Public administration	1.941	2.017	2.163	2.447
24. Recreational services	1.965	2.034	2.155	2.442
25. Other services	1.868	1.939	2.063	2.351
Average	1.942	1.999	2.093	2.334
Weighted Average	1.970	2.027	2.123	2.364

case is the endogenising of part of income tax paid in Scotland. Thus the multiplier values do not increase by as much as in the other cases.

However, the move to the "Scotland Bill" and the "Fiscal Devolution" settings from the "BASE" are much larger. These differences are due to the higher degree of fiscal devolution that are endogenised in the "Scotland Bill" and the "Fiscal Devolution" cases. Recall that the "Scotland Bill" SAM captured the devolution of all of income tax, part of VAT and other taxes as well as the transfer of some welfare payments.

In the "Fiscal Devolution" SAM, the UK Government is essentially taken out and the Scottish Government is assigned all the revenue and expenditure from the UK Government (apart from the block grant payment of course). Note that the "Fiscal Devolution" SAM is a variant of full fiscal autonomy for Scotland, but not full independence.

In the SAM models calibrated on the SAMs capturing higher degrees of fiscal autonomy, the multiplier effects on Scottish industries are increased. This is due to the induced effects, which increase with a larger proportion of the Government endogenised in the model.

That is to say that the sensitivity of the models increases, i.e. the sensitivity of the Scottish economy to both internal and external shocks is greater. Note that in the exogenous demand shocks modelled below, the higher sensitivity to the shocks results in larger output and employment effects. However, a key point of this is that any adverse shocks, i.e. a fall in demand results in greater negative output and employment effects for the SAM models capturing greater degrees of fiscal devolution.

Figure 6.4.1 plots the multiplier values from Table 6.4.1 for all four endogenous Government SAM multipliers by all 25 sectors. The graph shows that the multipliers by sector generally move in the same direction across the four different models. Further, Figure 6.4.1 shows that the difference between multipliers grows larger with increasing degrees of fiscal devolution, as discussed above.

Figure 6.4.1: SAM Multiplier Comparison

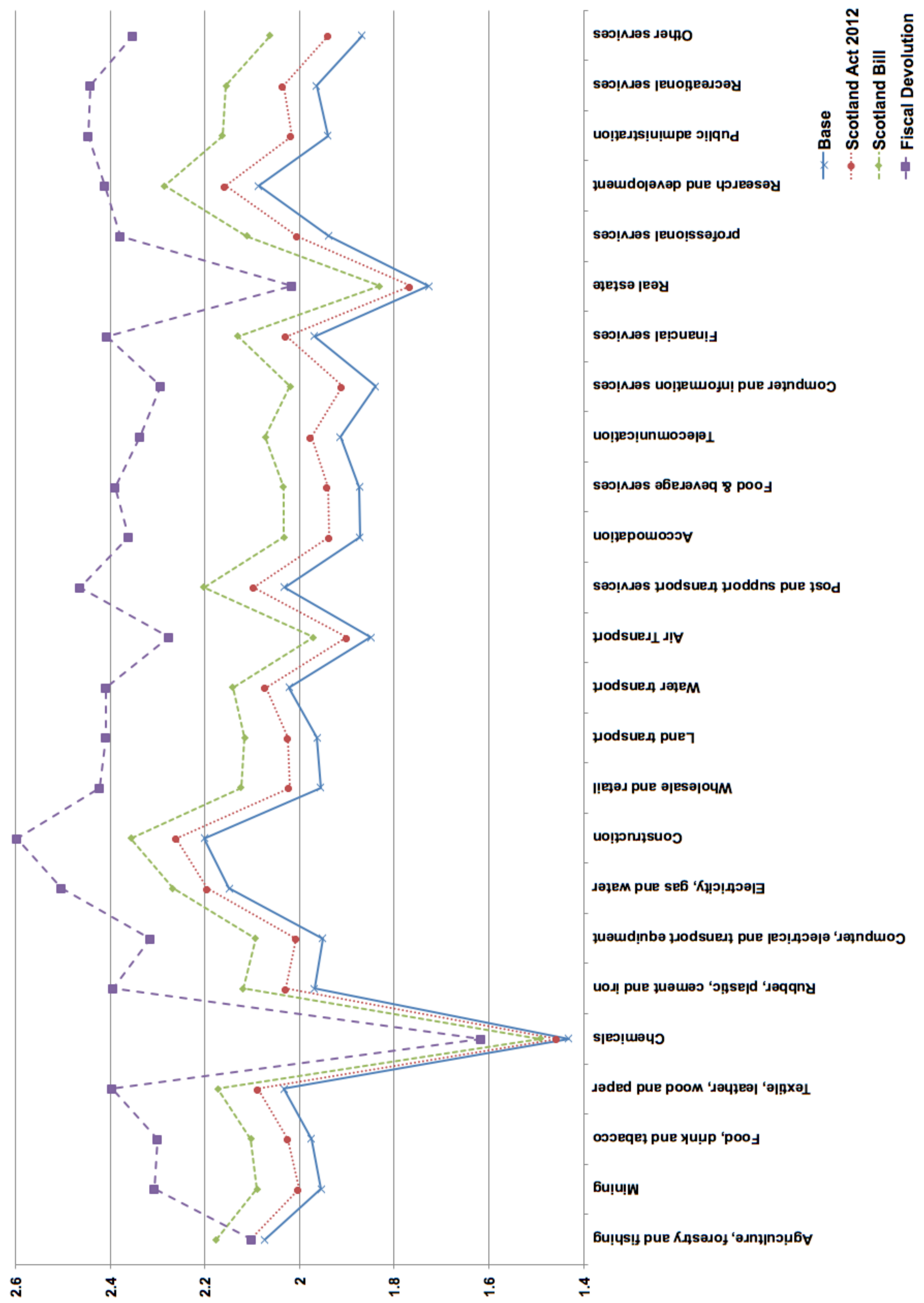


Figure 6.4.1 shows that the multipliers for some industries are closer than for others. For example, the multipliers for the "Chemicals" and the "Real Estate" sectors are comparatively low for all models and in contrast, the multipliers for the "Electricity, gas and water" and the "Construction" sector are high.

However, Figure 6.4.1 also shows that multipliers for the same sector increase for some models and decrease for others when compared to other multipliers. For example, the multiplier computed under the "Fiscal Devolution" calibration of the SAM for the "Food & beverages services" sector is shown to increase when compared to the "Accommodation" sector, whilst the multipliers for those two sectors are nearly identical for the other three settings.

Note that the multiplier for the "Agriculture, forestry and fishing" sector is smaller under "Fiscal Devolution" than for the "Scotland Act 2012" and the "Scotland Bill" setting. This is due to the negative taxes, i.e. subsidies, that are wholly endogenised here, which were previously exogenous (UK Government).

Figure 6.4.1 illustrates both the varying size of the endogenised Government component in the SAM multipliers but also the sensitivity of the multipliers. It highlights potential impacts of further devolution for Scotland in that internal and external shocks to the economy are subject to ever increasing multiplier effects. The next section (6.5) performs exogenous demand shocks on two sectors under the four different SAM model settings.

6.5 Exogenous Demand Shocks

The SAM Model computed in section 6.4 captures the direct, indirect and induced effects of exogenous demand shocks. Four SAM multiplier models are calculated here; each reflects a different degree of fiscal autonomy for Scotland. The SAM models are employed to simulate the effects on the Scottish economy of exogenous demand shocks under different fiscal arrangements for Scotland.

This section models two exogenous demand shocks under the four different stages of fiscal devolution for Scotland discussed in section 6.3. The first shock is imposed on the "Foods & Drinks" sector and the second shock on the "Public Administration" sector. Both shocks reflect a £500m increase in external demand for each sector individually.

The shock to the "Foods & Drinks" sector is motivated by a Scottish Government policy to increase exports of Scottish food and drink products in the coming years. The policy goal corresponds to an increase in the sector's output of £500m for the year 2009 (Scottish Government, 2013d).

The "Public Administration" sector offers a different set of characteristics to the "Foods & Drinks" sector. "Public Administration" is the largest sector in the Scottish economy in terms of 'Total Final Demand' with £39,923m. This sector is largely dependent on the Government sectors, which purchase a combined total of £28,582m of total output from the "Public Administration" sector.

This is in stark contrast to the "Foods & Drinks" sector, which does not sell any output to the Government sectors (Emonts-Holley et al., 2014). Hence, the assumption is that the two shocks results in different multiplier effects across industries and stages of fiscal devolution.

6.5.1 SAM Model Setup

The results of the SAM modelling are reported as first, the "Indirect & Induced Output Effect" for all 25 industries in the SAM model in Table 6.5.1. This effect is the impact that the exogenous shock has on the output of each of the industries, excluding the direct effect of the exogenous shock. That is to say that the initial direct effect from the shock (the increase on the 'shocked' sector, which is equal to the size of the shock) is not included in the results.

The "Indirect & Induced Output Effect" shows how the different industries are linked with each other (see section 6.4.1) as well as the impact of endogenous consumption and some government expenditure.

Recall from section 6.4.1 that the SAM multiplier accounts for direct and indirect effects as well as the induced effects on factor and household income. Since, the Government sector is partially endogenised here, larger degrees of fiscal autonomy for Scotland are reflected in the increasing multiplier values. That is to say that the indirect and induced effects in the SAM multipliers in Table 6.4.1 rise with a more devolved public sector in Scotland.

Next, the results report the "Indirect & Induced Employment Effect" for all 25 industries, j, in the SAM model (Miller & Blair, 2009). These are the indirect and induced effects that the exogenous demand shock has on the number of people employed in each industry. Note that this implies a linear increase in workers/employees in each industry following the rise in production to respond to the upward move of demand.

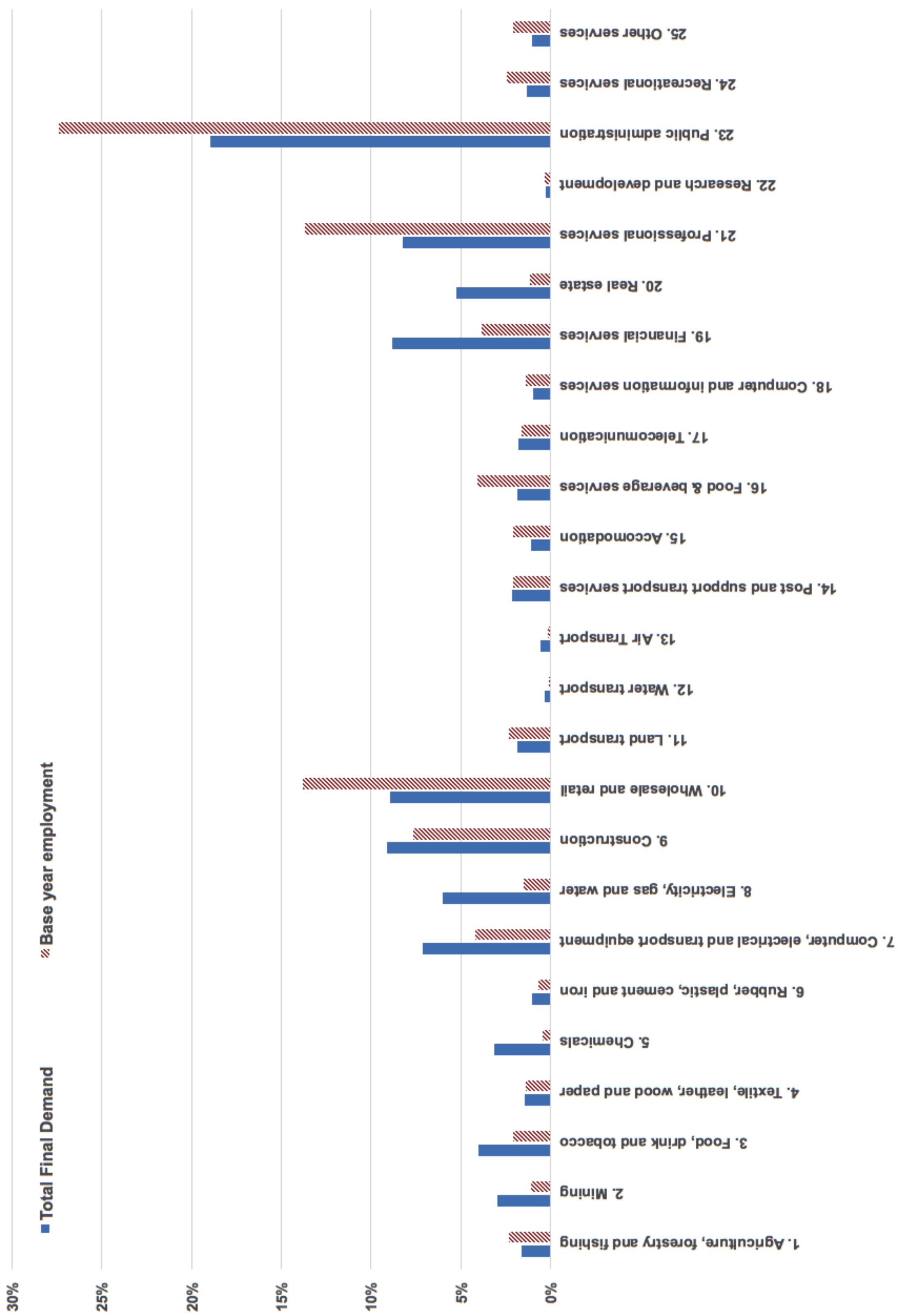
The "Indirect & Induced Employment Effect" is computed by taking the vector of indirect and induced output effects and multiply this by the vector of employment/output ratios (Miller & Blair, 2009). Table 9.7.3 reports the 'Base year employment figures' from the 2009 SAM for Scotland. Table 9.7.4 shows the 'Employment-output coefficient' for all sectors.

The SAM model results also report the "Percentage Change Compared to SAM", which is simply the ratio of the indirect and induced effects to the SAM baseline figure for the corresponding sector (times 100). Note that the "Percentage Change Compared to SAM" is the same for the "Indirect & Induced Output Effect" as for the "Indirect & Induced Employment Effect", reflecting the fixed technology assumption of the SAM. The percentage changes reflect the importance of the multiplier effect relative to that sector.

Figure 6.5.1 plots the shares of Total Final Demand and Base Year Employment (full-time equivalent) from Tables 9.7.3 and 9.7.4. The shares are each sector's share of Total Final Demand of the total and each sector's share of employment compared to the total employment.

The graph shows that the "Public Administration" sector is the largest both in terms of final demand and of employment in Scotland. Note that this sector includes the

Figure 6.5.1: Total Final Demand and Base Year Employment Shares



‘Public Administration’ sector from the 104 industry aggregation of the SAM, as well as ‘Health’ and ‘Education’. Recall Table 9.7 is the aggregation matrix, which details how the 104 industries from the SAM are aggregated to 25 industries for the SAM model.

The “Construction”, “Wholesale and retail” and the “Professional services” sector are shown as the next three largest sectors in terms of both total final demand and employment.

However, Figure 6.5.1 also visualises sectors’ labour intensity with respect to their total final demand share. For example, the “Public Administration”, the “Wholesale and retail” and the “Professional services” sectors all have a significantly higher share of employment than of total final demand. Conversely, the “Chemicals”, the “Electricity, gas and water” and the “Real Estate” sectors are all relatively labour non-intensive.

These underlying characteristics of the sectors are key for both the output and the employment effects in the SAM model. For example, a positive (direct or indirect) shock on a labour intensive sector such as “Wholesale and retail” sector produces a larger indirect and induced employment effect than for a less labour intensive sector.

These indirect and induced effects are magnified when the endogenous Government sector in the model is devolved further fiscal autonomy, as for some of the models in this section. Now, a shock that results in higher tax revenue results in larger indirect and induced effect, since the endogenised Government consumption increases by more than before the devolution of more fiscal powers.

Note though, as mentioned above, that higher degrees of sensitivity to shocks results in a more volatile economy in the model. That is to say that a negative shock has a larger contractionary impact in the model with a partially endogenised Government sector. Hence, a fall in demand for the “Wholesale and retail” sector, for example, results in a proportionally large fall in employment and thus a fall in tax revenues and a contraction of the (endogenised) Government sector. Hence, increasing degrees of fiscal devolution result in larger negative effects in case of a contractionary shocks.

Modelling the same exogenous demand shock under different stages of fiscal devolution results in different indirect and induced effects on the Scottish economy. From 6.4.2 and the multiplier data in Table 6.4.1, the expectation is that the higher degree of fiscal autonomy, the bigger the impact of an exogenous demand shock on all Scottish industries. Furthermore, shocks on different sectors is assumed to produce different indirect and induced multiplier effects across industries.

6.5.2 Exogenous Demand Shock - Foods & Drinks Sector

The exogenous demand shock on the "Foods & Drinks" sector is performed on four different calibrations of the model as outlined above. Figure 6.5.2 plots the indirect and induced output multiplier effects for all four cases.

As expected, the SAM multiplier models reflecting a higher degree of fiscal autonomy for Scotland show larger indirect and induced output multiplier effects overall. However, the degree to which the indirect and induced output effects increase across models differs between sectors. That is to say that higher degrees of fiscal autonomy increase the sensitivity of sectors to demand shocks by different degrees.

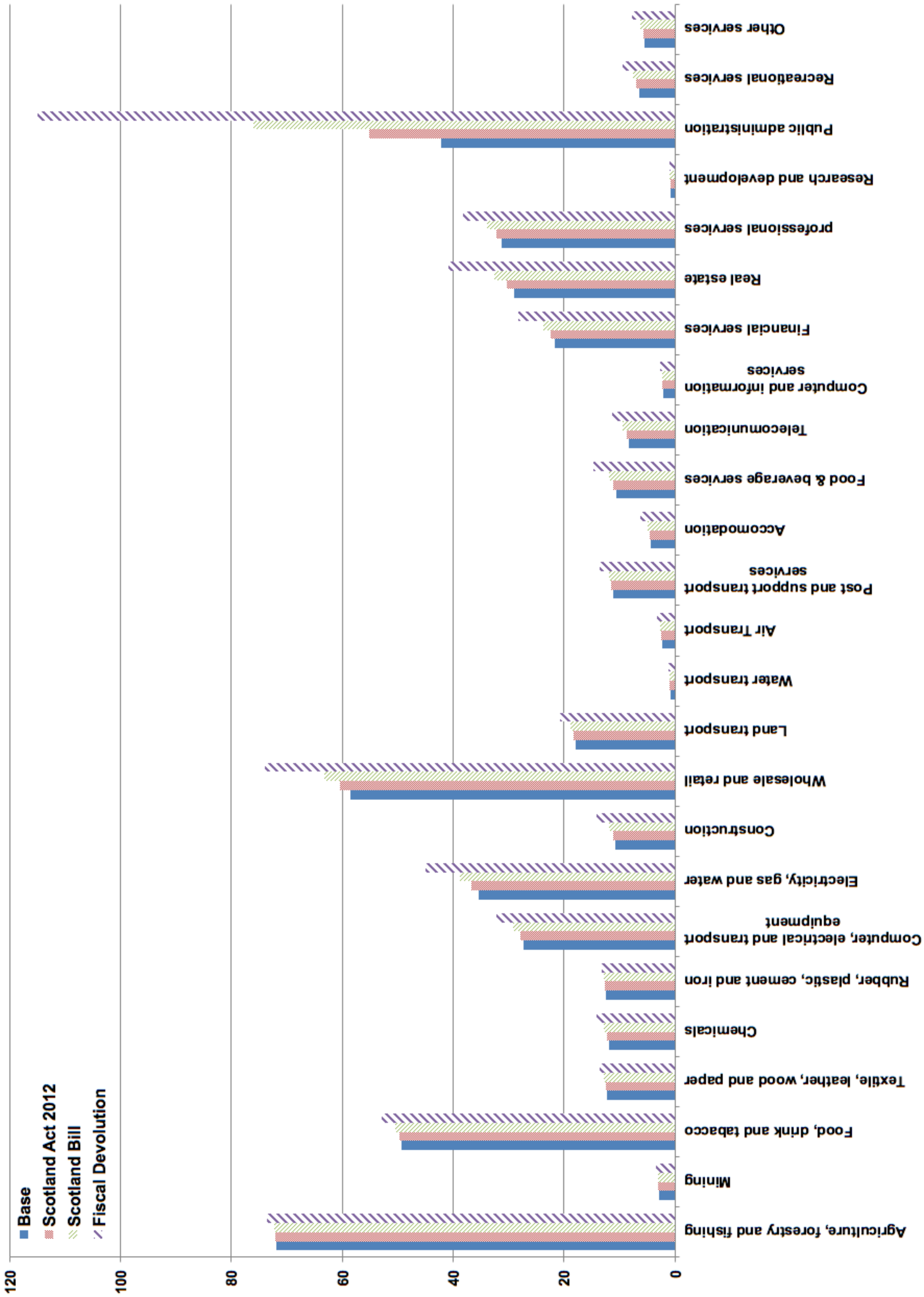
Note though that, as mentioned above, the exogenous demand shock simulates an increase in demand and the greater sensitivity of the economy to higher degrees of devolution would result in a larger economic contraction in case of a negative (internal or external) demand shock.

Furthermore, Figure 6.5.2 shows that there are significant differences between the indirect and induced output effects by sectors. These differences highlight, inter alia, the interdependencies between sectors, i.e. how a rise in final demand in one sector is dependent on intermediate inputs from other sectors. This is discussed for each of the models in more detail below.

"BASE" Analysis

Table 6.5.1 reports the output of the exogenous demand shock on the "Foods & Drinks" sector under the "BASE" calibration of the SAM model. The first column gives the in-

Figure 6.5.2: SAM Model Comparison: Indirect and Induced Output Effects - Food & Drink Sector Shock, in £m



direct and induced output effects in £m of the 25 sectors. Recall that this excludes the direct demand effect of £500m on the "Foods & Drinks" sector. The second column reports the indirect and induced employment effect and the last column gives the percentage change compared to the SAM baseline.

The total indirect and induced output effect of the shock is £487.37m.The total output effect of the shock is £987.37m, which includes the direct output effect. The average indirect and induced output effect on each sector is £19.49m. That is to say that the average output by each sector rises by £19.49m as a result of the initial shock on the "Foods & Drinks" sector. The total percentage change of the shock is given at 7.82% with an average increase of 0.31% for each sector (see Table 6.5.1).

The total indirect and induced employment effect is that the exogenous demand shock produces nearly 5,332 full-time equivalent (FTE) jobs in the economy. Note this excludes the additional jobs resulting from the direct effect, which reports 2,724 FTE jobs. The average effect by sector is approximately 213 FTE jobs (see Table 6.5.1). This is against a total employment figure for Scotland of 2,229,931 for 2009 (see Table 9.7.3).

Table 6.5.1 reports that the "Agriculture, forestry and fishing" sector, the "Wholesale and retail" sector, the "Food, drink and tobacco" sector and the "Public Administration" sector are subject to the largest indirect and induced output effects. These are £71.82m, £58.82m, £49.26m and £42.16m, respectively.

On the one hand, the size of the effect gives an indication to the interconnectivity between the sectors, i.e. how much the output of one sector is needed as intermediate inputs for the production of the additional total output of the sector which is subject to the shock. These are the indirect and direct effects, respectively. On the other hand, the size of the effect reflects the induced effects that is the additional income generated, which is then spend again. The induced effect therefore stimulates the economy additionally, through a rise in both final demand and intermediate inputs.

The results in Table 6.5.1 also highlight the unique identity characteristics, e.g. the cost structures of the sectors. For example, the indirect and induced output effect re-

Table 6.5.1:
Government Endogenised Multiplier - BASE
£500m External Demand Shock on the “Food, drink and tobacco” Sector

	Indirect & Induced Output Effect	Indirect & Induced Employment Effect	%age Change to SAM
1. Agriculture, forestry and fishing	71.82	1087.73	2.11%
2. Mining	2.94	11.53	0.05%
3. Food, drink and tobacco	49.26	268.40	0.58%
4. Textile, leather, wood and paper	12.31	121.06	0.40%
5. Chemicals	11.96	17.30	0.18%
6. Rubber, plastic, cement and iron	12.51	92.05	0.58%
7. Computer, electrical and transp. equip.	27.26	170.17	0.18%
8. Electricity, gas and water	35.48	92.77	0.28%
9. Construction	10.69	94.83	0.06%
10. Wholesale and retail	58.52	956.21	0.31%
11. Land transport	17.92	239.17	0.46%
12. Water transport	0.87	3.33	0.13%
13. Air Transport	2.39	8.05	0.20%
14. Post and support transport services	11.12	112.53	0.24%
15. Accommodation	4.39	90.46	0.19%
16. Food & beverage services	10.63	245.68	0.27%
17. Telecommunication	8.40	78.47	0.22%
18. Computer and information services	2.15	31.78	0.10%
19. Financial services	21.62	100.37	0.12%
20. Real estate	29.02	68.01	0.26%
21. Professional services	31.22	547.65	0.18%
22. Research and development	0.80	10.89	0.14%
23. Public administration	42.16	644.85	0.11%
24. Recreational services	6.47	121.95	0.23%
25. Other services	5.46	116.76	0.25%
Total	487.37	5331.99	7.82%
Average	19.49	213.28	0.31%

ported by the "Wholesale and retail" sector is largely due to the rise in consumption. This in turn is a result of the initial shock on the "Food, drink and tobacco" sector. Conversely, the indirect and induced output effect reported by the "Public Administration" is due to a rise in tax revenue.

The different channels that the effects work through for each sector are captured in the SAM[10]. Also, the indirect and induced output effect can be due to an industry using a large proportion of its own output for intermediate demand in order to meet a final demand increase.

For example, the aggregated "Food, drink and tobacco" sector includes both "Dairy products" as well as "Animal feeds". Hence, in order to meet the initial rise in final demand through the exogenous demand shock, the "Food, drink and tobacco" sector utilises at least parts of its own production as intermediate inputs to meet the rise in final demand.

The sectors reporting the largest indirect and induced employment effects also experience some of the largest indirect and induced employment effects. For example, "Agriculture, forestry and fishing" sector reports an increase of FTE jobs by 1087.73 out of a total of 5331.99. Note that this also exceeds the average indirect and induced employment effect of 213.28 FTE jobs by more than five-fold.

However, as discussed in section 6.5.1, the relative labour intensity of the sector determines the size of the indirect and induced employment effect (see Table 6.5.1). Thus, the "Public Administration" sector reports a rise in FTE jobs of 644.85 and the "Food, drink and tobacco" sector shows a rise in FTE jobs of 268.4, although the former reported a smaller indirect and induced output effect.

Figure 9.7.1 plots the indirect and induced employment effects from Table 6.5.1. Overall the impact on employment seems to be similar to the impact on output (see Figure 6.5.2). However, the magnitude of the effects differs by sectors and model. Furthermore, some sectors show substantial output effects, but comparatively small

[10] see Emonts-Holley et al. (2014) for the full 2009 SAM for Scotland, which identifies the flows for each of the 104 and the aggregated 25 industries.

employment effects. This is due to the underlying labour versus capital intensity for the production of final demand by sectors (see Table 9.7.3).

Some sectors report indirect and induced output effects that are larger than the average effect across sectors and smaller indirect and induced employment effects compared to the average, and vice versa. For example, the “Computer, electrical and transport equipment” sector reports an indirect and induced output effect of £27.26m (average is £19.49m) and an indirect and induced employment effect of 170.17 FTE (average is 213.28 FTE). In contrast to that the “Food & beverage services” sector reports an indirect and induced output effect of £10.63m and an indirect and induced employment effect of 245.68 FTE.

As discussed above, the exogenous demand shock on the “Food, drink and tobacco” sector impacts the 25 sectors to different degrees. The percentage changes reported in Table 6.5.1 reflect the effect that the shock has on the sectors compared to their baseline values from the SAM. Recall that these are the same for both the indirect and induced output effect as well as the indirect and induced employment effect.

The “Agriculture, forestry and fishing” sector is impacted the most by the shock, since its output increases by 2.11%. Next, the “Food, drink and tobacco” sector as well as the “Rubber, plastic, cement and iron” sector rise by 0.58%. Two more sectors show an indirect and induced output effect larger than the 0.31% average impact on sectors.

The “Land transport” sector increases output by 0.46% and the “Wholesale and retail” sector’s indirect and induced output effect is a rise of 0.31%. The indirect and induced output effect on these five sectors accounts for more half of the total impact of the shock (4.04% compared to a total of 7.82%). These sector constitute industries which capture aspects of food production, packaging, transportation and sale of food and drink products.

At the other end of the spectrum are the “Mining”, “Construction” and “Computer and information services” sector, which show a rise in output of 0.05%, 0.06% and

0.10%, respectively. These results indicate the interdependence between sectors in terms of intermediate demand. That is to say that in order to meet the rise in final demand from the initial shock on the “Food, drink and tobacco” sector, the output of other sectors in the economy are needed as intermediate inputs.

The percentage changes provide a useful tool for comparing each sector with its baseline. However, they can offer conflicting evidence as to the impact the shock has on the actual indirect and induced output and employment effects.

For example, “Chemicals” and the “Computer, electrical and transport equipment” sector both report a 0.18% rise compared to the SAM baseline (see Table 6.5.1). However, their indirect and induced output effects are £11.96m and £27.26m, respectively. Equally, the indirect and induced employment effects vary between the two sectors with the “Chemicals” sector increasing by 17.3 FTE jobs and the “Computer, electrical and transport equipment” sector adding 170.17 FTE jobs (See Figure 9.7.1).

“Scotland Act 2012”, “Scotland Bill” and “Fiscal Devolution” Analysis

Tables 9.7.5, 9.7.6 and 9.7.7 report the results of the same exogenous shock for the SAM model calibrated under the “Scotland Act 2012”, the “Scotland Bill” and the “Fiscal Devolution” SAMs, respectively.

Since the SAM model here endogenises part of the Government account (Scottish Government and Local Government), the models capture the effects of an increasingly larger endogenous public sector. Furthermore, the indirect and the induced effects in the SAM model are magnified through the higher degrees of fiscal autonomy in Scotland reflected by the four SAM variants.

This is because there are stronger income-expenditure linkages as incomes rise. With higher incomes, taxes rise and as implied by the model here, government expenditures increase. Hence, the same exogenous demand shock results in larger multiplier effects for the different SAM model calibrations.

The results of the shock on SAM models capturing higher degrees of fiscal autonomy for Scotland show that the indirect and induced effects increase. As mentioned above, the total indirect and induced output effect for the "BASE" model is £487.37m. This rises to £511.92m, £551.51m and £650.38m for the "Scotland Act 2012", the "Scotland Bill" and the "Fiscal Devolution" model, respectively.

Equally, the indirect and induced employment effect rises from 5,331.99 FTE jobs for the "BASE" model to 5,650.87 FTE jobs, to 6,164.24 FTE jobs and to 7,375.82 FTE jobs for the "Scotland Act 2012", the "Scotland Bill" and the "Fiscal Devolution" model, respectively.

These effects correspond to percentage changes compared to the SAM baseline of 7.82% under the "BASE" model, to 8.03%, to 8.37% and finally to 9.37% under the "Scotland Act 2012", the "Scotland Bill" and the "Fiscal Devolution" model, respectively. With the average indirect and induced on each sector rising from 0.31%, to 0.32%, to 0.33% and finally to 0.37% for the four different models.

Recall that Figure 6.5.2 plots the indirect and induced output effects for all four models. It shows that the ranking of sectors across models differs, that is the magnitude of the indirect and induced effects changes with different degrees of fiscal autonomy endogenised in the model.

For example, the "Agriculture, forestry and fishing" sector reports the largest indirect and induced output effects in both the "BASE" and the "Scotland Act 2012" model, with £71.82m and £72.01m, respectively (see Figure 6.5.2 and Tables 6.5.1 and 9.7.5). However, under the "Scotland Bill" setting, the "Public Administration" sector reports the largest indirect and induced output effect with £76.04m, compared to the "Agriculture, forestry and fishing" sector's £72.33m (see Table 9.7.6).

The "Public Administration" sector also reports the largest indirect and induced output effect under "Fiscal Devolution" with £114.9m. However, the "Wholesale and retail" sector shows the second largest indirect and induced output effect here with £74.04m. The "Agriculture, forestry and fishing" sector reports the third largest indirect and induced output effect under "Fiscal Devolution" with £73.51m (see Table 9.7.7).

Other sectors also report changes in the 'ranking' of the indirect and induced output effects. These results show that endogenising larger degrees of fiscal autonomy in the model, changes the sensitivity of not just the economy as a whole to exogenous shocks, but that of sectors to different degrees.

Note that the massive rise in the indirect and induced output effects for the "Public Administration" sector across the SAM models is due to the fact that this sector captures the highest share of Government spending as discussed in section 6.3. Hence the indirect and even more importantly the induced effects increase/ are magnified. In the "Fiscal Devolution" model, all of the UK Government expenditure are transferred to the Scottish Government, which is why the multiplier effect increases to such a large extent.

Comparative Analysis

As stated above, the degree to which sectors are affected by the shock under different fiscal frameworks endogenised in the model, varies. Note that the indirect and induced employment effects plotted in Figure 9.7.1 report a similar impact of the different stages of fiscal devolution endogenised in the models as the indirect and induced employment effects in Figure 6.5.2. For example, the 'ranking' between the sectors also adjusts in the same way as with the indirect and induced output effects.

However, Figure 9.7.1 clearly shows that the aggregate increases in employment are significantly more concentrated on some sectors. The largest indirect and induced employment effects are reported for the "Public Administration", "Agriculture, forestry and fishing", "Wholesale and retail" and the "Professional services" sector.

Recall from Figure 6.5.1, that around 55% of all employment in Scotland is concentrated in the "Public Administration", "Wholesale and retail" and the "Professional services" sector. The share of total final demand for these sectors is approximately 36%. Each of the sectors reports a base year employment share of the total, which is around 5% higher than their corresponding total final demand share. That is to say that the labour intensity in these sectors is high, which affects the indirect and induced employment effects on these sectors. This in turn results in further effects on other sectors, which benefit from an increase in aggregate income levels across the economy.

Additionally, these sectors are also the first, second and fifth ranked sectors in terms of total final demand. These baseline figures give an indication that a shock to the economy might result in substantial effects reported by these sectors. What is more important here though are the cost structures of the sectors, i.e. through which channels the initial exogenous demand shock results in output and employment adjustments in these sectors.

For the “Public Administration” and the “Professional services” sector, the degree of fiscal autonomy endogenised in the model results in increasing indirect and induced output and employment effects. This is because, the above-mentioned flow of higher employment, yielding more tax revenue, which leads to higher Government spending and this in turn results in more employment in sectors linked to Government spending. The “Public Administration” sector captures the largest share of (endogenised) public consumption, since it includes the “Health” and “Education” sector as well (see Table 9.7).

The SAM reports that a large share of “Public Administration” spending flows to the “Professional services” sector, which includes “Architectural services”, e.g. planning and ‘quantity surveyor’ work. Hence, the stimulus to the “Public Administration” sector results in indirect and induced output and employment effects to the “Professional services” sector.

The “Wholesale and retail” sector reports comparatively large indirect and induced output and employment effects, since the rise in the consumption level of the economy increases as a result of the exogenous demand shock. Higher levels of consumption and a rise in output in the “Wholesale and retail” sector induce further increases in employment for that sector and thus it reports one of the largest overall indirect and induced effects in the model.

In Table 6.5.1, the “Agriculture, forestry and fishing” sector is shown to account for around 2% of total final demand and an only slightly higher percentage of base year employment. Yet, as discussed above, it reports some of the largest indirect and induced output as well as employment effects.

Note though that the effects reported by the “Agriculture, forestry and fishing” sector are more or less fixed in size across the different models. This is in stark contrast to the “Public Administration”, “Wholesale and retail” and the “Professional services” sectors, which report substantial increases with higher levels of fiscal autonomy endogenised in the models.

The comparatively large effects by the “Agriculture, forestry and fishing” sector shown in Tables 6.5.2 and 9.7.1 are due to the production links of that sector with the “Food, drink and tobacco” sector. That is to say that the sector which was subject to the initial exogenous demand shock requires most of its intermediate inputs from the “Agriculture, forestry and fishing” sector in order to meet the rise in final demand.

The SAM identifies that only around 2% of final demand from the “Agriculture, forestry and fishing” sector is purchased from the “Public Administration” sector. Hence, the indirect and induced output effects across models reported by the “Public Administration” sector do not flow through to the “Agriculture, forestry and fishing” sector.

Furthermore, Figure 6.5.2 shows that the most substantial increase in the “Public Administration” sector’s output is under the “Scotland Bill” and the “Fiscal Devolution” settings. However, these models endogenise a larger proportion of the negative tax, i.e. subsidy, that the “Agriculture, forestry and fishing” sector receives from the Government. Hence the indirect and induced output and employment effects are mitigated with higher degrees of fiscal devolution endogenised in the model.

The discussion above highlights that the initial exogenous demand shocks results in different degrees of indirect and induced output and employment effects. The channels through which the additional activity is induced differs between sectors, however. Overall, the effects increase with greater levels of fiscal devolution endogenised in the model.

6.5.3 Exogenous Demand Shock - Public Administration

The second shock is an exogenous demand shock on the "Public Administration" sector of also £500m. As above, the shock is run on four different calibrations of the SAM model, the "BASE", the "Scotland Act 2012", the "Scotland Bill" and the "Fiscal Devolution" setting.

Figure 6.5.3 plots the indirect and induced output effects on the 25 sectors under all four models. The shock on the "Public Administration" sector results in a more concentrated effect, i.e. the majority of the indirect and induced effect is due to increases in fewer sectors, than in the shock in section 6.5.2. Also, the effects of the higher degree of fiscal autonomy endogenised in the different models impacts the sectors to different degrees. First, the shock on the "BASE" model is analysed below.

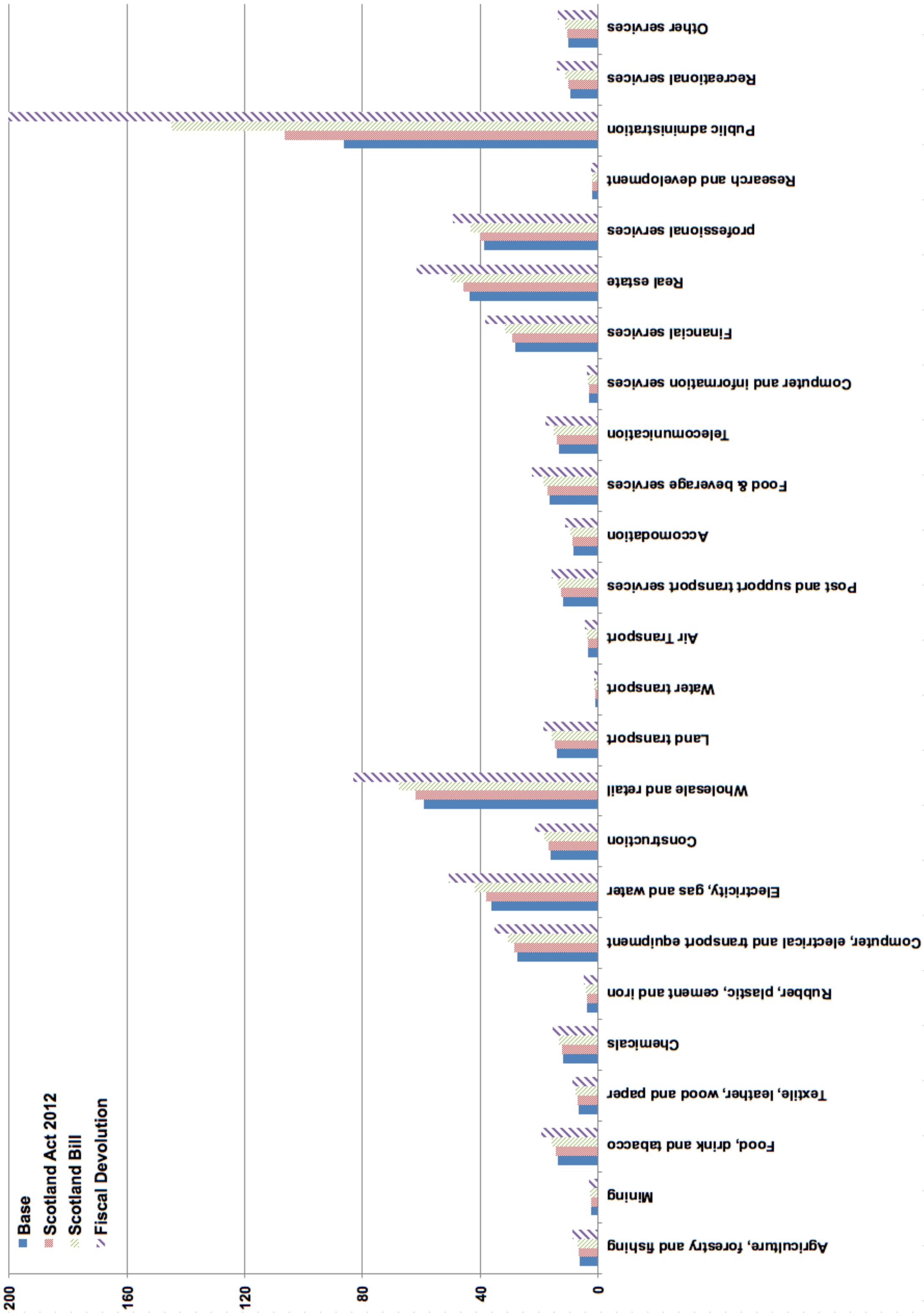
"BASE" Analysis

Table 6.5.2 reports that the total indirect and induced output effect of the shock on the "Public Administration" sector under the "BASE" setting of the SAM model is £470.34m. As in section 6.5.2 this excludes the direct effect on the "Public Administration" sector, thus the total effect of the exogenous demand shock is £970.34m. The average indirect and induced output effect by sector is £18.81m.

The largest indirect and induced output effects are reported by the "Public Administration" sector with £86.22m. Thus around 18% of the total indirect and induced output effects are due to the output rise by the "Public Administration" sector. That suggests that this sector uses a lot of its own production as intermediate inputs to meet the exogenous demand shock. The SAM reports that around a quarter of intermediate inputs from the "Public Administration" sector are stemming from the sector itself.

Furthermore, as discussed in section 6.5.2, the "Public Administration" sector is labour intensive and thus the indirect and induced employment effects are large. As Table 6.5.2 reports, the "Public Administration" sector creates 1,318.82 FTE jobs as indirect and induced effects from the initial shock. That is around a quarter of all jobs

Figure 6.5.3: SAM Model Comparison: Indirect and Induced Output Effects - Public Administration Sector Shock, in £m



added in the “BASE” model. Note that Figure 9.7.2 plots the indirect and induced employment effects for all four models and by sector.

The second largest increase in output is reported by the “Wholesale and retail” sector with a £59.2m rise. Also Figure 9.7.2 shows that this sector has the second largest indirect and induced employment effect in the “BASE” model. It adds 967.4 FTE jobs as a result of the shock (see Table 6.5.2). The rise in the “Wholesale and retail” sector is, as with the exogenous demand shock on the “Food, drink and tobacco” in section 6.5.2, due to a rise in consumption. That is to say that the increase in the “Wholesale and retail” sector is largely due to the positive stimulus to the overall performance of the economy.

This assumption is supported by the results of section 6.5.2, which reported nearly identical increases in both the indirect and induced output and employment effects for the “Wholesale and retail” sector. Hence, a general economic expansion is shown, in the SAM model, to induce output and employment in this sector. Conversely, these results suggest that economic downturns are likely to lead to a contraction in this sector, independent on which sector was subject to the initial shock.

The sectors reporting the third and fourth largest indirect and induced output effects are the “Real estate” and the “Professional services” sectors, respectively. Both increase their output by around £40m as a result of the exogenous demand shock on the “Public Administration” sector. The SAM identifies that the “Public Administration” sector purchases around 11% from the “Real estate” and the “Professional services” sectors as intermediate inputs. Thus, a shock on the “Public Administration” sector translates to indirect and induced output effects for “Real estate” and the “Professional services” sector.

Figure 9.7.2 highlights that the indirect and induced employment effects of the two sectors vary significantly. The “Professional services” sector adds 675.69 FTE jobs in the “BASE” model. In contrast to this, the “Real estate” sector adds only 102.35 FTE jobs (see Table 6.5.2).

Table 6.5.2:
Government Endogenised Multiplier - BASE
£500m External Demand Shock on the “Public Administration” Sector

	Indirect & Induced Output Effect	Indirect & Induced Employment Effect	%age Change to SAM
1. Agriculture, forestry and fishing	6.11	92.58	0.18%
2. Mining	2.30	9.01	0.04%
3. Food, drink and tobacco	13.60	74.08	0.16%
4. Textile, leather, wood and paper	6.62	65.10	0.21%
5. Chemicals	11.76	17.00	0.18%
6. Rubber, plastic, cement and iron	3.52	25.90	0.16%
7. Computer, electrical and transp. equip.	27.41	171.10	0.18%
8. Electricity, gas and water	36.02	94.18	0.29%
9. Construction	16.14	143.15	0.08%
10. Wholesale and retail	59.20	967.40	0.31%
11. Land transport	13.98	186.68	0.36%
12. Water transport	0.94	3.60	0.14%
13. Air Transport	3.14	10.58	0.27%
14. Post and support transport services	11.91	120.50	0.26%
15. Accommodation	8.28	170.85	0.36%
16. Food & beverage services	16.28	376.25	0.41%
17. Telecommunication	13.24	123.59	0.35%
18. Computer and information services	2.82	41.66	0.14%
19. Financial services	27.85	129.26	0.15%
20. Real estate	43.67	102.35	0.39%
21. Professional services	38.52	675.69	0.22%
22. Research and development	1.80	24.36	0.30%
23. Public administration	86.22	1318.82	0.22%
24. Recreational services	9.17	172.78	0.32%
25. Other services	9.84	210.36	0.45%
Total	470.34	5326.84	6.13%
Average	18.81	213.07	0.25%

The difference in the indirect and induced employment effects is due to the labour intensity of each sector. Figure 6.5.1 reports that the "Real estate" sector employs less than 2% of base year employment compared to a total final demand share of over 5%. Conversely, the "Professional services" sector reports a base year employment share of around 14% compared to a total final demand share of approximately 8%.

Thus, the "BASE" model reports varying levels of both indirect and induced output and employment effects. Furthermore, as in section 6.5.2, the multiplier effects the sectors experience are induced through different channels. These results are important as they highlight both the interconnectivity between sectors, but also how some sectors are mainly sensitive to the overall economic performance and thus fairly independent to which sector is subject to the initial shock.

"Scotland Act 2012", "Scotland Bill" and "Fiscal Devolution" model & Comparative Analysis

Tables 9.7.8, 9.7.9 and 9.7.10 report the indirect and induced output and employment effects for the "Scotland Act 2012", "Scotland Bill" and "Fiscal Devolution" models, respectively. Figures 6.5.3 and 9.7.2 plot these effects for all four models.

As with the exogenous demand shock on the "Food, drink and tobacco" sector, the increasing levels of fiscal autonomy endogenised in the model result in both the indirect and induced output effect and the indirect and induced employment effect to rise for all sectors. However, the sensitivity to the shock varies between sectors, as with the shock analysed in section 6.5.2.

Recall that the £500m exogenous demand shock on the "Public Administration" sector produced a total indirect and induced output effect of £470.34m and a total total indirect and induced employment effect 5,326.84 FTE jobs for the "BASE" model. The "Scotland Act 2012", "Scotland Bill" and "Fiscal Devolution" report total indirect and induced output effects of £508.53m, £581.44m and £723.39m as well as total total indirect and induced employment effects of 5,823.02 FTE jobs, 6,768.81 FTE jobs and 8,505.17 FTE jobs, respectively.

Figure 6.5.3 shows that the increasing degree of fiscal autonomy endogenised in the model increases the sensitivity to the (exogenous) demand shocks. That is to say that the marginal increases of the indirect and induced output effects get larger between the models.

The sensitivity of the indirect and induced output effects to the shock increases most for the “Public Administration”, “Wholesale and retail” and the “Real Estate” sectors. And the increases between models is most drastic between the “Scotland Bill” and the “Fiscal Devolution” models. Figure 9.7.2 shows similar variations between the models for the indirect and induced employment effects. Hence, the degree of Government sector endogeneity results in the largest multiplier effects in the “Fiscal Devolution” model.

In particular, the indirect and induced output and employment effects for the “Public Administration” sector increase substantially between the models. For example, the multiplier effects for the “Fiscal Devolution” model double compared to the “BASE” model. As a result, the “Public Administration” sector carries a larger share of the total indirect and induced output and employment effect with 28% and 36%, respectively. Recall that in the “BASE” model these shares are: 18% and 25%, respectively.

These results indicate that the initial shock to the economy produces significantly different output and employment effects in the economy by sectors. Furthermore, the degree of fiscal autonomy endogenised in the model magnifies sectors’ multiplier effects by different degrees. Again, as discussed in section 6.5.2, these results also highlight that positive shocks to the economy result in larger overall economic expansions under greater degrees of endogenised fiscal autonomy. However, this greater degree of sensitivity to shocks would result in equally magnified economic contractions in case of a negative (exogenous) demand shock.

6.6 Discussion

The model results above report that the effects of the same size exogenous demand shock are larger when the "'Food, drink and tobacco" sector is shocked than when the "Public Administration" sector is shocked. Overall, the shock on the former results in a more evenly distributed effect across sectors than the shock on the "Public Administration" sector (see Figures 6.5.2, 6.5.3, Figure 9.7.1 and Figure 9.7.2).

The analysis in section 6.5.2 and 6.5.3 highlighted that the two shocks impacted sectors in the economy differently. Furthermore, the channels that resulted in the multiplier effects by sectors differ. Some sectors are shown to report larger indirect and induced output and employment effects due to an aggregate rise in consumption whilst others provide larger shares in terms of intermediate inputs to the sector which was directly shocked.

Overall, with increasing degrees of fiscal autonomy, both shocks show a larger impact on the Scottish economy. In both cases, the indirect and induced output and employment effects are mainly carried to an increasing degree by sectors more closely linked with the "Public Administration" sector. This is because the "Public Administration" sector captures the largest share of the endogenised Government consumption.

The indirect and induced output and indirect and induced employment effects are also shown to differ in size depending on the underlying size, i.e. total final demand and base year employment, of the sector (see Figure 6.5.1). However, the channels which stimulate the multiplier effects are more significant for the model results and therefore for directing potential demand stimulating (fiscal) policies.

For example, the "Wholesale and retail" sector and the "Professional services" sector have near identical total final demand and base year employment figures (see Figure 6.5.2). However, the "Wholesale and retail" sector reports larger multiplier effects for all models than the "Professional services" sector. That is, despite both sectors providing similar volumes in terms of intermediate inputs to the "Public Administration" sector. Hence, the degree of endogenised fiscal autonomy should impact the output and employment multiplier approximately the same for the two sectors.

This suggests that the channel, which result in increases in the indirect and induced output and employment effects for the "Wholesale and retail" is aggregate consumption. Higher degrees of fiscal autonomy endogenised in the models simply increases the sensitivity of the sector to potential internal and external shocks.

A key point of the model results is that the greater degree of sensitivity to shocks also increases the volatility of the economy. The models above were subject to a positive exogenous demand shock. However, a negative demand shock would result in the model reporting increasing aggregated and sectoral contractions with larger endogenous levels of fiscal autonomy.

Two additional take away points from the analysis above are, first, that some sectors report larger effects under certain levels of fiscal autonomy but that this 'ranking' can shift with different degrees of fiscal autonomy. That is to say that for a greater aggregate expansionary effect, different sectors should be 'targeted' by policies for the different stages of fiscal devolution for Scotland (see 6.5.2 for a discussion on the 'rankings').

Second, given the high degree of sensitivity of the "Public Administration" sector, in particular under the "Scotland Bill", it is worth pointing out that policy-makers ought to consider 'sheltering' this sector. Having this sector exposed to larger degrees of fiscal autonomy in terms of the sensitivity to shocks, the potential downside is substantial. This is of particular importance, given that the Scotland Bill is in the later stages in the House of Commons and that the current Scottish budget deficit is larger than anticipated (The UK Parliament, 2015).

6.7 Conclusion

This chapter significantly contributes to the modelling framework for the Scottish economy. First, SAMs representing different degrees of fiscal autonomy are constructed in section 6.3. Second, a SAM multiplier model with a partially endogenised Government is derived in section 6.4. This model allows for the different degrees of fiscal autonomy captured in the SAMs to be endogenised and demand shocks to be simulated.

Third, two exogenous demand shocks are modelled under four different variants of the model. The results show that there are different channels operating in the economy, which produce varying output and employment multiplier effects. Also, that the Scottish economy is more sensitive to internal and external shocks with increasing levels of fiscal autonomy.

Chapter 7

AMOS

7.1 Introduction

Chapters 2, 3 and 4 build and disaggregate the 2009 SAM for Scotland. The 'Disaggregated SAM' identifies seven Household types and three Government and Tax accounts. Chapter 5 discusses the differences between IO and SAM modelling and concludes that the latter offers a more comprehensive modelling tool for the Scottish economy. Chapter 6 employs a SAM model with a partially endogenised Government sector to simulate an exogenous demand shock on the Scottish economy.

IO and SAM models provide useful tools to analyse demand shocks to an economy. However, these models are subject to some strong assumptions, like fixed prices and essentially infinite supply of labour and capital. Also, both IO and SAM models are limited to simulate demand shocks only, hence they do not allow for supply side shocks such as changes to the level of income tax paid in an economy. Since they do not contain any detailed specification of the supply side of the economy.

Computable General Equilibrium models (CGEs) are arguably a natural extension of IO and SAM models in that they combine the data of a SAM with economic theory. Further, CGE models overcome the above-mentioned limitations of these models. A key benefit of CGE models is that they have a fully specified supply side, which enables the simulation of, for example a tax shock to the model. Analysing the impact of fiscal policies to the Scottish economy is a key motivation for this thesis, which is why CGE modelling is employed here.

This chapter is structured as follows. Section 7.2 gives a general overview of CGE models. Section 7.2.1 discusses the standard version of the CGE model employed here, *AMOS*. Section 7.3 extends the model to capture seven Household types and three Government types, i.e. the same specification as the SAM model in chapter 6. Section 7.4 concludes.

7.2 CGE Models Overview

CGE models have their roots in the 'general equilibrium' concepts developed by Leon Walras (1874). His work captured the economy in a state of general equilibrium, which was represented by a set of simultaneous equations. A key aspect of this system is that supply equals demand in all markets simultaneously as a result of market prices determining this equilibrium (Hosoe et al., 2010).

Walras' general equilibrium concepts were further developed in the 1960s and 1970s by Arrow and Debreu (1954), Debreu (1959) and McKenzie (Dueppe & Weintraub, 2014). This body of work ultimately resulted in the Computable General Equilibrium /Applied General Equilibrium modelling, which is still in use today.

The CGE model employed here, *AMOS*, is also influenced by the work of Leontief (1986). Leontief developed the foundation for the modern IO modelling approach and consequently for SAM modelling (see chapter 5 for a detailed discussion on IO and SAM multiplier models). A key aspect of Leontief's work is that all inputs vary linearly in response to demand changes. Note that the development of the *AMOS* model was inspired out of the 'development economics' literature of the time, which acknowledged important market imperfections (Harrigan et al., 1991).

The key point of CGE (or Applied General Equilibrium) models is that they are empirically implementations of general equilibrium theory. CGE models are numerical models which combine actual economic data of a given region for a given year with economic theory. The model specifications are chosen by the modeller, and therefore they are a reflection of the modeller's 'view of the world' (Greenaway, Leybourne, Reed, & Whalley, 1993).

The level of aggregation of a model are determined by the research objective as well as data constraints. For example, models employed with a focus on the energy sector in an economy, tend to have a disaggregated energy sector and a higher level of aggregation for other sectors in the economy (McIntyre, 2012). The model employed in this chapter, uses a more general 25 industry sector disaggregation, but the focus is on the distributional impact of a disaggregated Household account.

The dataset employed for a CGE model is usually a SAM (see chapter 2), and thus the calibration and level of aggregation of the SAM are determining factors for the level of detail that the model can capture. For example, the disaggregation of the Household and Government accounts in Chapters 3 and 4 enable the disaggregation of these sectors in the CGE model employed here.

A key feature of CGE models is that the system can be subjected to supply side shocks. This is in contrast to IO and SAM modelling, which traditionally simulate demand side shocks, only (Hosoe et al., 2010). Furthermore, CGE models capture the interdependencies and feedback mechanisms in the economy and allow for price variations. Note that both IO and SAM models do identify some of these mechanisms in that they capture demand-side interdependencies through IO linkages. However they have no detailed specification of the supply side. Greenaway et al. (1993) also highlight that the main strength of the CGE framework is its foundation in microeconomic theory.

The equations, which attempt to capture the structure of the economy, are calibrated to a base year dataset - the SAM. This includes the behavioural responses of agents in the economy, for example, Households, Corporations and Government. The aim of the mathematical structure of the CGE model is to capture the responses of the economy's agents following a shock imposed on the system, which is initially in equilibrium. Also parameters (exogenous) parameter values are given to the model, e.g. trade elasticities (Scottish Government, 2015a).

In general, CGE models are based on neoclassical theory, where Households are utility-maximisers and firms profit-maximisers. That is to say, Households' attempt to maximise their utility from the consumption of goods & services under a budget constraint. This constraint is traditionally computed as the sum of incomes plus transfers, minus taxes.

Corporations are modelled seeking to maximise profits by setting their supply levels and choice of technique so as to maximise profits and minimising costs. Firms utilise labour and capital inputs for the production of value added. Value added is then combined with intermediate inputs for the production of final outputs. The initial structural characteristics of the economy are captured by the underlying SAM data (Hosoe et al., 2010).

Most CGE models include a Government sector. This sector collects taxes from both Households and Corporations as well as transfers funds, for example welfare payments, back to these sectors. Governments produce and consume goods, which can be utilised in the CGE model to initiate a shock to the system. For example, the Government's taxation level can be altered as a shock to the economy and the model solves for the behavioural responses of the agents in the economy to this shock under their utility-and profit-maximising constraints (Scottish Government, 2015a).

Traditionally, CGE models also identify an external sector, which trades with Households, Corporations and the Government sector. Households and the Government purchase goods & services from the external sector and Corporations buy intermediate inputs from and sell final outputs to the external sector[1]. The level of trade between the domestic sector and the external sector is determined, inter alia, by the price difference between the two markets(Hosoe et al., 2010).

The behaviours of the agents in a CGE model are predominantly determined by either Cobb-Douglas, Constant Elasticity of Substitution (CES) or Leontief functional form. Also, the level of product differentiation between the domestic and the external sector is usually determined by an elasticity of substitution, for example 'Armington' (Armington, 1969).

[1]Note that in the SAM analysis (see chapter 6), the industrial sector, which imports intermediates, and the corporate account are separate.

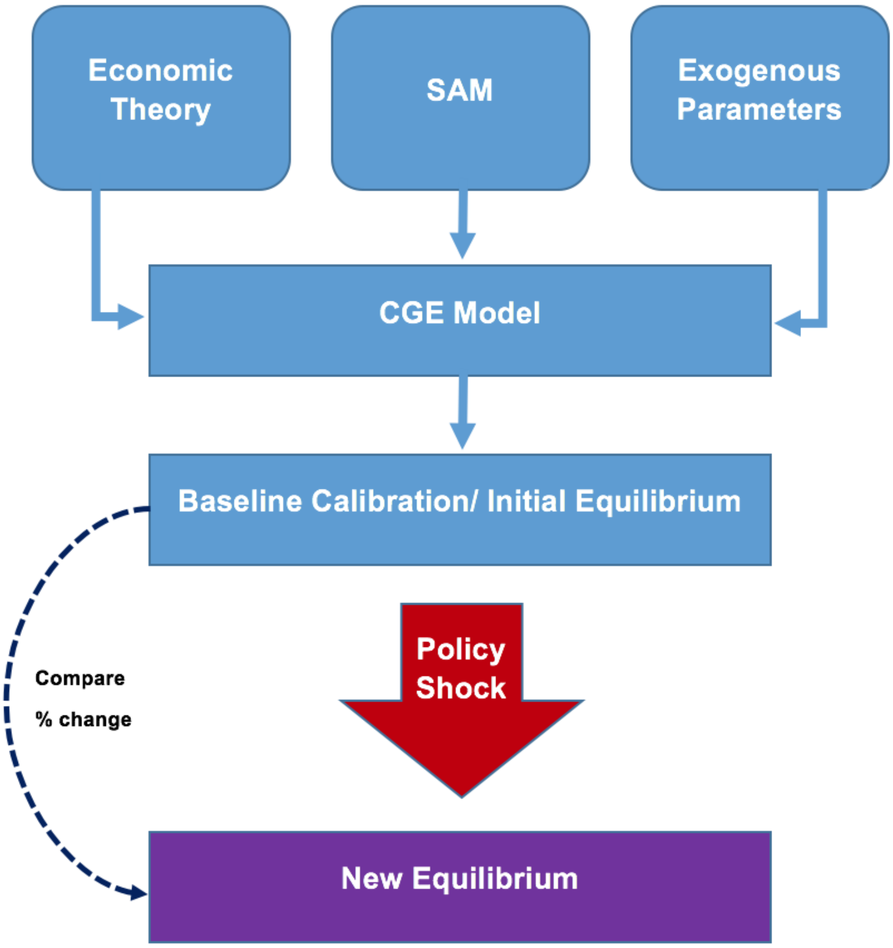
Following a simulated policy shock, the CGE model solves for a new short run and/or long run equilibrium. The CGE model needs to have specific closures, which are a set of equations that the model solves simultaneously, for various parts of the system. Closure rules are invoked in order to determine key macro-economic variables, such as the level of employment, investment and trade. It has to be noted that the particular model closures of a CGE model are subject to the assumptions placed on the model by the researcher (Greenaway et al., 1993).

In order to find a solution, the model needs to have determined which variables are endogenous and which ones are exogenous, with the number of independent equations determining the number of endogenous variables that the model can solve for (Hosoe et al., 2010). A common way of determining the endogenous variables in a model is through imposing either balanced budgets or balanced trade. But in a regional context neither of these might be appropriate (Lecca et al., 2014).

Figure 7.2.1 gives a visual overview of the different aspects of the CGE modelling process. The first part is combining the dataset, the SAM, with the mathematical framework for the model. The model equations are determined through both the data characteristics as well as economic theory. For example, depending on the research objective, the behaviour of agents could be modelled through employing either CES or Leontief functional forms. Also, model closures can be specified to either clear markets or allow for a relaxation of some assumptions, such as unemployment can be present in the new equilibrium (Hosoe et al., 2010).

Furthermore, the values of certain key parameters are introduced to the model (see Figure 7.2.1). These parameters are usually taken from econometric analyses and include the elasticity parameters, such as the elasticity of substitution between domestic and external goods & services (Armington, 1969; Hosoe et al., 2010) Note that these key parameters are in the model specification, but their values have to be determined to allow numerical representation.

Figure 7.2.1: CGE Outline



After the 'CGE Model' (see Figure 7.2.1) is constructed, it is then calibrated. In this process, the mathematical structure of the model and the behavioural parameters are fitted to the data. The first task for the model is to reproduce base, which confirms that the calibration was successful. Note that the calibrated model assumes that it is in an initial equilibrium, i.e. the economy in the base year of the SAM is in equilibrium. The calibrated model matches the structure of the economy as specified in the SAM (Scottish Government, 2015a).

Next, the 'Policy Shock' is introduced to the system and the model solves for a 'new equilibrium' (see Figure 7.2.1). This new equilibrium is determined through the economic relationships dictated by the system of equations in the CGE model. The shock to the initial equilibrium results in price changes, which drive a new allocation of goods and factors in order to reach the new equilibrium. Note that prices and quantities are determined simultaneously (Scottish Government, 2015a).

The analysis of the results of CGE modelling focuses primarily on the difference between the initial and the new equilibrium, i.e. it is typically "comparative static" in nature. Results are usually reported as percentage changes for variables comparing the system before the shock and in the new short run or long run equilibrium. Also, the study of the adjustment paths of key variables provides useful insight into how the economy adjusts to its new equilibrium (Lecca, McGregor, & Swales, 2013; Lecca et al., 2014).

As a side note, apart from IO and SAM modelling (see Chapters 5 and 6), there are other popular modelling tools, which share some of the characteristics of CGE models. Arguably the most popular one amongst those are 'Dynamic Stochastic General Equilibrium' models (DSGE). A key distinction between DSGE models and CGE models is that the former focus on capturing (short run) business cycle adjustments(Scottish Government, 2015a). Also, they do not allow for the type of sectoral disaggregation as is employed in the CGE model in this chapter.

The section above has outlined the structure and benefits of CGE models. It is a natural extension from the IO and SAM analysis in previous chapters and offers the added modelling tool of shocking the supply side of the economy. CGE modelling acknowledges supply-side constraints that can shape and limit the economic responses to demand-side shocks. Recall that both traditional IO and traditional SAM modelling is restricted to demand shocks only. There are however, also limitations of CGE models that researchers have to be aware of.

The strengths and weaknesses of CGE models are discussed in detail in Greenaway et al. (1993) as well as in Kehoe and Kehoe (1994). Additionally, Hermannsson (2012) provides a detailed overview of these as well as the discussion in more recent publications. Here, two key limitations of CGE models are highlighted.

First, is the (strong) assumption that the economy is in an initial equilibrium in the base year. A SAM identifies the flows of funds in a given region/country and year. But it does not take into account any larger macroeconomic fluctuations and therefore the baseline calibration of the model (see Figure 7.2.1) does not necessarily represent the economy in a state of equilibrium (Greenaway et al., 1993).

Second, are the difficulties in solving a mathematical system of many non-linear equations. As outlined above, CGE models typically adopt a Cobb-Douglas, CES or Leontief functional form. These are all well-behaved, which simplifies the process of finding solutions to the model. However, choosing one of these forms for a particular model implies the assumption that the functional form is representative of an agent's behaviour (Greenaway et al., 1993).

It is argued, however, that these functional forms have been proven to perform well in econometric studies. Hence, they are good approximations for the overall system. In order to account for this limitation, studies employing CGE models typically conduct a 'sensitivity analysis' post-simulation. This analysis is centred around the values of key parameters as well as functional forms, which are key for the model deriving its 'new equilibrium' (Greenaway et al., 1993; Hosoe et al., 2010).

CGE models are based on real economic data and also incorporate both parts of economic theory and intuition as well as exogenously estimated parameter values. Their flexibility allows for a wide range of policy analysis both for the short run and for the long run. Hence, CGE models have found wide usage amongst public policy researchers and they are or have been employed by the World Bank, OECD, IMF, HMRC and the Scottish Government (Bank, 2015; HMRC, 2013b; Scottish Government, 2015a).

7.2.1 Outline of the Standard Forward-Looking AMOS Model

Section 7.2 provided a general overview of CGE models. The model employed for the CGE analysis in this thesis is a variant of *AMOS*, which is an acronym for 'A Macro-Micro Model of Scotland (Harrigan et al., 1991). The focus in this section is on highlighting some key aspects of the *AMOS* model with particular focus on those elements of the standard model, which are expanded on here.

AMOS is a Computable General Equilibrium (CGE) model developed at the University of Strathclyde. There are several variants of the model, including variants with a highly disaggregated energy sector as well as multi-regional Scotland-RUK model (McIntyre, 2012; Tamba, 2014; Scottish Government, 2015a). This is due to its inherent flexibility with regards to parameter values, model closures and functional forms (Harrigan et al., 1991).

This section presents an overview of a single-region dynamic CGE model, with a full model specification in Lecca et al. (2013). The complete mathematical representation of the model is provided in Appendix 7. The elements of the model that are extended in this thesis are detailed in section 7.3.

The model variant of *AMOS* used here is the forward-looking (FL) model developed by Lecca et al. (2013). The main differences compared to the myopic, recursive model variant of *AMOS* are the specifications of consumption and investment. In the myopic model, consumption is abstracted from future periods, as it is derived from a simple budget equation and investment is independent of saving.

In the FL model, consumption is computed through a jump variable, which is derived from an inter-temporally additive utility function. Key point here is that consumption is a consequence of inter-temporal optimisation by households subject to their lifetime budget constraint(Lecca et al., 2013).

Lecca et al. (2013) argue that regional policy is traditionally an exogenous variable for regions and thus no Ricardian equivalence of regional fiscal deficits applies. However, the aim of the model extensions performed in this chapter is to build a model, which can capture the devolved fiscal powers for Scotland through a (partially) endogenised Government sector.

Hence, regional policy is treated as an endogenous variable, with a regional public sector that has supply side levers. Note that the model does include exogenous levers too, such as tax rates. However, the impact will depend on, for example, the extent to which government expenditure responds endogenously.

In this model, agents are forward-looking and hence consumption and investment decisions reflect inter-temporal optimization with perfect foresight. In *AMOS* these dynamics are driven through the migration and investment functions. The stocks that change relate to migration (population) and capital stocks. Dynamic inter-temporal optimisation is apparent in consumption and investment. Every period represents a static equilibrium, where over time, the gradual relaxation of factor constraints generates a different outcome in each period (Hermannsson, 2012; Lecca et al., 2013)

The standard *AMOS* model has three domestic transactor groups and two external transactor groups. The domestic transactors are Households, Corporations and the Government. Note that the standard version of the model treats Households as a unified account and the Government also a single account. The external transactors are the Rest of the UK (RUK) and the Rest of the World (ROW)(Lecca et al., 2013).

The version of the model developed and used here has 25 domestic industries, seven Household groups, a corporate sector, three Government sectors and two external sectors (RUK and ROW). The 25 industries are aggregated from the initial 104 industries in the 2009 SAM for Scotland from chapter 2 (see table 9.7 for the aggregation).

The elements of final demand in the model are consumption, investment, government and export expenditure. In this model, a part of government demand is considered endogenous. The assumption is that any change in government expenditure, resulting from a rise in the government income through a policy shock, does note change the composition of the expenditure.

The labour market is characterised as a single (Scottish) labour market with perfect sectoral mobility. The model incorporates three labour market closures, which allow the model to simulate a labour market, which reflects either nationally-set wages or locally-set wages. The first is the regional wage bargaining (RB) case, the second is the fixed real wage (FRW) case and the third is the national bargaining (NB) case (Lecca et al., 2013).

$$Wage\,setting \begin{cases} ln[\frac{w_t}{cpi_t}] = \omega - \epsilon\,ln(u_t) & (Regional\,Bargaining) \\ \frac{w_t}{cpi_t} = \frac{w_{t=0}}{cpi_{t=0}} & (Fixed\,Real\,Wage) \\ w_t = w_{t=0} & (National\,Bargaining) \end{cases} \tag{7.2.1}$$

where w is the nominal wage, cpi is the Consumer Price Index, ω is a parameter calibrated to the steady state and u is the regional unemployment rate. ϵ is the elasticity of wages related to the level of the unemployment rate and it can also be interpreted as an index of wage flexibility (Lecca et al., 2013).

Income from labour, i.e. wages, are derived through the regional wage bargaining process that has just been discussed. The take home wage derived through the bargaining process, determines the level of total employment and the demand for labour. With labour income being the product of the real wage and employment. Note that the regional real take-home wage is inversely related to regional unemployment rate (Blanchflower & Oswald, 1994; Minford, Stoney, Riley, & Webb, 1994; Tamba, 2014).

In the RB case, wages are directly related to workers' bargaining power and respond to excess demand for labour. The NB closure reflects a case, where wages are set nationally, i.e. workers do not have any bargaining power for their local wages, since wage bargaining is performed on a national level. Note that the NB closure assumes that the nominal wage is fixed at the base year level. This case is a typical Keynesian closure (Lecca et al., 2013; Harrigan et al., 1991).

The FRW closure reflects a case where bargaining ensures that the purchasing power of wages remains stable over time. It could therefore be interpreted as a "real-wage-resistance" hypothesis (Lecca et al., 2013). Note that the simulation in chapter 8 selects the RB closure only.

The model endogenises migration, where the attractiveness of the region to potential workers (currently outside the region) determines the level of migration. Conversely, a less attractive region leads to outward migration. The attractiveness of the region, i.e. inward migration is positively related to the real wage differential, i.e. the log of regional and national real wages, w^N/cpi_N, and negatively related to the unemployment rate differential, i.e. the difference between the log of regional and national unemployment rates, u^N (Layard, Nickell, & Jackman, 1991).

$$nim_t = \zeta - v^u[ln(u_t) - ln(\overline{u}^N)] + v^w \left[ln\frac{w_t}{cpi_t} - ln\frac{w^N}{cpi^N} \right] \tag{7.2.2}$$
$$LS_{i,t}$$

where nim_t is the rate of net migration and ζ is a parameter calibrated in order to ensure zero net migration in the base period. v^u and v^w are elasticities that measure the impact of the gap between the logs of regional and national unemployment and real wage rates.

In the initial equilibrium, the economy is assumed to be characterised by 'zero net migration'. The new long run equilibrium is assumed to have re-established net migration equal to zero, through net migration flows in the transition period between equilibria (Lecca et al., 2014).

The way the model solves allows the observation of the adjustment from initial equilibrium, which is subject to the policy shock, to the new equilibrium. For example, the migration adjustment outlined above, can be analysed through this progressive updating of the labour market . Note that all variables in the model are tracked, and hence their adjustment paths to the new equilibrium can be observed. (Lecca et al., 2013).

Equally, the capital stock adjusts progressively, through changes in investments. The capital stock is updated between period, thus in every one period, the investment in period t affects the capital stock of period $t+1$. The changes in investment are driven by the inter-temporal optimisation by firms (Lecca et al., 2013).

Since, the economy is assumed to be in an initial equilibrium, desired capital stock is equal to actual capital stock in period 0, i.e. before the policy shock. As with migration, the capital stock will adjust to a new optimal position in the new long run equilibrium. The actual stock is a function of last period's level of capital in the economy and is adjusted in the current period for depreciation and gross investment. The level of stock is also determined by the inter-temporal optimisation of firms (Lecca et al., 2013).

The model parameters are obtained through the usual calibration process from the SAM, here the 'Disaggregated SAM' (see chapter 4). As shown in 7.2.1, the economy is assumed to be in a steady state equilibrium at this stage. However, some parameter values remain unspecified through this method and they have to be obtained from exogenous sources. This section presents some of the exogenously obtained parameter values, see Lecca et al. (2013) for a full breakdown of the calibration process.

For all sectors, trade elasticities are set at 2 (Armington, 1969). Production elasticities are set at 0.3 and the wage curve elasticity is set to -0.033. In the migration function (see Equation 7.2.2), v^u is set to -0.08 and v^w is set equal to -0.06. These elasticity values are commonly set for *AMOS* and are econometrically estimated by Layard et al. (1991). The depreciation rate is set equal to 0.07 and the inter-temporal elasticity of substitution is 1.5 (Lecca et al., 2013).

7.3 Model Extensions

The CGE simulation conducted in chapter 8 is a fiscal policy shock, specifically a shock on income tax. The basic *AMOS* has been employed for several fiscal policy shocks, including a rise in the rate of income tax under the devolved powers of the Scotland Act 1998 (The UK Parliament, 1998; Lecca et al., 2014).

The The UK Parliament (2012) extended the degree of tax devolution to Scotland through the introduction of the Scottish Rate of Income Tax (see chapter 8 for a detailed discussion). Understanding the implications of this new fiscal power for Scotland is imperative for Scottish policy makers.

The SAM constructed in chapter 4 identifies both a disaggregated Household as well as disaggregated Government account. Extending *AMOS*'s fiscal policy simulations by these two disaggregated sectors enhances the modelling capacity of the CGE model. It enables two distinct additions to the policy modelling framework. First, distributional impacts of a fiscal policy shock on different Household types can be observed. Second, the three Government sectors in Scotland can be identified separately in the model. This is important in order to capture recent changes in the degree of Scottish fiscal autonomy (see chapter 6).

The *AMOS* model outlined in section 7.2.1 has a disaggregated Household sector built in (Lecca et al., 2013). However, the income identification for households was previously not tied down. Therefore, studies have not been able to utilise on the disaggregated Household account in the model, as the SAMs employed for the calibration of the model identified a unified Household account only. The disaggregated Household SAM (see chapter 4) enables the *AMOS* model to be calibrated and a policy shock to be run with a disaggregated Household sector.

The number of Household groups can be flexible in the model in Lecca et al. (2013). Hence, the model can be calibrated for the 7 Household types in the disaggregated Household account computed in chapter 4. Note that the Household account is simply split into seven groups in the model, with no transfers or flows between Household accounts .

The model outlined in Appendix 7 identifies a unified Government account. However, the model needs to be extended in order to be able to identify the three Government sectors captured in the 'Disaggregated SAM' from chapter 4. This disaggregation is performed in section 7.3.1 below. Note that the disaggregated Government sector in the SAM and the CGE model captures inter-governmental transfers.

7.3.1 Government

The standard *AMOS* model treats the Government sector as a unified account. This section disaggregates the Government account to capture the three Government sectors identified in the SAM computed in Chapters 3 and 4. The Government sector is disaggregated in the model, through the steps outlined below.

Equations 9.8.37, 9.8.38 and 9.8.39 in Appendix 7 provide the formal description of the Government sector in the standard *AMOS* model outlined above. These are replaced in the Government disaggregated model by the equations derived below.

The Government sector is disaggregated in the model by identifying three separate Government accounts, which are subject to a combined budget constraint, here the 'Fiscal Deficit' (see Equation 7.3.1). That is to say, that the model is able to be calibrated with the three government accounts identified in the 'Disaggregated SAM', namely the UK Government, the Scottish Government and the Local Government.

$$FD_t = \sum_g GBAL_{g,t} \tag{7.3.1}$$

Note that equation 9.8.37 is the 'Fiscal Deficit' with unified Government. This is replaced in the disaggregated model by Equation 7.3.1.

Equation 7.3.1 says that the 'Fiscal Deficit' condition for the aggregate public sector is the sum of the 'Government Balances' of the various Government sectors identified in the model. The Government Balance for each of the government sectors is identified as,

$$GBAL_{g,t} = \sum_i QG_{g,i,t} PQ_{i,t} + \overline{GSAV_g} + \sum_{ins} TRG_{ins,g,t} PC_t - (d_g^k \sum_i rk_{i,t} K_{i,t} + d_g^h \sum_i rh_{i,t} H_{i,t} + \sum_{i,t} IMT_{i,t} + \sum_h dtr_h + (ssce_g + ire_g + cre_g) \sum_j L_{j,t} w_t + \overline{FE_g} \epsilon_t) \tag{7.3.2}$$

Equation 7.3.2 is key for the disaggregation of the Government sector in *AMOS*. It captures the income and expenditure balance for each of the Government accounts similar to the Fiscal Deficit in the standard model (see Equation 9.8.30). Note that the subscript g identifies the individual Government accounts, here, either the UK Government, Scottish Government or Local Government. Equation 7.3.2 is detailed term-by-term below.

The first item of the Government Balance is the government expenditure, $QG_{g,i,t}$. However, in this variant of the model, government expenditure is split between the three governments identified in the model. That is to say that the model treats the UK Government, the Scottish Government and the Local Government as three sectors. $PQ_{i,t}$ is simply the commodity price (see Equation 9.8.4).

Next, the Government Balance includes the 'Government Savings' term, $\overline{GSAV_g}$. Government saving is held fixed for all governments, as in the standard model outlined above. The baseline for this parameter is the as the 'Payments to Capital' transfer from the respective government, obtained from the 'Disaggregted SAM' (see chapter 4, section 4.6).

The term $\sum_{g,ins} TRG_{g,ins,t}$ captures all Government transfer payments. Recall that in the standard *AMOS* model, the Government sector made transfer payments to Households and the Corporations only. The disaggregated model extends this to capture both inter-governmental transfers such as the 'block grant' from the UK to the Scottish Government. Also, international transfer payments are captured here, which include the 'non-identifiable' spending discussed in chapter 3 in detail.

In the simulation performed in chapter 8, the transfer payments are held constant. That is to say that, a change in government revenue does not affect the amount of transfer payments from the government to other sectors of the economy. Augmenting this setting to allow for transfer payments to change with varying levels of government revenue is something to be explored at a later stage. Because, if the Scottish Government was to raise taxes and in turn collect higher revenues, the Local Government ought to benefit from the increase in Scottish public revenues.

Next, $(d_g^k \sum_i rk_{i,t}K_{i,t}$, $d_g^h \sum_i rh_{i,t}H_{i,t}$ and $\sum_i IMT_{i,t}$ are all terms, which do not change in the disaggregation. These are transfer payments from the other two agents in the model, Households and Corporations, as well as import tax payments.

The treatment of taxes changes in the disaggregated model, where local taxation by Government account is now identified. This is captured by $(ssce_g + ire_g + cre_g)\sum_j L_{j,t}w_t$. The $ssce_g$, ire_g and cre_g are social security, direct Household tax and Household consumption tax receipts, respectively. Hence, the model now also captures Household consumption tax receipts separately. (These are all a function of labour demand multiplied by the wage rate.)

This extension to the Government account is crucial to allow *AMOS* to identify devolved taxation more clearly and model changes to taxes more accurately. The change to the treatment of taxes enables the model now to capture the different stages of fiscal devolution as discussed in chapter 6 more directly. The last term is 'Government remittance', $\overline{FE_g}\epsilon_t$, which also identifies the different Government sectors.

In effect, the model identifies one 'Government Balance' function for each of the Government sectors (UK Government, Scottish Government and Local Government). Hence, the sum of all Government Balances is the Fiscal Deficit condition identified above in Equation 7.3.1.

Equation 7.3.3 is the disaggregated 'Government expenditure' function, which replaces Equation 9.8.31 in the standard model (see Appendix 7). The changes here only include the government identifier for the terms QG and QGR.

$$QG_{g,i,t} = \gamma_i^g(\delta_i^{gr} QGR_{g,i,t}^{\rho_i^A} + \delta_i^{gm} QGM_{i,t}^{\rho_i^A})^{\frac{1}{\rho_i^A}} \tag{7.3.3}$$

The disaggregated model solves with the usual closures, including the 'balanced budget' closure. This condition implies, for example that any additional revenue collected by the government through higher tax income is spent on Government expenditure with the same composition as in the baseline.

Also note that the elasticities remain unchanged in the disaggregated model. That is, because the Government sectors are treated as three separate sectors here, with fixed transfer payments. Future iterations of the model are planned to adjust the treatment of the government sectors, for example, with the grant payments between the Scottish and Local Government adjusting due to changes in Scottish Government tax revenue.

7.4 Conclusion

This chapter provided an outline to CGE models, which are a natural extension to the IO and SAM models from chapter 5 and 6. IO and SAM models are effectively CGE models, but with the supply side rendered entirely passive (P. G. McGregor, Swales, & Yin, 1996). Next, the standard forward-looking version of the CGE model *AMOS* was outlined. This model was then extended to include a disaggregated Government sector.

Chapter 8

Scottish Fiscal Policy: Towards a Scandinavian Model?

8.1 Introduction

The Scottish Government will be bestowed with greater fiscal autonomy in the coming years. The biggest share in the devolution process of fiscal powers is due to the changes to the income tax regime both under the Scotland Act 2012 as well as the proposed changes by the Smith Commission, which are now formalised in the Scotland Bill 2015-16 (The UK Parliament, 2012; The Smith Commission, 2014; The UK Parliament, 2015).

In the lead-up to the vote on Scottish Independence in September 2014, the Scandinavian (or Nordic) economies were frequently used as a comparative model, which Scotland could emulate following independence (Scottish Government, 2014). The current fiscal framework for Scotland does enable the Scottish Government to pursue a fiscal policy, which can, at least partially, emulate the fiscal stance of the Nordic economies. This chapter explores the an income tax hike to the average rate on income tax paid in Scotland, which mirrors the level of income tax paid in the Scandinavian economies.

Section 8.2 explores some characteristics of the Nordic economies and discusses how they compare to the relevant Scottish economic institutions. Section 8.3 outlines the simulation strategy. The extended *AMOS* model from chapter 7 is shocked with a balanced budget increase in the average rate of income tax that emulates Scandinavian levels of taxation. Section 8.4 discusses the theory relating to an income tax shock. Section 8.5 analyses the simulation results. Section 8.6 discusses the wider policy implications of the results and section 8.7 concludes.

8.2 Fiscal Option - The Scandinavian Model

Recall from chapter 6, section 6.2 that the Scotland Act 2012 enables the Scottish Government to set income tax rates that differ significantly from the rates in the RUK. These powers are likely to be extended through the proposals of the Smith Commission and the Scotland Bill 2015-16 (The UK Parliament, 2012, 2015). One option for Scotland, outlined below, would be to move towards a Scandinavian Model of high public spending and high taxation.

Section 8.2.1 explores some key aspects of Scandinavian economies, with particular focus on the impact of changing tax rates on migration and wage bargaining behaviour. This is then contrasted in section 8.2.2 with the current Scottish economic framework. These findings inform the simulation strategy of the CGE modelling in Sections 8.4 and 8.5.

8.2.1 Observations from the Scandinavian Economies

The proposal for Scotland to move towards a Scandinavian model is advocated in one branch of the literature, prominently in the book "Small Nations in a Big World: What Scotland Can Learn" by Keating and Harvey (2014). Here, the economic set-up of the Scandinavian nations is described as a "human investment model that relies on human capital to provide social protection to citizens" (Keating & Harvey, 2014). In this model, the role of the state is much more predominant than in other western economies, including in the UK.

Table 9.9.1 gives an overview for aggregate taxation and benefit levels for the UK and the Scandinavian economies (Denmark, Finland, Norway and Sweden here) [1].

[1] The "Scandinavian" average here is simply the mean across the four countries' rates.

This table shows that total tax revenue as a percentage of GDP was 11% higher in the Scandinavian economies at 43.3% compared to the UK at 32.3% in 2009[2].

Also, social security contributions as a percentage of GDP were significantly larger at 10.9% in Scandinavia in contrast to 6.4% in the UK for the same year. Furthermore, direct and indirect taxes are generally observed to be higher in the Scandinavian economies. In 2009, the average income tax rate paid across Scandinavia was 40.6% compared to 32.4% in the UK. Similar, the VAT rate in the former was higher at 24.8% and that in the latter was 20% for 2009. These figures suggest that, as Keating and Harvey (2014) argue, the Scandinavian state plays a larger role in the general economic composition than in the UK.

Apart from the higher tax and higher spend model of the Scandinavian economies, there are also institutional differences from the UK, which are crucial to the way the Nordic states operate. Two of these are outlined here. First, the "tripartite bargaining" in the Nordic economies is characterised by national wage negotiations which include workers' unions, employers' associations and the government. Further, this system is subject to an annual bargaining cycle, which is believed to reduce tensions in these negotiations that are commonly observed in other European economies, for example in Germany (Keating & Harvey, 2014; Financial Times, 2015).

The second institutional difference is the principle of "universalism". This concept implies that even the middle-class is included in the benefit system. Through the inclusion of most of society in the social system, social solidarity is ensured, which allows the system to thrive (Keating & Harvey, 2014).

The principle of "universalism" was also upheld in economic crises, e.g. in the 1980s and 1990s as well as the recent financial crisis around 2008. During those times, the Scandinavian economies continued to pursue their 'social investment state', instead of the austerity measures observed in other western economies. However, it has to be noted that prolonged downturns put strain on the system, which relies on

[2]The year 2009 is the base-year that the model used in the simulations in this chapter is calibrated for, which is why the figures from that year are used where possible.

near full-employment levels to allow for its inclusive social solidarity system (Keating & Harvey, 2014).

8.2.2 Scotland Moving Towards a Scandinavian Model

Scotland would have to undergo drastic changes to its economic structures in order to mirror the fiscal framework of the Scandinavian economies outlined above.This includes promoting a more dominant role of the government in wage bargaining as well as institutional changes. The Scotland Act 2012 enables Scotland to emulate the Scandinavian model more closely with the Smith Commission's proposals allowing even closer emulation of that model.

One option to fund an increase in public consumption would be to raise additional tax revenue through a higher rate of income tax. The average rate of income tax across the Scandinavian economies in 2009 was approximately 8 percentage points higher than in the UK (see Table 9.9.1).

In this chapter, an income tax hike in a balanced budget scenario is simulated, where the additional tax revenue funds a linear increase in public consumption (see section 8.4). This is referred to as capturing the "Scandinavian Model". Note that the current version of the Scotland Bill 2015-16[3] extends the borrowing facilities to approximately £4.75bn from £2.7bn in the Scotland Act 2012 (The UK Parliament, 2012, 2015).

However, changing the fiscal framework to a high-tax high-spend model as simulated in this chapter begs the question whether Scotland would need more substantial changes to its borrowing facilities in order to cushion any potential shortfalls in tax revenue. This is because Scotland is likely to be subject to a greater sensitivity of public finances to external shocks under a high-tax-high spend model.

A balanced budget expansion of the magnitude modelled in this chapter would probably require institutional change in Scotland. Specifically, this section is interested in the two principles outlined in section 8.2.1. First, the bargaining mechanism

[3] 3rd Reading in the House of Lords

for Scotland would need to change, since the role of the state is that much more pronounced and the higher level of public amenity provision would need to be reflected in lower real take home wage setting.

Thus, the move towards "tripartite bargaining", where the government has a bigger role in wage setting than it currently has in Scotland is a potential outcome. The Scandinavian system of "tripartite bargaining" is subject to workers represented by unions and firms by employer associations, which would also require a significant change compared to the current model. For example, unionisation in the UK was at 26% compared to 64% in Scandinavia in 2012 (see Table 9.9.1).

The other feature of the Scandinavian model highlighted in section 8.2.1 is the principle of "universalism". Adopting this principle in Scotland would require that the higher levels of public consumption, as modelled in this chapter, would also result in higher welfare spending, which would be a more inclusive welfare system than is currently operated in Scotland. One example would be raising childcare provision, which is arguably quite extensive in the Scandinavian economies (Keating & Harvey, 2014).

The changes outlined here are likely to result in differences in "behavioural" responses to the change in the fiscal framework. This chapter adopts the stance that the composition of public consumption and in particular of any proposed increases, following a balanced budget expansion as simulated in this chapter, in government expenditure matters and are influenced by voters' preferences. This chapter tries to capture various settings of the above institutional differences through the simulation of a range of settings of the model, as outlined in section 8.5.

8.3 Theoretical Income Tax Shock

This section outlines the theoretical *AMOS* model and the theoretical mechanisms of the model following a rise in income tax. The focus of this section is on the effect on employment and wages following the fiscal policy shock under certain parameter values. Note that Lecca et al. (2014) provide a detailed analysis of a theoretical income tax shock for a larger array of parameter values.

8.3.1 Theoretical Model Outline

The model is a regional, long run, open economy model similar to the model derived by Layard et al. (1991). Output is produced under perfectly competitive conditions with prices of imports and the cost of capital set exogenously. Regional output is assumed to be an imperfect substitute for the output of other regions. This is due to the price variation between regional and extra-regional output adopted by the model through employing conventional trade functions in the model (Armington, 1969; Lecca, McGregor, Swales, & Yin, 2010).

The variation of prices between regional products and products from other regions is an important assumption for this model, as it allows for a 'competitiveness' effect. That is to say, that a change in the relative price level of a region's output can either result in a stimulus or a contraction in the demand for its output. Furthermore, this allows for a variation in the nominal and in the real wage in the long run (Lecca et al., 2010).

Production occurs under a linear homogeneous production function. The model has two factors: labour and capital. There are seven Household types in the model, with Households treated as homogeneous, hence the model does not distinguish between workers and potential migrants, inter alia.

The long-run equilibrium of this economy is characterised by both zero net migration as well as zero net investment. The regional migration function is characterised by net migration being determined through the inter-regional relative real wage and the employment rates. The capital stock adjustment is characterised with actual and desired capital stock being equal in equilibrium (Lecca et al., 2010).

This chapter models a balanced budget fiscal expansion, where the additional revenue collected through a rise in the average rate of income tax is 'recycled' and funds an increase in government consumption.This expansion has two opposing effects.

First, the rise in government consumption has a positive demand-side impact on regional output.

Second, the income tax hike has adverse supply-side effects, for example through the change in the inter-regional relative price. However, the additional public consumption is assumed to have no direct supply side effects, i.e. there is no change to the productivity level of capital and labour. This assumption simplifies the theoretical analysis of the tax hike (Lecca et al., 2014).

In particular the focus here is on the adjustment of the imperfectly competitive labour market. The increase in public consumption is assumed to be reflected by some level of amenity valuation. The level of this valuation and the degree to which it is reflected in regional wage bargaining determines the change to the nominal wage after tax and thus part of the price adjustment following the fiscal expansion. These key parameters are detailed below.

Equation 8.3.1 is the zero net migration condition,

$$w = (1-\tau)^{\beta} z(e) \qquad \beta \geq 0; 1 > \tau \geq 0; z_e < 1; w_{\beta}, w_{\tau} \leq 0 \tag{8.3.1}$$

where the post-tax real consumption wage, w, is a function of the proportionate rate of income tax, τ, the employment rate, e and the parameter capturing the amenity valuation that Households place on public versus private consumption, β. Thus when equation 8.3.1 balances, net migration is zero.

Equation 8.3.1 identifies a negative relationship between the post-tax real consumption wage, w,and the employment rate, e. That is to say, that a high local wage, for example caused through a hike in income tax, is compensated for by a low local employment rate.

Equation 8.3.1 also includes the term $(1-\tau)^{\beta}$, which captures the effect that the rise in public amenities has on the migration decision of potential migrants.

The public amenity valuation parameter, β, captures the degree to which workers and potential migrants prefer private versus public consumption. The parameter takes a value between 0 and 2 (Lecca et al., 2010). With a low value for β, that is $\beta < 1$, private consumption is preferred to public consumption. At a parameter value of one, workers and potential migrants are indifferent between private and public consumption and with $\beta > 1$, they prefer public consumption over private consumption.

Hence, the value of β is key for determining the flow of migration. For a given level of employment, a small β requires the post-tax real consumption wage, w, to be relatively large to prevent net out-migration. When β is equal to one, then w drives the migration decision of workers and potential migrants. When β is greater than one, then, for a given level of employment, the post-tax real consumption wage can be fairly small to hold zero net migration.

Equation 8.3.2 defines the pre-tax nominal wage, W,

$$W = \frac{w\, cpi}{1-\tau} \tag{8.3.2}$$

where the regional consumer price index, cpi, is defined as,

$$cpi = cpi(W) \qquad 0 < cpi_W \leq 1 \tag{8.3.3}$$

Thus, cpi here is defined as a function of the pre-tax nominal wage, W, only.

Next, labour demand is defined as a function of the pre-tax nominal wage, W and the proportionate rate of income tax, τ,

$$n = n(W, \tau) \qquad n_\tau > 0; n_W < 0 \tag{8.3.4}$$

Note that equation 8.3.4 represents a general equilibrium relationship, which is based on full income endogeneity (Lecca et al., 2010).

Equation 8.3.4 captures the relationship between the labour demand and the nominal pre-tax wage. It is a negative relationship, since a higher nominal pre-tax wage rate causes a factor substitution effect from labour to capital. Also, a higher nominal pre-tax wage rate has adverse competitiveness effects.

Further, equation 8.3.4 captures the relationship between the labour demand and the tax rate. This relationship is positive, because of the conventional Keynesian balanced budget multiplier as well as the differential import propensities of public and private consumption expenditure and the greater labour intensity of the public sector (Lecca et al., 2010).

The real consumption wage is, through the bargaining function, determined as

$$w = (1-\tau)^{\alpha\beta} b(e) \qquad b_e > 0, w_\alpha, w_\beta, w_\tau \leq 0, 0 \leq \alpha \leq 1 \tag{8.3.5}$$

where the real consumption wage, w, is positively related to the regional employment rate (Lecca et al., 2010).

Expressing the real consumption wage, w, as in equation 8.3.5, allows the amenity created through a rise in public consumption to influence the regional wage bargaining behaviour, which is reflected by α.

The wage bargaining behaviour parameter, α, takes a value between zero and one (Lecca et al., 2010). At zero, wage bargaining does not reflect any valuation of the increase in public amenity provision. That is to say that the case of α equal to zero can be interpreted as a case where the wage is set nationally, not locally.

The higher the value of the wage bargaining behaviour parameter, α, the greater the degree to which the public amenity valuation is reflected in the regional bargaining process. At a value of one, the amenity valuation is fully reflected.

8.3.2 Equilibria for the Regional Bargained Real Wage and Flow Migration

Expressing equations 8.3.1 - 8.3.5 in total differentials allows the value of the exogenous tax rate, $d\tau$, to determine the endogenous variables dn, de, $dcpi$,dw and dW (see section 8.3.1). Lecca et al. (2010) provide the relevant total differential equations.

The focus here is on tying down the effect that the public amenity valuation parameter, β, and the wage bargaining parameter, α, have on the (changes in the) nominal pre-tax wage, dW and the employment rate, de. That is to say that the change in the nominal pre-tax wage, dW, alongside the change in the employment rate, de, allow the study of the impact of the tax cut on the regional economy. That is because these relationships determine the competitiveness effect caused by the (potential) change in the relative regional price.

Equations 8.3.1 and 8.3.5 identify the migration and bargaining behaviour in the model. These can be adapted to reflect the effect that a change in the real consumption wage, w, has on the change in the nominal pre-tax wage, W (Lecca et al., 2010).

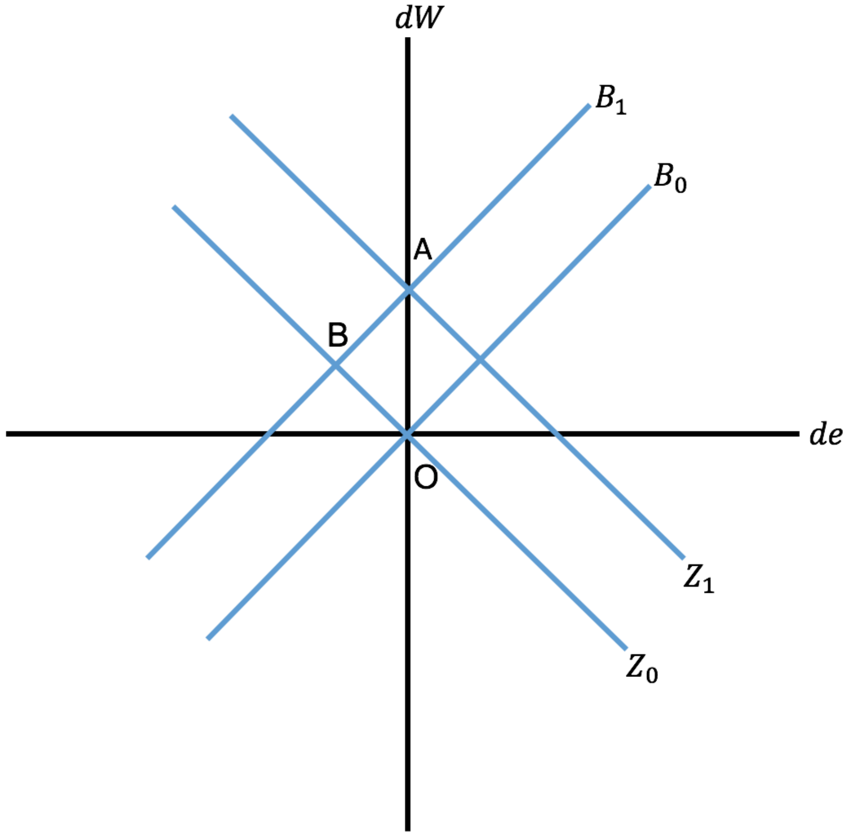
In order to tie down the relevant equations, the zero net migration function (Equation 8.3.1) is combined with the pre-tax nominal wage (Equation 8.3.2) and the regional consumer price index (Equation 8.3.3) definitions. This yields the following expression,

$$dW = \frac{z_e}{1 - cpi_W} de + \frac{1-\beta}{1 - cpi_W} d\tau \tag{8.3.6}$$

The first part of the RHS is the conventional term, and the second part reflects the addition of the amenity-value parameter, β, as well as the exogenous tax shock, $d\tau$. The term $1 - cpi_W$ in the denominator gives the change in the nominal pre-tax wage, dW. Setting $d\tau = 0$, i.e. the state of the economy without the tax shock, yields the initial zero net migration (ZNM) function.

The initial ZNM is shown in Figure 8.3.1 as the Z_0 function, which passes through the origin. The slope of this function is $\frac{z_e}{1-cpi_W} < 0$.

Figure 8.3.1: Theoretical Income Tax Adjustment



Next, the bargaining real wage (BRW) function is constructed, which is obtained by combining the pre-tax nominal wage (equation 8.3.2) with the regional consumer price index (equation 8.3.3) and the regional bargaining function (equation 8.3.5). Expressed in differentials, this yields,

$$dW = \frac{b_e}{1 - cpi_W} de + \frac{1 - \alpha\beta}{1 - cpi_W} d\tau \tag{8.3.7}$$

Setting $d\tau$ equal to zero yields the initial BRW function. This is the B_0 curve in Figure 8.3.1 with a slope of $\frac{b_e}{1-cpi_W} > 0$.

Equations 8.3.8 and 8.3.9, allow the analysis of the impacts of a tax change, $d\tau$, on both the employment rate, de, as well as the changes to the nominal pre-tax wage, dW, producing

$$de = -\frac{\beta(1-\alpha)}{b_e - z_e} d\tau \leq 0 \tag{8.3.8}$$

$$dW = \frac{b_e(1-\beta) - z_e(1-\alpha\beta)}{(1-cpi_W)(b_e - z_e)} d\tau \tag{8.3.9}$$

The following Sections analyse the tax hike under three parameter settings for α and β. Therefore, it is useful to describe the general movement of the ZNM and the BRW in the dW-de space.

A rise in the local rate of income tax, $d\tau$, shifts the ZNM function vertical. That is the ZNM function shifts from Z_0 to Z_1 in Figure 8.3.1. The move is equal to $\frac{1-\beta}{1-cpi_W} d\tau$.

The tax rise also shifts the BRW function vertically, which moves by $\frac{1-\alpha\beta}{1-cpi_W} d\tau$. This shift is shown in Figure 8.3.1 as B_0 shifting to B_1. Note that the parameter restrictions imply that $1 - \alpha\beta \geq 1 - \beta$, hence the BRW function shifts by at least as much as the ZNM function (Lecca et al., 2010).

8.3.3 Fiscal Expansion: Conventional - Macro

The "Conventional - Macro" model has the parameter settings of $\alpha = \beta = 0$. Thus the additional public amenity provision is not valued by worker and potential migrants ($\beta = 0$) and wage bargaining does not account for any public amenity valuation ($\alpha = 0$).

With $\alpha = 0$, the tax hike causes the bargaining function to shift upwards. From Equation 8.3.9, the bargaining curve shifts by $\frac{d\tau}{1-cpi_W}$ for any value of β. Since $\beta = 0$, the new equilibrium is at "A", since the ZNM curve shifts up to Z_1.

The change in the nominal pre-tax wage is positive here, since substituting $\beta = 1$ into 8.3.9 yields,

$$dW = \frac{z_e d\tau}{(1 - cpi_W)(b_e - z_e)} > 0 \tag{8.3.10}$$

For the scenarios with $\alpha = 0$, the results of the income tax shock are driven by $d\tau$, although the price changes operate through the impact on W. Essentially, no matter what the valuation of the additional provision of public amenities, it is not incorporated in the wage bargaining, but the tax hike is. This is why the bargaining curve shifts upward by $\frac{d_\tau}{1-cpi_W}$.

8.3.4 Fiscal Expansion: Conventional - Micro

The "Conventional - Micro" model has the parameter settings of $\alpha = 0$ and $\beta = 1$. Here, both workers and potential migrants value the increase in public amenity provision. With $\beta = 1$, the degree of that valuation is that foregone private consumption is valued equally to the increase in public consumption.

For the case with $\alpha = 0$ and $\beta = 1$ the the BRW shifts upwards again, but ZNM curve remains static, and thus the new equilibrium here is at "B". Note that this results indicates that there are changes in the pre-tax nominal wage, dW, and in the employment rate, de. However, only the sign of the changes are known, positive and negative, respectively, but the exact location of the new equilibrium can only be determined through simulation (see section 8.5).

8.3.5 Fiscal Expansion: Social Wage

The "Social Wage" model has the parameter settings of $\alpha = \beta = 1$. Here, neither the ZNM nor the BRW curve adjusts, and the new equilibrium is also at the origin "O". This is because there is no price distortions caused by workers bargaining for a higher nominal wage, since they value the increase in public consumption equal to the foregone private consumption. There is also no change in the employment rate.

The theoretical analysis above shows that the parameter values of α and β are significant for the overall results of the balanced budget fiscal expansion. In particular, with the wage bargaining behaviour parameter α close to zero, there is no value of β that yields an economic stimulus following the tax hike for the economy.

8.4 Simulation Set-Up

This chapter employs a Computable General Equilibrium (CGE) model for Scotland in order to simulate the policy shock. Section 8.2.1 outlines key aspects of the extended *AMOS* model from chapter 7. Next, section 8.2.2 sets out the modelling strategy for the CGE simulation.

8.4.1 AMOS

This chapter employs *AMOS*, which is a long-run open economy model following the framework developed by Layard et al. (1991), to simulate a balanced budget fiscal expansion. The version employed here is the forward-looking model calibrated on the Household and Government disaggregated SAM from chapter 4 ('Disaggregated SAM').

Therefore, the CGE model's simulation output is reflective of the underlying base structure of the SAM as well as, of course, the specification of the model itself. That is, the the base year linkages between the various sectors in the model, including inter alia Households, Government and the External sector, are provided by the SAM.

The model reports the percentage changes from the baseline, i.e. no policy shock, and the simulated model solution following some exogenous shock, here the rise in average income tax rates. The simulations are run for 50-periods with AMOS reporting percentage changes of each period compared to the initial steady state. This enables the study of the policy shock for the short-, medium- as well as the long run, in isolation from other possible influences on the economy. The short-run is defined as a period during which both the level and sectoral distribution of physical capital is fixed.

The labour force is fixed, but employment can vary as can the unemployment rate and workers can move between sectors. This corresponds to period 1 of the simulations. The model solves with forward-looking agents, i.e. utility maximising Households and profit maximising firms. The model reports the adjustment paths for all variables from the first period, until the new steady state equilibrium in period 50 is found. The increase in the average rate of income tax, is introduced in period 1 and the model attains long-run equilibrium by period 50.

The long-run equilibrium of this economy is characterised by both zero net migration as well as zero net investment. Any adjustments in the labour force over time are due to migration as since the assumption is that there is no natural population change. The migration function incorporates public amenity valuation (see section 8.4), i.e. the value workers and potential migrants place on the increase in public consumption following the balanced budget fiscal expansion. Also, migration is a function of the relative real wage and employment rates across regions (this is the difference between the Scottish rates and the rates in the RUK and the ROW).

Government Expenditure is equal to the spending level in the initial steady state plus the additional revenue generated through the increase in the average rate of income tax here. Therefore, a positive stimulus to the economy following the tax hike results in a positive multiplier effect for public consumption and vice versa. Output is produced under perfectly competitive conditions with linear homogeneous production functions with two factors, capital and labour.

The prices of goods in RUK and ROW are taken to be exogenous and domestically produced goods are imperfect substitutes for the same goods produced out-with the local economy. Thus, local price variations, caused by changes in wages and/ or capital rental rates, affect Scotland's trade with the RUK and ROW economies.

AMOS allows the simulation of the impact of the balanced-budget fiscal expansion under various economic scenarios. This chapter simulates a rise in the average rate of income tax in Scotland by 8 percentage points, which is then used to fund a rise in government consumption. The economy is taken to be in a steady state equilibrium in period 0. The rise in the income tax rate is then applied in period 1 and the model is run for 50 periods.

The results presented in section 8.5 are the percentage changes between the initial steady state and the economy subject to the policy shock. This chapter simulates several variants of the model as discussed below.

8.4.2 Simulation Strategy

This chapter focuses on varying the value workers and potential migrants place on the additional public amenity provision as well as how the rise in the 'social wage' is reflected in the wage bargaining process. There is no compelling evidence to suggest which assumptions apply most closely for the Scottish case, however (Lecca et al., 2010). Additionally, if Scotland were to move closer to a Scandinavian Model, institutional changes as outlined above (see section 8.2.1) would almost certainly alter the salience of the various scenarios.

The nature of wage determination proves to be the most important, as discussed in section 8.2.2. Thus it is useful to compare the three cases, as implementing any policy changes following the Smith Commission's proposals needs careful consideration of how the economy is likely to absorb the shock. Note that the income tax increase is the same for all settings at 8 percentage points.

The income tax hike simulated here is used to fund higher levels of public expenditure under three model configurations [4]. First, in the "Conventional - Macro" model ($\alpha = \beta = 0$) neither local residents nor potential migrants place no value on the increase in public consumption following the balanced budget expansion. Here, workers attempt to bargain to restore their net take-home wage following the change in the average rate of income tax.

[4] More flexible approaches are simulated and discussed in Lecca et al. (2014).

Secondly, the "Conventional - Micro" setting of the model ($\alpha = 0$, $\beta = 1$) simulates workers and potential migrants valuing the increase in their 'social wage' equally to the foregone private wage as a result of the income tax increase. However, this valuation is not reflected in regional wage bargaining. Thus, this model can be interpreted as a case where only migrants value the rise in government expenditure as equal in value to their foregone private consumption, since workers seek to restore their take home pay, i.e. they do not reflect their valuation of the increased public spending in their bargaining behaviour.

For example, potential migrants might value an increase in healthcare provision in Scotland funded by a rise in the income tax, which would induce a potential migrant to move to Scotland. However, workers do not seek to reflect this change in public consumption in their wage bargaining; indeed they cannot do so if wages are determined in competitive markets.

The third setting of the model in this chapter is the "Social Wage" case ($\alpha = \beta = 1$). Here, the increase in public consumption is valued, as in the Conventional - Micro setting, but now the amenity valuation of the change in public expenditure is fully reflected in regional wage bargaining. Workers value the increase in government consumption equally to the foregone private consumption and thus do not bargain to restore their take-home wage following the policy shock, since they feel no worse off after the change.

The policy shock simulated under the three cases outlined above has a direct Demand-side impact. The increase in tax revenue is directly used to linearly increase government consumption, while maintaining the composition of that expenditure. The simulations do not allow for a direct supply-side effect e.g. there is assumed to be no direct change in the efficiency of production as a consequence of increased spending.

The wage bargaining assumptions under the three scenarios has impacts on the competitiveness of the region (Scotland) due to the wage and price variations caused when workers seek to restore their net take home pay (Conventional - Macro and Conventional - Micro cases). A rise in the local price index reduces the region's competitiveness, e.g. making goods produced in the region less desirable for the External sector to buy in forms of imports. Thus total export volume falls. In contrast, a stable price index (Social Wage case) does not alter the region's competitiveness.

The income tax hike negatively affects Household consumption under all settings of the model, since net take home pay falls at least initially and remains suppressed in the Social Wage case. Additionally the rise in the cost of labour, i.e. real wages in the Conventional - Macro and Conventional - Micro cases results in a displacement effect, where production shifts towards a more capital intensive production and away from labour input.

Note that this chapter only explores changes to the average rate of income tax here. A change of this magnitude is possible under the changes to income tax in Scotland about to come in effect in April 2016 (The UK Parliament, 2012).

The Smith Commission and the Scotland Bill 2015-16 proposes a higher degree of devolution for income tax as well as other taxes. Through the potential devolution of the first 10p of VAT revenue as well as other taxes, the Scottish Government's total revenue is more exposed to the general performance of the Scottish economy than is simulated in the scenarios in this chapter (The Smith Commission, 2014; The UK Parliament, 2015). Thus any economic effects following a fiscal intervention are likely to be of a bigger magnitude than simulated in this chapter.

Further, this chapter assumes an equiproportional increase in government consumption here, so that the scale of government spending is greater, but its composition is unaffected. Policy-makers are arguably more likely to propose focusing on a subset of public expenditures to be stimulated by higher taxes. For example, a higher rate of income tax might be justified through more public childcare provisions. Thus demand- and supply-side effects would differ under these specific packages compared to what is simulated here.

8.5 Simulation Results

This section reports the simulation results. First the long-run percentage changes in key variables associated with each of the three cases is considered comparatively. Second, the adjustment paths for some key labour market indicators for all cases are analysed and compared. Next, the short run versus long run impacts for all 25 sectors are discussed for Employment and GRP. Lastly, a sensitivity analysis for some key parameters is performed and discussed.

8.5.1 Aggregate Long-Run Results

Table 8.5.1 shows the long-run percentage changes from the initial steady state generated by the balanced-budget fiscal expansion. The increase in the average rate of income tax of 8 percentage points results in a change of the income tax rate in period 50 of 23.78% for all three cases. This is reported in the first line in Table 8.5.1. The overall economic impact on the broad macroeconomic indicators shown in Table 8.5.1 varies significantly among the three cases.

The fiscal stimulus to government consumption is reported for the aggregated Government sector. Recall that the UK Government is assigned all of income tax in this calibration of the model, which reflects the fiscal position in Scotland of the SAM base year, 2009. However, the balanced budget hike is in the Scottish tax rate. Furthermore, the model output is reported for the aggregated and the disaggregated Household sector. Recall that the wage bargaining closure for the model here is the "Regional Bargaining" case.

Table 8.5.1: Long Run Percentage Change from Initial Steady State

	Conventional - Macro	Conventional - Micro	Social Wage
Income Tax	23.78	23.78	23.78
GRP Income Measure	-7.83	-7.23	0.47
Consumer Price Index	2.90	2.68	0.00
Unemployment Rate	0.00	4.40	0.00
Total Employment	-8.26	-7.60	1.08
Nominal Gross Wage	9.39	8.70	0.00
Nominal Wage after Tax	2.90	2.24	-5.91
Real Gross Wage	6.31	5.86	0.00
Real Wage after Tax	0.00	-0.43	-5.91
User Cost of Capital	2.80	2.59	0.00
Labour Force	-8.26	-7.15	1.08
Households Consumption	-5.24	-5.05	-2.89
HH 1 Consumption	-6.12	-5.87	-2.85
HH 2 Consumption	-6.93	-6.71	-4.11
HH 3 Consumption	-0.60	-0.58	-0.29
HH 4 Consumption	-4.15	-4.02	-2.52
HH 5 Consumption	-3.30	-3.23	-2.40
HH 6 Consumption	-6.31	-6.09	-3.48
HH 7 Consumption	-7.54	-7.33	-4.89
Capital income	-4.47	-4.18	-0.52
Labour income	0.35	0.43	1.10
Total Government Consumption	1.22	1.65	7.07
Investment	-7.07	-6.60	-0.52
Export RUK	-4.69	-4.35	0.00
Export ROW	-5.03	-4.67	0.00

Conventional - Macro

The first column reports the long run percentage changes for some broad macroeconomic variables under the Conventional - Macro scenario. Recall that the values for the public amenity valuation and the wage bargaining parameter are 0, i.e. $\beta = \alpha = 0$.

Hence, workers and potential migrants do not value the rise in public amenities through the increase in government consumption, plus wage bargaining does not reflect any amenity valuation.

Recall from section 8.3.3, that a rise in income tax under these parameter values causes both the ZNM and RBW curve to shift up. That is to say that, in Figure 8.3.1, Z_0 moves to Z_1, and B_0 moves to B_1 with the new long run equilibrium at 'A'. Accordingly, workers seek to restore the initial value of their real take home pay, i.e. the new equilibrium moves up on the dW axis. However, there are no long run changes in the employment rate.

Table 8.5.1 reports that in the balanced budget fiscal expansion, an Income Tax rise of 23.78% results in a hike in the nominal wage and no change in the unemployment rate.

The hike in the average rate of income tax by 23.78%, i.e. an increase of 8 percentage points on the baseline average income tax rate, results in real wages falling initially . This fall in real wages decreases the labour force and unemployment rises. The economy experiences net out-migration as the population contracts.

Workers bargain to restore their net take home pay and the adjustment of real wages and unemployment continues until both are restored to their original levels. This is shown in Table 8.5.1 by the Unemployment Rate and the Real Wage after Tax at 0% change in the long run. Note that this adjustment results in a smaller Labour Force and thus decreased Total Employment, both are reported to fall by -8.26% in the long run in Table 8.5.1.

The wage bargaining process seeks to restore workers net take home pay as mentioned above. That is, workers seek to raise their nominal pay back to the level prior to the fiscal intervention. Additionally, the wage bargaining behaviour of workers seeking to restore their net take home pay also results in a rise of prices. The CPI increases by 2.9%, which is also reflected in the rise of the Nominal Wage after Tax by 2.9%.

The combination of the rise in the income tax rate and price changes results in the Nominal Gross Wage increasing by 9.39%. However, the Real Wage after Tax is restored at that level of nominal wage increase.

At the same time, the price variations, reduce the competitiveness of the region. Therefore exports to both RUK and ROW fall by -4.69% and -5.03%, respectively. Also, the rise in the region's prices result in the User Cost of Capital to increase (2.8%) and Investment is affected by the above-outlined price effects, which falls by -7.07%.

Note that there are both demand and supply side effects in operation here and the outcome reflects the net effect of these. On the demand side, there is a stimulus to demand as government expenditure is less import-intensive than consumption expenditure. On the supply side the hike in income taxation reduces the real take home pay and creates upward pressure on wages and prices. The overall impact is the 'net' effect of these two forces: positive demand side effect but negative supply side effect.

The adverse supply side effects outweigh the positive demand side effects in the Conventional Macro model, since GRP is reported in Table 8.5.1 to fall by -7.83% in the long run. That is to say that the rise in Government consumption is not sufficient to outweigh the adverse supply side effects.

The rise in the average rate of income tax naturally lowers Total Household Consumption, here by -5.24% in the long run. The model does report also the change for the different Household types, which all see a decrease in their long run consumption. The speed of adjustment to the new long run equilibrium is the same for all Households, since Households are treated as homogeneous. However, the tax hike results in varying long run effects for Households, since the model captures the different Household characteristics that are reflected in the SAM.

Recall from chapter 4: HH1) Working without children, HH2) Working with children, HH3) Non-working without children, HH4) Non-working with children, HH5) Pensioners, HH6) Multiple tax units without children and HH7) Multiple tax units with children. The initial calibration of Household type consumption from the 'Disaggregated SAM' is reflected in the long run results in 8.5.1.

The largest impact of the tax hike is for the 'working' Household types, HH1 and HH2, as well as for HH6 and HH7. The latter also receive their largest share of total income from wages, hence the income tax hike, reduces their real wage after tax in the short run by as much (see Figure 9.9.1). Note that out of these two groups, the tax shock affects the Household types with children (HH2 and HH7 with -6.93% and -7.54%) more than the comparative Household types without children (HH1 and HH6 with -6.12% and -6.31%, respectively).

The effect on the non-working Household types is less pronounced with -0.6% for HH3 and -4.15% for HH4. However, the effect on HH4 is significantly larger than on the other non-working Household group, HH3. This reflects the characteristics of these households. Recall from chapter 4, section 4.5.2, that Household type 4 receives over 60% of its income from wages. Whereas Household 3 receives the majority of its income through benefit payments from the Government and only around 6% from wages.

The tax hike does also decrease Household consumption for 'Pensioners' (HH5). Table 8.5.1 reports that their consumption falls by -3.3%. Again, the effect on Household consumption for this group reflects the underlying income sources. Around 27% of total income for 'Pensioners' stems from wage income, and therefore this Household type is also affected the rise in income tax rates. Refer to chapter 4 for a detailed discussion on the classifications and Household type characteristics.

The disaggregated Household consumption results reflect the characteristics of the different Household types. Hence, these results enhance the economic analysis of a balanced budget expansion, compared to previous work with a unified Household sector (Lecca et al., 2014). That is to say that capturing the varying responses of Household types to the income tax hike, allows for the distributional effects to be observed, which in turn could aide in informing policy makers to a greater level of detail.

Overall, the rise in the average rate of income tax under the Conventional - Macro model results in a contraction of the economy, with GRP falling by -7.83%. The long run effect on the economy is a smaller Labour Force and population with higher nominal wages and a reduction in the region's competitiveness due to price changes.

The adjustment paths of some key economic variables for the Conventional - Macro model are presented in Figure 9.9.1. These are the "Nominal Gross Wage", the "Real Wage after Tax", the "Consumer Price Index", the "Total Employment" and the "Labour Force" variables. These five variables inform on the adjustment of the wage bargaining behaviour and process, the effect of wage bargaining on the price level and the adjustment of the workforce to the balanced budget fiscal expansion. Hence, the variables in Figure 9.9.1 reflect parts of the theoretical effects analysed in Figure 8.3.1 from section 8.3.

The graph shows that it takes around 25 periods before the variables shown here adjust close to their new long-run equilibrium values (as displayed in Table 8.5.1). The reduction in competitiveness of the Scottish economy in the short run is exemplified by the the major rise in the nominal wage as workers attempt to compensate for the fall in their real take home pay. In fact, the Real Wage after Tax falls by nearly 2% initially. The economy experiences net outmigration, which continues until the Real Wage after Tax and unemployment rates return to their original levels.

That is to say that the period-by-period results show that the fall in aggregate economic activity in the long run, caused by the net contraction due to the predominant adverse supply side effect, leads to lower employment. Note that the contraction in the labour force, which falls by the same level in the long run as total employment, results in no change to the employment rate (see section 8.3). Thus, the long-run results show no change in after tax real wage rates (or the unemployment rate), but do reflect a significant fall in employment and population of over 8% in both cases (see Table 8.5.1).

Figure 9.9.1 shows that the policy shock in period 1 results in the Real Wage after Tax falling, as does the nominal wage after tax. The re-adjustment of the Real Wage after Tax to its initial level is caused by the bargaining behaviour of workers, who are seeking to restore their net take home pay following the policy shock. This is seen by the adjustment path of the nominal wage after tax. With workers bargaining for a net of tax real wage in the "bargained real wage" model.

The gap between the real and nominal wage after taxes in the graph reflects the price variations resulting from the bargaining behaviour, i.e. the rise in CPI here. Essentially, adjustment in the Real Wage after Tax is equal to the adjustment in the Unemployment Rate through migration.

Conventional - Micro

The second column in Table 8.5.1 reports the long run results for the Conventional - Micro model. Recall that in this case, the rise in public amenities is valued, but this is not reflected in regional wage bargaining. Thus, this case could be interpreted as a scenario where potential migrants value the increase in public consumption, but workers do not or where wages are set at a national level.

Accordingly, the wage bargaining parameter is set equal to zero, $\alpha = 0$, and the public amenity valuation parameter is set equal to one, $\beta = 1$. Recall that with $\beta = 1$, private consumption and public consumption are valued equally, i.e. the fall in one can be offset by the rise in the other (if levels are equal).

The analysis of the theory relating to an income tax shock in section 8.3.4 showed that under these parameter settings, the BRW function shifts to B_1, but the ZNM function remains static at Z_0. Hence the new long run equilibrium is at 'B', which is a point associated with a rise on the dW axis, but a leftward shift on the de axis. Hence, this equilibrium is associated with an increase in the nominal wage and a reduction in the employment rate.

Since the increase in public amenity provision is not reflected in workers' wage bargaining behaviour, the impact on wages is comparable to the Conventional - Macro case. Workers seek to restore their Real Wage after Tax, by bargaining for higher nominal wages. The Nominal Gross Wage increases in the long run by 8.7% and the Nominal Wage after Tax rises by 2.24%. Note that these increases are slightly smaller than in the Conventional - Macro model (see Table 8.5.1).

However, workers are unable to fully restore their net take home pay, which decreases in the long run by -0.43%. This is due to Labour Force and Unemployment Rate adjustments in this Conventional - Micro model. Recall that although the increase in the public amenity provision is not reflected in the regional bargaining process, $\alpha = 0$, workers and potential migrants do value the rise in public consumption, $\beta = 1$.

Therefore, the fiscal policy intervention is seen as a desirable attribute of the region by potential migrants. This is shown by the long run Labour Force adjustment, which decreases by less here than in the Conventional - Macro case, -7.15% compared to -8.26% respectively. The smaller degree of net outmigration in the $\alpha = 0$ and $\beta = 1$ case, results in a rise in the unemployment rate in the long run by 4.4% (Recall that the unemployment rate was restored to its initial level in the Conventional - Macro case, see Table 8.5.1).

The wage bargaining behaviour of workers produces an upward shift in prices, CPI increases by 2.68%, which lessens the competitiveness of the region. This is reflected by the decrease in exports to the RUK by -4.35% and to the ROW by -4.67%. Also, the User Cost of Capital increases here by 2.59% and the price distortions decrease overall investment by -6.6%.

The effect on total Household consumption is negative with a fall of -5.05% in the long run. Also, the disaggregated Household consumption reports a fall for all Household types, but again to different degrees. These are close to the results for the Conventional - Macro model. The degree of the contraction in Household consumption by Household types is as in the Conventional - Macro model, discussed above.

The fiscal expansion, with a rise in the average rate of income tax of 23.78%, results in a rise in Total Government consumption of 1.65% in the long run. Overall, public consumption increases by more in the Conventional - Micro model than in the Conventional - Macro model discussed above.

The overall impact of the balanced budget fiscal expansion for the Conventional - Micro model is similar to the Conventional - Macro one with GRP decreasing by

-7.23%. Notable for the $\alpha = 0$ and $\beta = 1$ case is the long run impact on unemployment, however. Without the positive public amenity valuation by workers and potential migrants reflected in the wage bargaining process, the region will experience higher levels of unemployment in the long run than it did prior to the fiscal intervention.

Figure 9.9.2 presents the adjustment paths for the same key economic variables as Figure 9.9.1. The magnitude and speed of adjustment for each of these variables is very close to those for the Conventional - Macro model discussed above. However, the long run equilibria values for these variables in the Conventional - Micro model are mitigated compared to the Conventional - Macro ones.

Recall from section 8.3.4, that the new long run equilibrium is characterised with a fall in the employment rate. Note that both the Conventional - Micro and the Social Wage case are shown to have no change in the employment rate in the long run in Figure 8.3.1.

Since the wage bargaining parameter, α, is set equal to zero, the rise in the public amenity provision is not reflected in the wage bargaining process. Thus, Figure 9.9.2 reports that the Nominal Gross Wage rises in order to restore the Real Wage after Tax back to its initial level. The rise in the nominal wage causes the CPI to increase, as in the Conventional - Macro case.

However, the Labour Force is reported to fall by less than Total Employment, which is reflected in the negative effect on the employment rate, as in Figure 8.3.1. Furthermore, wage bargaining is unsuccessful in restoring the Real Wage after Tax. Hence, the new long run equilibrium is characterised, as expected, by a fall in the employment rate and a rise in the nominal wage.

Social Wage

In the Social Wage model, the rise in public amenity provision is valued equally to the foregone private consumption. Recall that private consumption falls, due to the fall in the real wage that is caused by the income tax hike. In contrast to the Conventional

- Micro model, wage bargaining incorporates the public amenity valuation, however. That is to say that the wage bargaining and the public amenity valuation parameters are set at $\alpha = \beta = 1$.

Section 8.3.5 showed that with those parameter values, neither the ZNM function, nor the BRW function move as a result of the tax rate, $d\tau$ (see Figure 8.3.1). Hence, the equilibrium remains at the origin 'O', with no change to the nominal wage and to the employment rate.

The third column in Table 8.5.1 reports the simulation results for the Social Wage model. The overall effect of the balanced budget fiscal expansion is positive under the Social Wage model, with GRP increasing by 0.47% in the long run. The rise in GRP is a result of the positive public amenity valuation by workers and potential migrants ans workers' wage bargaining behaviour.

The Social Wage model is unaffected by price changes in the long run and no rise in pre-tax wages. Hence, there is no adverse effect on the competitiveness of the region. Also, the initial demand side stimulus of the rise in public consumption is compounded by the overall increase in economic performance of the region. Tax revenue increases over time, which results in larger public consumption, and so forth.

As outlined above, workers do not seek to restore their cut in real take home pay, reported in Table 8.5.1 by the change in the Nominal Gross Wage of 0. Workers do accept the decrease in the Real Wage after Tax, equal to the fall of the Nominal Wage after Tax of -5.91%.

As a result of workers' wage bargaining behaviour, there are no price changes in the Social Wage model, i.e. the CPI remains unchanged in the long run. The adverse effects stemming from the change in prices reported for the two 'Conventional' models above, are therefore not present here. Hence, there is no affect on the competitiveness of the region, with exports to to both RUK and ROW at 0%change in the long run (see Table 8.5.1).

Household Consumption contracts in the Social Wage model by a total of 2.89%.

This is comparatively low when compared with the other models reported in Table 8.5.1. In the Social Wage model. Households are subject to the same initial income tax hike, but do not restore their net take home pay in the long run. However, the stable price level and the demand side stimulus from the rise in Government consumption produce an overall expansionary effect.

As a result of the stimulus to the economy and a stable CPI, Labour income rises by 1.1% in the long run. Note that Labour income rises by only 0.35% and 0.43% in the Conventional cases. Hence, Household consumption does not contract by as much in the Social Wage model than in the other two cases.

The disaggregated Household consumption in Table 8.5.1 shows that the effect on Household types varies. As outlined above, the characteristics of household types, as reflected in the SAM, is key for explaining the distributional effects. Also, the effects on the different Household types is comparatively close for the two Conventional models.

In the Social Wage model, Households report different consumption effects resulting from the initial fiscal policy shock. Households 1 and 3 contract by over 50% of the change they experience in the Conventional - Macro model, at -2.85% and -0.29%, respectively. In contrast to this, Household 5 and 7 contract by only 27% and 35% when compared to the results of the Conventional - Macro case (the long run results are Household consumption decreases by -2.4% and -4.89%, see Table 8.5.1).

The balanced budget fiscal expansion produces a rise of 7.07% in Total Government consumption in the long run. Thus, the net demand side effect in the Social Wage model is the biggest in the Social Wage model.

Figure 9.9.3 shows the adjustment paths for the same key variables as discussed for the other cases, but for the Social Wage model. Note that all variables approach their new long run equilibrium values around period 7.

Recall from section 8.3.5 that with the wage bargaining and the public amenity valuation parameter equal to one, i.e. $\alpha = \beta = 1$, neither the ZNM nor the BRW function shift. Hence, the new long run equilibrium remains at the origin ('O' in Figure 8.3.1), with no change in the nominal wage and no change in the employment rate.

In the short-run the Nominal Gross Wage increases and there is a positive gap between Total Employment and Labour Supply, which generates net in-migration. This process pushes down the private element of the social wage until the Nominal Gross Wage is restored to its original level. The CPI experiences a small rise in the first period, which tapers off to its original level, however.

Thus, since workers accept the decrease in their Real Wage after Tax, there is no long run change in prices and hence no competitiveness effect in this model. Also, since Total Employment and the Labour Force adjust to the same long run levels, there is no change in the employment rate, as shown in Figure 8.3.1 at point 'O'.

When comparing the three cases, it is clear that the overall impact of a balanced budget fiscal expansion is crucially dependent on the public's valuation of the amenity associated with the greater public expenditure, and the extent to which this is reflected in workers' wage bargaining behaviour. The social wage model is a special case in which the amenity is valued equally to the displaced private consumption and this is fully reflected in wage bargaining.

Recall that Figures 9.9.1, 9.9.2 and 9.9.3 show the adjustment paths for some key economic variables for the Conventional - Macro, the Conventional - Micro and for the Social Wage model, respectively. Apart from the differences in the values of the parameters between the models, the speed of adjustment of the economy is significantly different for the Social Wage model compared to the two 'Conventional' models.

The differences in the adjustment paths between the Social Wage and the other two models can be attributed largely to the wage bargaining process. That is because the two Conventional models have $\alpha = 0$, but different values for β, however the speed of adjustment is similar for both cases.

This illustrates the fact that the wage bargaining process 'hinders' the economy to adjust to a new long run equilibrium, i.e. it slows the adjustment down. This links back to the institutional change that Scotland would have to adopt if it was to emulate a Scandinavian-style macro economic model. Recall that annual "tripartite bargaining" is one of the key features of the Scandinavian labour market. These results indicate that wage bargaining ought to be subject to a more regular cycle following the fiscal expansion in order to avoid this 'lagging effect' of adjustment to the economy's new long run equilibrium.

It is possible to explore other cases, for example, where workers value public consumption more than private consumption or where public consumption is valued but not as high as private consumption[5]. Note that the sensitivity analysis in section 8.5.3 explores how the long run total employment effect varies with different values of α and β.

The models report the distributional effects on Household consumption. These results reflect the actual Household characteristics and therefore they give important insight into the effects of the shock on different Household types.

Recall from chapter 4, section 4.7.2, that tax and welfare flows differ significantly between Households. Households 3 and 4 are both 'non-working' and hence report the lowest household tax liabilities as well as the highest total receipts for welfare.

The balanced budget fiscal expansion could therefore be assumed to reduce Household consumption the least for these two Households. That is because of the reduced exposure to the adverse supply effects from a hike in taxes and at the same time the rise in government consumption (i.e. also a rise in welfare payments).

Table 8.5.1 reports that, as expected, the long run percentage change for Household's 3 consumption is only slightly negative for all three models (ranging from -0.29% to -0.6%). However, Household consumption for Household 4 is reported to decrease much steeper (ranging from -2.52% to -4.15%).

[5] see (Lecca et al., 2014) for additional variations of those two parameters settings.

The effects reported here are due to the Household income characteristics reported in the disaggregated IncExp accounts in Table 9.5.12. They show that Household 4 is, although classified as 'non-working', receiving 59% of its income through wages. In contrast, Household 3's main source of income are Government transfer payments at 65%.

Given that the data have captured the Household income sources correctly, these results suggest that the classifications of Households can be misleading with respect to accurately portraying Household characteristics. This is of particular importance for policy-makers. For example, when assessing the effect of income tax changes on households with children as well as tackling wealth inequality across households (Scottish Government, 2015c).

The results therefore suggest, that simply assessing Households by their level of tax liability or level of welfare support could be misleading. Policies designed to use these characteristics only could therefore be counter-productive, given the overarching policy goal. Hence, employing modelling frameworks such as the one used in this chapter, which utilises actual data of Scottish households can prove to be invaluable for helping to design policies to achieve the intended outcome more accurately.

Overall, the economy experiences a contraction under both the Conventional - Macro and the Conventional - Micro models. The Social Wage model, shows that the fiscal intervention produces an expansionary effect on the economy. It could be argued, however, that people who are able to remain in Scotland and are employed in the long run are better off under the Conventional - Macro case than under the other model settings. Since, people still in Scotland in the long run have their net take home pay restored, whilst being able to benefit from increased public consumption.

However, this is obviously subject to the (social) cost of out-migration and a lower-performing economy than it would have been without the policy shock.

8.5.2 Sectorally Disaggregated Short- and Long-Run Results

The section above described the aggregate results for both the new long-run equilibrium values for some broad economic indicators as well as the adjustment paths for some key variables. This section discusses the short run (1-period) and the long run (50-period) model output for Total Employment and GRP, for all 25 sectors in the model.

Table 8.5.2 reports the short run and the long run effects on Total Employment following the rise in the average rate of income tax for all three models. It shows that the fiscal expansion affects industry sectors differently, but overall, most sectors contract in both the short run and the long run for all three models.

The short run effect is smaller for all sectors than the long run effect for all three models. The impact on the sectors of the fiscal intervention is very similar for the Conventional - Macro and the Conventional - Micro model. Overall, the short run effects are nearly identical for both models. But in the long run, the change of Total Employment compared to the baseline values is larger in the Conventional - Macro case. Below, the Conventional Macro is discussed first and then the Social Wage case.

In the short run, the fiscal expansion causes Total Employment in the "Construction" sector to decrease by -4.3% in the Conventional Macro case. This is the largest fall in employment for any sector. The short run Total Employment effect for the "Food & beverage services" and for the "Rubber, plastic, cement and iron" sectors are of -2.97% and -2.9%. These are the second and third largest changes of all sectors in the short run.

The "Public administration" sector is the only sector that experiences an increase in Total Employment in the short run with a 2.29% rise. This is due to the initial rise in Government consumption following the fiscal expansion. The 'Disaggregated SAM' in chapter 4 shows that 99.8% of all UK Government consumption expenditure flows to the "Public administration" sector. Since the composition of public consumption

Table 8.5.2: Short Run vs Long Run Results by Sectors - Total Employment

	Conventional - Macro		Conventional - Micro		Social Wage	
	SR	LR	SR	LR	SR	LR
1. Agriculture, forestry and fishing	-1.06	-7.22	-1.07	-6.78	-0.40	-1.13
2. Mining	-0.41	-3.95	-0.41	-3.67	-0.05	-0.11
3. Food, drink and tobacco	-1.29	-6.12	-1.29	-5.74	-0.44	-0.91
4. Textile, leather, wood and paper	-2.33	-7.92	-2.32	-7.38	-0.40	-0.48
5. Chemicals	-0.97	-6.29	-0.97	-5.85	-0.08	-0.27
6. Rubber, plastic, cement and iron	-2.90	-9.35	-2.88	-8.71	-0.33	-0.40
7. Computer, electrical and transport equip.	-2.67	-8.44	-2.64	-7.85	-0.15	-0.13
8. Electricity, gas and water	-0.99	-6.37	-0.99	-5.95	-0.30	-0.66
9. Construction	-4.30	-9.47	-4.18	-8.83	-0.46	-0.49
10. Wholesale and retail	-2.72	-8.03	-2.71	-7.57	-1.30	-1.83
11. Land transport	-2.31	-8.60	-2.31	-8.04	-0.67	-0.87
12. Water transport	-1.73	-6.29	-1.73	-5.90	-0.65	-0.87
13. Air Transport	-1.89	-7.30	-1.89	-6.87	-0.93	-1.49
14. Post and support transport services	-1.97	-9.54	-1.98	-8.90	-0.39	-0.67
15. Accommodation	-1.97	-5.88	-1.97	-5.53	-0.92	-1.18
16. Food & beverage services	-2.97	-7.29	-2.96	-6.92	-1.74	-2.28
17. Telecommunication	-1.99	-8.49	-1.99	-7.95	-0.66	-1.00
18. Computer and information services	-2.57	-8.89	-2.56	-8.27	-0.44	-0.20
19. Financial services	-1.02	-6.34	-1.02	-5.93	-0.27	-0.66
20. Real estate	-1.17	-7.03	-1.17	-6.68	-0.89	-2.33
21. Professional services	-2.09	-8.81	-2.08	-8.19	-0.22	-0.05
22. Research and development	-2.32	-8.22	-2.33	-7.58	0.38	0.75
23. Public administration	2.29	-3.93	2.29	-3.30	4.17	4.96
24. Recreational services	-1.87	-7.20	-1.87	-6.70	-0.34	-0.44
25. Other services	-2.63	-8.71	-2.63	-8.20	-1.18	-1.72

remains unchanged following a shock to the model, and transfer payments are held constant, the additional UK tax revenue is spend mostly on this sector. As a result, employment in this sector rises.

However, the long run Total Employment effects for all sectors are negative. The contraction in the "Public administration" is smallest with -3.93%, followed by the "Mining" sector with -3.95% (which also had the lowest contraction in the short run). Most sectors show Total Employment falling around the 8% mark. The highest figures for this reported in Table 8.5.2 are for the "Post and support transport services" sector with -9.54% and for the "Rubber, plastic, cement and iron" sector with -9.35%.

As stated above, the results for the Conventional - Micro case are very similar to those discussed above. The short run and long run effects are of similar magnitudes as well as the sectoral effects in terms of the effect on Total Employment for the different sectors.

The Total Employment effects for the Social Wage model differ significantly. First, the short run effects are closer to the long run effects than in the other two models. Second, sectors are affected differently in the Social Wage model. Third, some sectors experience a positive long run effect, which is also larger than the short run effect.

Overall, the impact on Total Employment reported in Table 8.5.2 is smallest under the Social Wage scenario. In the short run, the largest contraction in employment is reported for the "Food & beverage services" sector with -1.74% and the second largest is for the "Wholesale and retail" sector with -1.3%. In contrast, the "Public administration" sector reports an increase in Total Employment in the short run of 4.17% and the "Research and development" sector of 0.38%.

The "Food & beverage services" sector also reports the largest decrease in Total Employment in the long run with -2.28%. Six sectors report long run decreases in Total Employment between 1% and under 2% and sixteen sectors show a decrease of less than 1%.

As in the short run, the "Public administration" and "Research and development" sectors show increases in Total Employment, by 4.96% and 0.75%, respectively. Also, the "Computer, electrical and transport equipment" and the "Computer and information services" sectors report long run Total Employment decreases that are less pronounced than the sort run effects. The short run Total Employment effect for the former are -0.15% and -0.13% in the long run. For the latter sector these are -0.44% in the short run and -0.2% in the long run.

Note that this is in stark contrast to the other sectors, which all show the long run Total Employment effects to be larger than the short run ones. Hence, the Social Wage model represents a case, which shows an overall smaller impact on Total Employment in the short run and the long run than the other two models. Furthermore, the adjustments from the initial shock to the new long run steady state are smoother.

Table 9.9.2 reports the short run and long run results for GRP by all 25 sectors. Again, the results are shown for all three models, the Conventional - Macro, Conventional - Micro and Social Wage case. The results show that the overall short run and long run results for GRP mirror those of the Total Employment results discussed above.

The effect of the balanced budget fiscal expansion is larger on GRP than on Total Employment for all models. For the two Conventional models, the short run and long run decreases in GRP are both larger. The Social Wage case, however reports very similar results to the Total Employment results in Table 8.5.2.

8.5.3 Sensitivity Analysis

Figure 8.5.1 shows the long run percentage change in GRP compared to the initial steady state for different increases in the average rate of income tax under the Conventional - Macro and -Micro case as well as under the Social Wage scenario. The increase in the average rate of income tax varies from 1 to 20 percentage points. Recall that the simulation here was subject to an 8 percentage point increase in the average income tax rate, which corresponds to the 40% mark in Figure8.5.1.

Figure 8.5.1: GDP Long-Run Percentage Change Variations

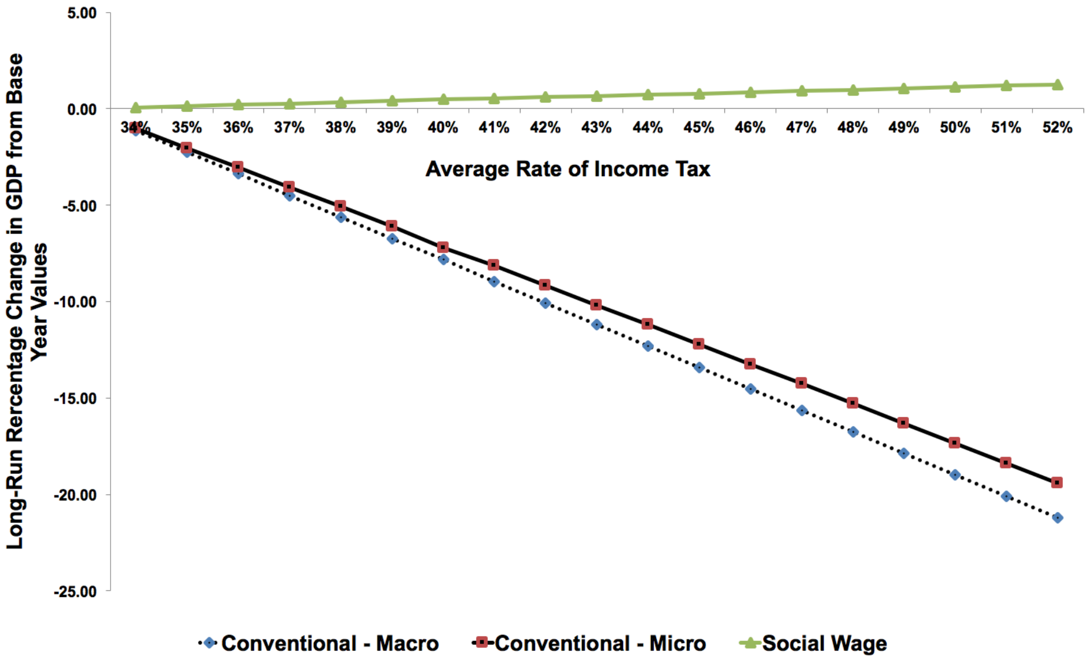


Figure 8.5.1 suggests that a positive policy outcome is strongly linked to the assumptions placed on the Social Wage scenario with higher average rates of income tax being associated with a higher increase in GRP here. In contrast, higher income tax rates result in a fall in GRP under the Conventional - Macro and the Conventional - Micro models.

Any deviation of workers and potential migrants' behaviour towards the assumption made in the Conventional - Macro and the Conventional - Micro model lead to an economic contraction relatively quickly. For example, assuming the actual behaviour of the economic agents modelled here would reflect a position "in-between" the two models, the policy shock would yield a negative net outcome.

To identify the values of α and β, which lie at the intersection between a positive and a negative impact of a balanced budget intervention, Table 8.5.3 reports the long run percentage change results for Total Employment. Note that as shown in section 8.5.2, the overall direction and sectoral impact of the fiscal intervention are similar for Total Employment and GRP.

Table 8.5.3: Long Run Percentage Change in Employment Following the Increase in the Average Rate of Income Tax, for Combinations of Parameters α and β

		α					
		0.00	0.20	0.40	0.60	0.80	1.00
	2.00	-6.95	-3.45	0.02	3.46	6.88	10.26
	1.80	-7.08	-3.93	-0.80	2.30	5.39	8.45
	1.60	-7.21	-4.41	-1.62	1.12	3.89	6.62
	1.40	-7.34	-4.89	-2.45	-0.02	2.39	4.79
	1.20	-7.47	-5.37	-3.27	-1.19	0.86	2.95
β	1.00	-7.60	-5.85	-4.10	-2.36	-0.63	1.08
	0.80	-7.74	-6.33	-4.93	-3.53	-2.14	-0.76
	0.60	-7.87	-6.81	-5.76	-4.71	-3.67	-2.62
	0.40	-8.00	-7.30	-6.59	-5.89	-5.19	-4.49
	0.20	-8.13	-7.78	-7.43	-7.08	-6.73	-6.37
	0.00	-8.26	-8.26	-8.26	-8.26	-8.26	-8.26

Table 8.5.3 reports that there is no positive stimulus for Total Employment resulting from the balanced budget fiscal expansion for any β value below 1. At this point, where workers and migrants place equal value on the rise of public consumption versus foregone private consumption, the only value of α that produces an increase in long run employment is 1. Recall that these are the parameter values for the Social Wage model.

For β values above 1, the value of α governs whether there is a positive stimulus. Only with α close to unity, does Total Employment in the long run rise by any significant value. Note that the cases with β larger than one represent scenarios where both workers and potential migrants prefer public consumption to private consumption.

Overall, 51 out of 66 potential combinations of the α and β parameter values in Table 8.5.3 show a decrease in Total Employment. Also, the negative long run employment values (51) report on aggregate a higher contractionary effect than those combinations (15) that result in a positive stimulus to Total Employment.

The results from Table 8.5.3 support the observations above with regards to Figure 8.5.1, that there is a 'fine line' between a positive fiscal stimulus and an economic contraction resulting from the balanced budget fiscal expansion. In particular, the figures from Table 8.5.3 highlight that public consumption has to be valued at least by as much as private consumption, but preferably by even more, in order to ensure that the fiscal policy shock produces an overall positive stimulus for the economy.

As the analysis in section 8.5.1 highlighted, the overall size of the economic impact from the fiscal stimulus is also dependent on the competitiveness effect. Due to the bargaining behaviour of workers in the Conventional - Macro and the Conventional - Micro case, prices change, which results in a substitution effect away from Scottish products, i.e. exports to RUK and ROW decrease.

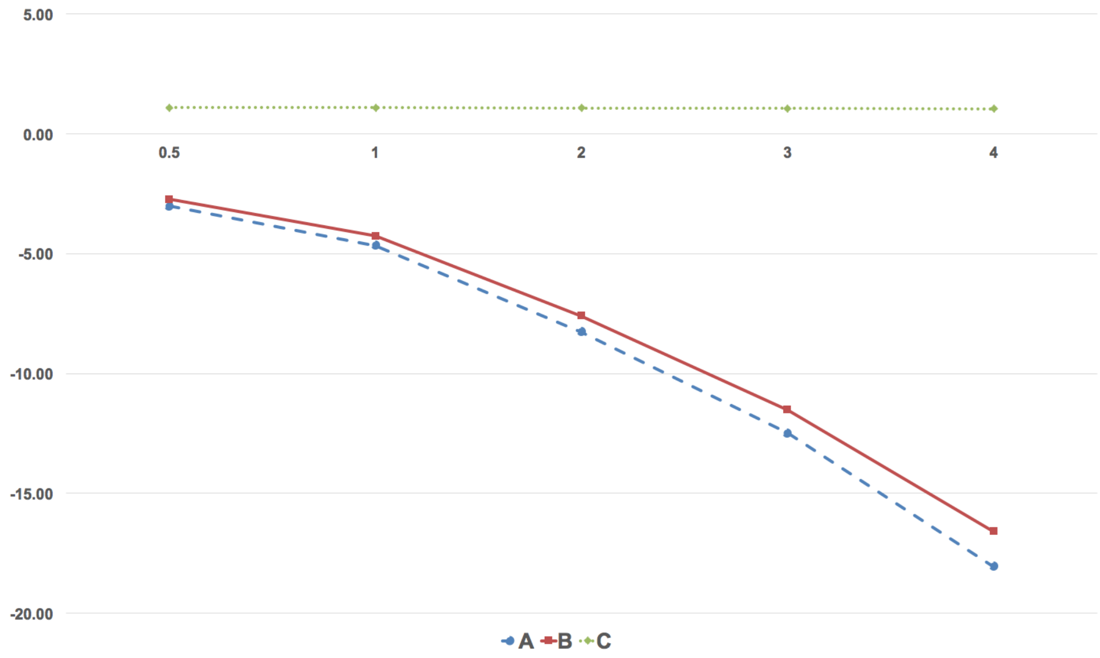
There are two key reasons why trade is so important for a regional economy, such as the Scottish economy modelled here. First, export demand makes up a significantly larger share of overall production than for a national economy. Second, the price elasticity of demand of regional products is higher than for national products. This is because of the lower transaction costs for regional products and there are closer substitutes for regional products than for national products.

Therefore, the sensitivity of the results to the chosen export demand elasticities are analysed here. Recall that the simulations above were calibrated with the standard export demand elasticity for *AMOS* of the value: 2 (Armington, 1969; Gibson, H., 1990). Here, the parameter is allowed to vary and the three cases considered here are the same as in the simulation above: $\alpha = \beta = 0$ (A), $\alpha = 0$ $\beta = 1$ (B) and $\alpha = \beta = 1$ (C).

Table 8.5.3 reports that the long run results for Total Employment under parameter combination A is: -8.26%, B is -7.60% and C is 1.08%. These results are replicated in Figure 8.5.2, at the horizontal axis point 2. The Figure illustrates that the long run percentage change in employment varies significantly under A and B. This is expected, since those cases have a competitiveness effect present, which will increase with higher elasticity values.

In contrast to this, the parameter combination of C, i.e. the Social Wage case,

Figure 8.5.2: Long-Run Percentage Change Variations in Employment - Export Demand Elasticities



shows only a very slight variation in the long run percentage change of employment under different demand elasticities. This is because, there is no competitiveness effect in this model hence no variation with respect to the elasticity

Note that the change in Total Employment in A and B is negatively related to the export demand elasticity, which affects the magnitude of the employment change. Due to the size of the balanced budget expansion, i.e. a rise in income tax by nearly 24%, there is no positive value of the trade elasticity, which would result in A or B to report a positive long run percentage change in employment.

Figure 8.5.2 indicates that the more open the economy the greater the effect on Total Employment and the more closed the economy, the smaller the effect. Figure 9.9.4 reports the sensitivity analysis for the same parameter combinations as above, but on GRP. The results mirror the ones reported for Total Employment. Note that the sign of the long run results for both Total Employment and GRP are affected by the size of the shock. Lecca et al. (2014) report a positive sign for some of the lower export demand elasticity values tested here, because this reduces the scale of the competitiveness effect.

8.6 Discussion

This section discusses the broader economic consequences of further fiscal devolution with reference to the simulation results discussed in section 8.5. The scenarios simulated in this chapter yield different net outcomes for the Scottish economy depending on the treatment of wage bargaining behaviour and amenity valuation within the model.

The new long-run equilibrium as measured by GRP, in Figure 8.5.1, indicates how the Scottish economy performs following the balanced budget expansion. A balanced budget fiscal expansion is shown to yield a net growth effect only under strict a certain regional wage bargaining behaviour with positive amenity valuation. However, if these assumptions are relaxed by a small degree, the net effect on the economy is a contraction of economic output.

The policy shock simulated above is inspired by the continuous debate about more fiscal devolution for Scotland, which is particularly driven by the ruling party in Scotland, the SNP. However, it has to be noted that this far the Scottish Parliament has a poor track record of using its extended fiscal powers. For example, the 2011 SNP Manifesto for the Scottish Parliament election clearly states that it does not intend to use the Scottish Variable Rate (SVR) in the next parliamentary cycle[6].

But at the same time the party demands more taxation powers, e.g. full devolution of corporation tax (The BBC, 2011). Similarly, in the manifesto for the 2015 UK Parliament election, the SNP urged the Scottish Parliament to move to “full financial responsibility” (The BBC, 2015).

This lack of open debate for such a major change to the Scottish fiscal framework is worrisome. Also, at odds is the continued anti-austerity language used in the mani-

[6]The SVR was an income tax power devolved to Scotland under the Scotland Act 1998. It enabled the Scottish Parliament to add up to 3p in the pound on the base rate of income tax paid in Scotland. This power has been superseded by the SRIT under the Scotland Act 2012. The potential impact this tax power might have had is discussed and simulated using AMOS in Lecca et al. (2014).

festos alongside the statements to increase public expenditure whilst no tax increases apart from upping the top end of income tax (as put forward by the Labour party, only) are promoted.

The simulations performed in this chapter try to address the likely impact of higher public expenditure through higher tax revenue, since the additional funds need to be found somewhere. Note that Scotland has only limited borrowing facilities, which are insufficient to fund long run changes to public expenditure without additional revenue sources or cost cutting measures being identified (see section 8.2.1).

Additional to the assumptions placed on the model, there are wider economic conditions to be taken into consideration if the government were to move towards a “Scandinavian Model”. First, Scotland is characterized by a highly open economy, which relies heavily on trade with its external partners. Given that price changes are only ‘avoided’ in the Social Wage case, it is likely that the income tax hike would result in price distortions. This would result in adverse competitiveness effects following the fiscal intervention (as discussed in section 8.5), which might have a severe impact on the overall performance of the Scottish economy.

Second, the Social Wage model assumes that workers and potential migrants value foregone private consumption equally to a rise in government spending. However, the long run decrease in the Real Wage after Tax, nearly 6% in the Social Wage scenario for example, is significant. It is questionable whether workers would be willing to accept a cut of this magnitude in their net take home pay. This is despite the fact that the adjustment to the new long run equilibrium would be gradual and a increase in government consumption might be applied to suit voters’ preferences more closely.

Third, the model assumes a generic increase in current government consumption. This spending includes health, education and welfare payments. The value placed on the increased government consumption will differ among current workers, i.e. income tax payers. Also, it will differ among current Scottish workers and potential migrants who might place a significant value on health and education above other current spending examples.

Therefore, the argument could be made that workers seek to benefit immediately from the cut in their take home pay through higher public spending on Demand-side levers. However, workers' valuation of the rise in public amenities is crucial. In contrast, migrants might prefer a higher level of government expenditure on items that have more indirect Supply-side effects. Thus the composition of the proposed increase in public consumption matters greatly.

Fourth, the bargaining character of the Scandinavian and the UK economy differs as alluded to in section 8.2.2. The UK experienced higher levels of unionisation for a period in the second half of the 20th century, but this has declined to around 26% in 2009 whereas the average across Scandinavia was 64% for the same year (see Table 9.9.1).

As outlined in section 8.2.1, "tripartite bargaining" characterises the annual wage setting negotiations in the Nordic countries, which involves unions, employer associations and the government. If Scotland were to move towards a Scandinavian model, it would need to address the changes necessary in order to ensure regular and inclusive bargaining similar to the "tripartite bargaining" system was experienced in Scotland.

Important to note though is the fact that a significant share of Scottish workers are subject to national UK-wide wage bargaining. This is likely to result in some worker being subject to wage bargaining behaviour, which does not resemble the outcome achieved under "tripartite bargaining".

If national bargaining was widespread workers in Scotland would not be in a position to compensate for Scottish tax changes and the results would be similar to the Social Wage case. However, there would be a question over whether national bargaining would survive if the Scottish Government does impose significant tax changes.

Fifth, further institutional changes would require Scotland to emulate a 'social investment state' with a more inclusive welfare system to move closer to a "Scandinavian Model". Without the institutional changes, simply increasing the role of the state in the Scottish economy is likely to have adverse effects as shown under the Conventional

- Macro and Conventional - Micro scenarios. These scenarios could be interpreted as cases where Scandinavian style taxation and public expenditure are imposed on Scotland, without any changes to the institutional framework as outlined above.

The fact that there is free worker mobility between England and Scotland (with Scottish firms employing English residents and vice versa) complicates an accurate simulation of the likely labour market impacts of Scottish fiscal policies. Thus, only if the Scottish Government was sure that the parameter values of the Social Wage model were close to the conduct of economic agents in Scotland, would a move towards a Scandinavian model be advisable.

Also note that the there is a positive demand-side shock through a variant of the standard balanced budget multiplier. However, this might be offset by a negative supply-side shock operating through the impact of higher income tax rates on the nominal wage, generated by regional bargaining.

8.7 Conclusion

This chapter has outlined some of the new fiscal powers extended to the Scottish Government and Parliament following the Scotland Act 2012 as well as the potentially further devolution of powers as proposed by the Smith Commission. Within the next fiscal year, Scotland is able to alter its fiscal policy direction significantly from that of the RUK. One direction Scotland could pursue is to move closer to a Scandinavian model characterized by comparatively high levels of government expenditure funded through taxation, as is simulated here.

This chapter employs CGE modelling to assess the economic impact of a balanced budget fiscal expansion funded through increases in the average rate of income tax. The scale of the shock reflects income tax levels as present in Scandinavian economies. The scenario analysed here shows that wage bargaining behaviour of Scottish workers and potential migrants to Scotland as well as their valuation of public amenities are pivotal.

The simulation output analysis shows that any positive valuation of a fiscal expansion needs to be reflected in the wage bargaining behaviour of workers in order to result in a positive impact on the overall performance of the Scottish economy. The discussion above emphasized the urgency for Scottish policy makers to seriously consider the potential implications of altering income tax in Scotland. In particular with respect to the indications made by the Scottish Finance secretary John Swinney during his presentation of the draft budget for 2016-17 (Scottish Parliament, 2015).

Furthermore, the discussion touched upon the fact that Scottish policy is subject to external economic conditions such as UK-wide national bargaining as well as the effect of a fiscal intervention on Scotland's competitiveness. Additionally, it is clear the the composition of the increase in public consumption may matter, but this is not modelled here. Also, the details with regards to the borrowing facilities provided under Smith have not been revealed.

In summary, Scottish policy makers need to be able to assess the aggregate economic effects of a potential fiscal intervention towards a more Scandinavian model given the underlying assumptions placed on the model here. Future research needs to address the following in order to provide policy makers with more inclusive advise.

First, the public consumption bundle that the average tax payer in Scotland would feel indifferent about giving up in order to fund higher levels of public consumption needs to be tied down. Second, the simulations need to be extended to address the effect of the fiscal expansion on the different branches of the government operating in Scotland simultaneously. And third, performing these simulations in an interregional setting with particular focus on the 'no detriment clause' seems to provide valuable insights for the impact that differential tax regimes between Scotland the RUK might have.

Chapter 9

Thesis Postlude

9.1 Conclusion

This thesis contributes to the multi-sectoral analysis for the Scottish economy through extending the commonly used SAM framework and enhancing the modelling capacity of shocks in both SAM and CGE models.

This is done through developing a method for constructing and disaggregating a SAM for Scotland. This method utilises to a large extend publicly available Scottish data, published by the Scottish Government. In particular the Scottish IxI table and GERS (Scottish Government, 2013c, 2013b). The remaining data sources are all UK national accounts data and again mostly publicly available.

The modelling capacity is enhanced through establishing which IO Type II output multiplier provides the most accurate estimations for Scotland and in turn that the SAM multiplier is the preferred method, if available. Further, the standard SAM model is extended to endogenise the 'Scottish' part of the public sector operating in Scotland.

The extended SAM model is employed to analyse the effect of different degrees of fiscal autonomy on the sensitivity of the Scottish economy to shocks. The extended CGE model is used to test the impact of a potential balanced budget fiscal expansion under different model settings.

This thesis finds that Scotland already has substantial fiscal powers. However, the evolving fiscal framework for Scotland requires sensitive analysis of how the shifting parameters in the Scottish fiscal framework alter the impact of internal and external shocks.

The contributions of each chapter individually are outlined below. Section 9.2 identifies areas of future work and concludes this thesis.

Individual Chapter Contributions

Chapter 2 builds on the framework of previously constructed SAMs for Scotland. However, the method developed here makes two distinct contributions to the Scottish SAM framework. First, the method provides a clear pathway from raw data to data calculation and finally to the Income and Expenditure accounts and the SAM.

This method is easily replicable for other base years and has since been employed multiple times in the Fraser of Allander Institute and the Scottish Government. Second, this method improved upon the accuracy of multiple entries through employing different data sources than previous iterations of Scottish SAMs.

Chapter 3 creates a unique and novel method for disaggregating the Government sector in the Scottish SAM. This work had not been done before. The method developed here utilises Scottish data for the disaggregation of the Government account and ensures that the disaggregated account retains the flow of funds information of the SAM from chapter 2. Also, the disaggregated Government account captures the inter-governmental flows.

Additionally, chapter 3 disaggregates the previously unified Tax account into three accounts by identifying a corresponding tax account for every Government sectors. The extended government and tax accounts in the SAM enable the tracking of devolved fiscal powers to Scotland, which cannot be captured by a unified government and a unified tax account. The method for the Government account is fully replicable through publicly available data.

Chapter 4 also creates a unique and novel disaggregation method, but for the household account. Again, this method is replicable, however, it does utilise some sensitive Government data, which is not publicly available. The household sector is disaggregated, through matrix transformations, to identify seven household types in the SAM. The method developed in chapter 4 disaggregates the household sector in a way that reproduces the initial unified household sector, if collapsed to one sector.

The disaggregation of the household account is done whilst retaining the ‘full’ industry aggregation of the SAM from chapter 2, that is 104 industries. Previous attempts of household sector disaggregation for both the UK and Scotland collapsed the industry classification, hence this is a unique method developed here. The disaggregated Household SAM captures the characteristics of the seven household types, which is also captured in the CGE model results in chapter 8.

Chapter 5 highlights that a commonly employed multi-sectoral analysis tool, the IO Type II output multiplier, is computed differently in published works. More importantly, the literature does not acknowledge the difference in the methods. This chapter shows that, using Scottish data, computing Type II multiplier with the different methods results in significant variations in the multiplier values.

The contributions of chapter 5 are first, highlighting the existence of this problem, second, highlighting that researchers are seemingly unaware of the different methods, third, which of the IO Type II multiplier models gives the ‘best fit’, and fourth that the SAM multiplier is best amongst the ‘output’ multiplier.

Chapter 6 utilises the government, tax and household account disaggregated SAM from chapter 4 to construct a SAM model. This model builds on the standard SAM model employed in chapter 5, but extends the model to endogenise part of the Government sector. Developing this extension to the standard SAM model is a unique contribution of this thesis.

The SAM is calibrated in four variants, which all reflect a different degree of fiscal autonomy for Scotland, from the Scotland Act 1998 to a variant of full fiscal devolution. Four (extended) SAM models are then built and used to simulate separate exogenous demand shocks on two industries, separately. The analysis highlights both the different channels through which the multiplier effects flow for different sectors.

Furthermore, chapter 6 shows the heightened degree of sensitivity to shocks of the Scottish economy under increasing degrees of fiscal autonomy. The different calibrations of the SAM and the extended SAM model offer a novel tool for policy analysis.

Chapter 7 provides a general outline of CGE models. Also it discusses the standard forward-looking *AMOS* model and gives the full mathematical representation of the model. The model is then extended to capture the three government sectors from the SAM and also to capture Household taxes in a more detailed level.

Chapter 8 outlines some key characteristics of the Scandinavian labour market and models a balanced budget fiscal expansion, which imposes Scandinavian income tax levels on the Scottish economy. The model captures the disaggregated household sector and thus the model can identify the distributional impacts of the income tax hike. This is a unique contribution of this chapter.

The model is run under three parameter settings for wage bargaining and public amenity valuation. The results indicate that the value of these parameters is key in determining the aggregate net effect of a balanced budget fiscal expansion. Note that the size of the shock is within the Scottish Government's current fiscal powers. Furthermore, the discussion highlighted that higher levels of income tax, would likely require changes to the way wages are bargained for in Scotland.

9.2 Future Work

This section outlines areas for future work and is structured to mirror the sequence of the chapters in this thesis.

As stated above, a major part of the contributions of this thesis are based around the construction of the 2009 SAM for Scotland and the disaggregation of the Household, Government and Tax accounts in the SAM. The extensive use of the data highlighted some areas that need to be addressed to improve the accuracy of the data in future works.

First, a newer source for the Gross Disposable Household Income figures needs to be identified, as the base SAM utilised rolled-forward data from an older SAM for Scotland due to a lack of data availability. Second, a more accurate figure for 'private pension' payments for Scottish households and third, more data on the flow of funds between Scotland and the external sector. Most publications only state the flow of funds between the UK and ROW, hence, more details on flows to and from Scotland and the RUK and ROW would also enhance the data quality of the SAM.

Fourth, the data work for the Government sector disaggregation showed that the calculation of the Government sectors' income from Other Value Added and payments to the Capital account ought to be checked for future Scottish SAMs. Additionally, the work in chapter 3 highlighted that there are some significant deviations between Government expenditure figures in GERS and the IxI table (Scottish Government, 2013c, 2013b).

The multiplier analysis in chapter 5 established, which Type II multiplier offers the 'best fit' for Scottish data. Extending this research to other regions and countries would prove informative. On the one hand, this would provide researchers with an indication as to which method to use for which national dataset. On the other hand, this work could provide insights into which method is best across multiple datasets.

The SAM modelling in chapter 6 already provides great insights into how the Scottish economy might respond to a shock under different fiscal arrangements. This work can be taken further, through either shocking other policy relevant sectors or by changing the degrees of fiscal devolution to capture more subtle adjustments to a more fiscally autonomous Scotland.

The extension of the *AMOS* model to include different Government sectors is to be taken further. One key area of development is to enable a variation in the intergovernmental transfer payments in the model. In its current iteration, the model holds these payments, such as the 'block grant' as fixed. However, higher tax revenue through a rise in income tax in Scotland, for example, ought to result in adjustments to the Scottish Government's grant payments to the Local Government.

Lastly, the simulation of the balanced budget fiscal expansion could also be reverted to model a fiscal contraction. Since the Scottish Government has the power to increase as well as reduce income tax rates, it could pursue a tax policy emulating more 'Balitc' levels of taxation, as discussed by Keating and Harvey (2014).

This thesis has made contributions to the multi-sectoral analysis of the Scottish economy through the development of methods for SAM constructions and disaggregations, as well as through extensions to models that can simulate policies and shocks in a more fiscally autonomous Scotland.

9.3 Appendix 2

Households

1. **Income**

   The Household income entry is derived from the latest revised figures of Scottish Gross Disposable Household Income (GDHI) for 2009 at NUTS2 level (ONS, 2013a). This figure is then used within the IncExp Accounts as a control total.

$$\begin{aligned} &\text{Total Income} = \\ &\text{Operating surplus and Mixed income} \\ &+\text{Compensation of employees} \\ &+\text{(Property income, received - Property income, paid)} \\ &+\text{Imputed social contributions and Social benefits} \\ &+\text{(Other current transfers, received} \\ &-\text{Other current transfers, paid)} \end{aligned} \tag{2.6.1}$$

$$107877 = 9437 + 64645 + (8485 - 551) + 23559 + (5102 - 2800)$$

2. **Income from Employment**

   This is the "Compensation of employees" || "Total intermediate demand" from one source, the IO Tables and the data from this source are taken to be fixed[1]. The data of the IO Tables is presented in the calendar year format and thus no

[1] References from the IO Tables are identified by first the column and then the row. In order to distinguish these the convention || is used between the name of the IO column and the name of the IO row.

adjustment is needed. The "Compensation of employees" in the IO Tables does include wage payments as well as non-wage labour costs, such as NI contributions (Scottish Government, 2013a).

$$\text{Income from Employment} = \tag{2.6.2}$$
$$(\text{Compensation of Employees}||\text{Total Intermediate Demand})$$

$$63561 = 63561$$

3. **Profit Income (OVA)**

This entry requires that the Gross Operating Surplus for Scotland is identified. Yet, these data are only available as an aggregate comprising of Operating surplus and Mixed Income. Therefore, the 'Operating surplus and Mixed income' figure is disaggregated to identify the Gross Operating Surplus and Mixed Income component separately. This is estimated by using shares derived from 1999 GDHI data which is the last data-set to report these figures individually. There are no alternative datasets available that would allow for a better estimation of Scottish Gross Operating Surplus for 2009.

GDHI data for 1999 is obtained from Hermannsson et al. (2010) and the shares of Gross Operating Surplus and Mixed Income are calculated. Gross Operating Surplus comprises of 56 percent and Gross Mixed Income comprises of 44 percent of total Operating and Mixed surplus and Mixed Income in 1999. These shares are used to disaggregate the aggregate 2009 figure. This process yields the required Gross Operating Surplus estimate for Scotland of £5,289m. Thus, 2009 data (the control total) is disaggregate by using 1999 shares to yield the necessary Gross Operating Surplus which is used as Household Profit Income in the IncExp Accounts (ONS, 2011c).

$$\begin{aligned}\text{Profit Income} =& \\ \text{Operating surplus and Mixed income}& \\ *\text{1999 Share of Gross operating surplus}&\end{aligned} \tag{2.6.3}$$

$$5289 = 9437 * 0.56\%$$

4. **Income from Corporations**

   The income households receive from corporations is the sum of Capital Gains, then any non-wage payments received and lastly from mixed and proportionate income[2] calculated in the Income Accounts for Households.

   First, deriving the Capital Gains Tax receipts from GERS and dividing them by the fixed Capital Gains Tax Rate for 2008-10 (at 18%), gives an estimate of the actual monetary value of the capital gain received by Scottish households for 2009 at £1,478m(Scottish Government, 2013b; HMRC, 2013a).

   Second, the non-wage income received by households from corporations is calculated. This comprises multiplying the Scottish GDP share (see equation* 2.6.80) by the total of “UK Private Dividends” paid out by private non-financial corporations in the UK. The calculated figure is then multiplied by the individual’s share of total equity[3], which gives an estimate of the dividend payments by non-financial corporations received by Scottish households at at £765m.

[2] This is a Balancing Item.

[3] This share is an average for the years 2008 and 2010, since a figure for 2009 is not available. This share is based on a UK-wide total equity share of individual’s.

This is then used to distinguish the dividend payments received by private shareholders versus, for example, funds (ONS, 2013b). Further, this part of the income figure is derived by adding an estimate of the "Total Private Pensions" [4] received by Scottish households at £9,691m as well as household's "Net Other Income" from the GDHI at at £2,302m to the non-wage income received by households from corporations(ONS, 2012).

Third, Households' Mixed and Proportionate Income Unallocated (Cell 8) at at £867m is added in order to balance this part of the Accounts.

$$\begin{aligned}\text{Income from Corporations} =& \\ \text{Household Income from Capital Gains}& \\ +\text{Household Income from Corporations}& \\ +\text{Mixed and Proportionate Income Unallocated}_{\text{IncExp}}&\end{aligned} \tag{2.6.4}$$

$$15103 = 12758 + 1478 + 867$$

---

where

[4] No estimate for Scottish Private Pension payments for 2009 could be obtained. This figure here is using the share of Scottish private pensions against Social Security payments received by households. This share is obtained from a 2006 Scottish SAM (Hermannsson et al., 2010) and multiplied by the 2009 Social Security payments for Scotland.

$$\begin{aligned}&\text{Household Income from Capital Gains} =\\&(1/4 * \text{Households' Capital Gains Tax Payments}_{\text{08-09}}\\&+3/4 * \text{Households' Capital Gains Tax Payments}_{\text{09-10}})\\&\div\text{Capital Gains Tax Rate}\end{aligned} \tag{2.6.5}$$

$$1478 = (1/4 * 572 + 3/4 * 164) \div 18\%$$

$$\begin{aligned}&\text{Total Household Income from Corporations} =\\&(\text{Scottish GDP Share} * \text{Individual Share of Total Equity}\\&*\text{Total UK Private Dividend Payments})\\&+\text{Total Private Pension} + \text{Net Other Income}\end{aligned} \tag{2.6.6}$$

$$12758 = 8.22\% * (\frac{10.2\% + 11.5\%}{2}) * 85816 + 9691 + 2302$$

$$\begin{aligned}&\text{Mixed and Proportionate Income Unallocated} =\\&(\text{Total Household Income}_{\text{GDHI}} - \text{Total Household Income}_{\text{IncExp}})\end{aligned} \tag{2.6.7}$$

$$867 = 107877 - 107010$$

5. **Income from Government**

This figure comprises the annualised "Social Protection Payments" to Scottish households (Scottish Government, 2013b) and the "Public Dividend Payments" received by Scottish households (ONS, 2013b). The latter is calculated in accordance with the methodology outlined above for "Private Dividend Payments". The dividend payments are sourced from non-financial corporations, Central Government and Local Government accounts and are multiplied by the Scottish GDP share as well as the average individual's share of total equity and further multiplied by the UK Public Dividend payments.

$$\begin{aligned}
&\text{Income from Government} = \\
&(1/4 * \text{Total Social Protection}_{\text{08-09}} \\
&+3/4 * \text{Total Social Protection}_{\text{09-10}}) \\
&+\text{Scottish GDP Share} \\
&*(\text{UK Public Dividends}_{\text{Non-Financial Corporations}} \\
&+\text{UK Public Dividends}_{\text{Central Government}} \\
&+\text{UK Public Dividends}_{\text{Local Government}}) \\
&*((\text{Individual's Share of Total Equity}_{2008} \\
&+\text{Individual's Share of Total Equity}_{2010}) \div 2)
\end{aligned} \tag{2.6.8}$$

$$\begin{aligned}
19835 = &(1/4 * 18653 + 3/4 * 20193) \\
&+(8.22\% * (25 + 2214 + 772) * ((10.2\% + 11.5\%) \div 2))
\end{aligned}$$

6. **Transfers from RUK**

These transfers are calculated by, first, deriving the total figure of dividends paid to Scottish households. This figure is calculated by using the share of Scottish Households over total UK Households (see equation* 2.6.82)[5] and multiplying it by "Total RUK Dividends" paid to UK households (ONS, 2013b). The latter figure is based on the average individual's share of total equity multiplied by the difference between Total UK- and Total Scottish- private dividends in order to obtain the RUK dividend payments to Households in Scotland (ONS, 2010b, 2011c).

Second, the difference of the "Compensation of Employees" according to the GDHI estimates and the actual figure of income from employment (Cell 2) is derived. The figures obtained from the first calculation and the second one are then summed up.

$$\begin{aligned} \text{Transfers from RUK} = \\ \text{Total RUK Dividends to Scottish Households} \\ +(\text{Compensation of Employees}_{\text{GDHI}} \\ -\text{Income from Employment}_{\text{IncExp}}) \end{aligned} \tag{2.6.9}$$

$$1853 = 767 + (64645 - 63561)$$

[5]the Household share is used here, since these are dividends paid to Scottish households specifically.

where

$$\text{Total RUK Dividends to Scottish Households} = \text{Scottish Household Share} * \text{Total RUK Dividends to Households} \tag{2.6.10}$$

$$767 = 9\% * 8546$$

7. **Transfers from ROW**

   This figure is calculated in two parts. First, the UK employment income from ROW (ONS, 2013b) is calculated with the Scottish share of Total Corporate OVA (see equation* 2.6.85). Using the Total Corporate OVA share for Scotland results in the most accurate estimate for this figure, since the Transfers from ROW are based on corporate flows of funds. Second, the amount of "UK Property and Entrepreneurial Income" is multiplied by the Scottish share of UK GDP (see equation* 2.6.80) and by the Scottish household share of OVA for UK property and entrepreneurial income (Scottish Government, 2013c, 2013b).

$$\begin{aligned} \text{Transfers from ROW} = & \\ & (\text{Scottish Share of UK Total OVA}* \\ & \text{UK Employment Income from ROW}) \\ & +(\text{Scottish Household OVA} * \text{Scottish GDP Share of UK} \\ & *\text{UK Property and Entrepreneurial Income}) \end{aligned} \tag{2.6.11}$$

$$2237 = (143588.31\%) + (169313 * 15\% * 8.22\%)$$

8. **Mixed and Proportionate Income Unallocated**

Balancing Item: equal to the difference between the control total for Households' Income (Cell1) and Total Household Income (Cell 9) (ONS, 2012).

$$\begin{aligned}\text{Income Unallocated} = \\ \text{Income}_{\text{IncExp}}^{\text{Households}} \\ -\text{Income from Employment}_{\text{IncExp}}^{\text{Households}}\end{aligned} \tag{2.6.12}$$

$$867 = 107877 - 107010$$

9. **Total Household Income**

Totals Figure: this figure is the sum of all of the above entries for this account, excluding the total household income figure obtained from the GDHI (sum of cells 2 to 8).

$$\begin{aligned}\text{Total Household Income} = \\ (\text{Income from Employment}_{\text{IncExp}}^{\text{Households}} \\ +\text{Profit Income (OVA)}_{\text{IncExp}}^{\text{Households}} \\ +\text{Income from Corporations}_{\text{IncExp}}^{\text{Households}} \\ +\text{Income from Government}_{\text{IncExp}}^{\text{Households}} \\ +\text{Transfers from RUK}_{\text{IncExp}}^{\text{Households}} \\ +\text{Transfers from ROW}_{\text{IncExp}}^{\text{Households}})\end{aligned} \tag{2.6.13}$$

$$107877 = 63561 + 5289 + 15103 + 19835 + 1853 + 2237$$

10. **Expenditure**

    Totals Figure: Summation of figures below, from IO Expenditure to Payments to Capital (Cells 11 to 16).

$$\begin{aligned} \text{Expenditure} = \\ \text{IO Expenditure}^{\text{Households}}_{\text{IncExp}} \\ +\text{Payments to Corporations}^{\text{Households}}_{\text{IncExp}} \\ +\text{Payments to Government}^{\text{Households}}_{\text{IncExp}} \\ +\text{Transfers to RUK}^{\text{Households}}_{\text{IncExp}} \\ +\text{Transfers to ROW}^{\text{Households}}_{\text{IncExp}} \\ +\text{Payments to Capital}^{\text{Households}}_{\text{IncExp}} \end{aligned} \tag{2.6.14}$$

$$107877 = 74669 + 6401 + 21379 + 5070 + 238 + 119$$

11. **IO Expenditure**

    This cell presents the consumption expenditure, including taxes paid on products, by both Households and “Non-Profit Institutions Serving Households” (NPISH). Examples for what NPISHs are include churches, sport clubs and political parties. These institutions are generally not mainly funded by governments and serve households either for free or for relative low cost (Eurostat, 2013). The IO Expenditure figure is calculated by using data solely from the IO Tables. This cell is constructed of "Total Intermediate Consumption at basic prices" || "Households' Final Consumption Expenditure" plus "Taxes less Subsidies on Products" || "Households Final Consumption Expenditure" and "Total Intermediate Consumption at basic prices" || "Non-Profit Institutions Serving Households' Final Consumption Expenditure" plus "Taxes less Subsidies on Products" || "Non-Profit Institutions Serving Households' Final Consumption Expenditure" from the IO Tables (Scottish Government, 2013c).

$$\begin{aligned} \text{IO Expenditure} = \\ \text{Total Intermediate Consumption} \| \text{Final Consumption Expenditure}_{\text{Households}} \\ + \text{Taxes less Subsidies on Products} \| \text{Final Consumption Expenditure}_{\text{Households}} \\ + \text{Total Intermediate Consumption} \| \text{Final Consumption Expenditure}_{\text{NPISH}} \\ + \text{Taxes less Subsidies on Products} \| \text{Final Consumption Expenditure}_{\text{NPISH}} \end{aligned} \tag{2.6.15}$$

$$74669 = 65421 + 6568 + 2680 + 0$$

12. **Payments to Corporations**

Balancing Item: Taking the Total Expenditure (Cell 17) and subtracting the sum of: IO Expenditure (Cell 11), Payments to Government (Cell 13), Transfers to RUK (Cell 14), Transfers to ROW (Cell 15), Payments to Capital (Cell 16) from it.

$$
\begin{aligned}
\text{Payments to Corporations} = \\
&\text{Total Expenditure}^{\text{Households}}_{\text{IncExp}} \\
&-\text{IO Expenditure}^{\text{Households}}_{\text{IncExp}} \\
&-\text{Payments to Government}^{\text{Households}}_{\text{IncExp}} \\
&-\text{Transfers to RUK}^{\text{Households}}_{\text{IncExp}} \\
&-\text{Transfers to ROW}^{\text{Households}}_{\text{IncExp}} \\
&-\text{Payments to Capital}^{\text{Households}}_{\text{IncExp}}
\end{aligned}
\tag{2.6.16}
$$

$$6401 = 107877 - 74662 - 21379 - 238 - 119 - 5070$$

13. **Payments to Government**

    These are the taxes paid by Households to the Government. The source for these entries is GERS and therefore these figures have to be annualised according to the method outlined above. These taxes are: Income Tax, Capital Gains Tax, Inheritance Tax, Stamp Duties, Half Insurance Premium Tax, Council Tax and Social Security Contributions (NI) (Scottish Government, 2013b). The figures are annualised as detailed in Section 2.4.1.

$$
\begin{aligned}
&\text{Payments to Government} = \\
&1/4 * (\text{Income Tax}_{\text{08-09}} + \text{Capital Gains Tax}_{\text{08-09}} \\
&+\text{Inheritance Tax}_{\text{08-09}} + \text{Stamp Duties}_{\text{08-09}} \\
&+\text{Half Insurance Premium Tax}_{\text{08-09}} + \text{Council Tax}_{\text{08-09}} \\
&+\text{Social Security Contributions}_{\text{08-09}}) \\
&+3/4 * (\text{Income Tax}_{\text{09-10}} + \text{Capital Gains Tax}_{\text{09-10}} \\
&+\text{Inheritance Tax}_{\text{09-10}} + \text{Stamp Duties}_{\text{09-10}} \\
&+\text{Half Insurance Premium Tax}_{\text{09-10}} + \text{Council Tax}_{\text{09-10}} \\
&+\text{Social Security Contributions}_{\text{09-10}})
\end{aligned}
\tag{2.6.17}
$$

$$
\begin{aligned}
21379 = &(1/4 * (10642 + 572 + 178 + 594 + 96 + 1960 + 7992)) \\
&+(3/4 * (10364 + 164 + 146 + 516 + 95 + 1961 + 7915))
\end{aligned}
$$

14. **Transfers to RUK**

This figure is calculated using the same methodology as outlined for (Cell 15). It is assumed that the transfers paid to the RUK are twice as high as those paid to the ROW, and thus this cell is equal to (Cell 15) times two.

$$
\begin{aligned}
&\text{Transfers to RUK} = \\
&\text{Transfers to ROW}^{\text{Households}}_{\text{IncExp}} * 2
\end{aligned}
\tag{2.6.18}
$$

$$
238 = 119 * 2
$$

15. **Transfers to ROW**

This figure is comprised of, first, the amount of employee compensation that is paid to the ROW, i.e. the part that is deducted from GDP in order to arrive at GNP figures. Then it is multiplied by the share of Scottish OVA of Corporate Income (see equation* 2.6.85) (ONS, 2013b).

$$\text{Transfers to ROW} = \text{UK Payments to ROW} * \text{Scottish Corporate Income OVA} \tag{2.6.19}$$

$$119 = 1435 * 8.31\%$$

16. **Payments to Capital (Savings)**

This cell is calculated by assuming that households save a share of their total expenditure. The Household Saving Rate obtained from the Scottish National Accounts Project (SNAP) for 2009 (Scottish Government, 2013e) is multiplied by Households' Total Expenditure (see Cell 17).

$$\text{Payments to Capital} = \text{Total Household Income}_{\text{IncExp}}^{\text{Households}} * \text{Household Savings Rate}_{\text{SNAP}} \tag{2.6.20}$$

$$5070 = 107877 * 0.047$$

17. **Total Expenditure**

    Corresponding Figure: Equal to the Total Household Income (Cell 9), based on the assumption that total income for households are equal to their total expenditure.

$$\text{Total Expenditure} = \text{Total Household Income}^{\text{Households}}_{\text{IncExp}} \tag{2.6.21}$$

$$107877 = 107877$$

Corporations

18. **Income**

Totals Figure: Equal to all other entries in this section (sum of Cells 19 to 23).

$$\begin{aligned}\text{Income} = &\\ \text{Profit Income}^{\text{Corporations}}_{\text{IncExp}} &\\ +\text{Income from Households}^{\text{Corporations}}_{\text{IncExp}} &\\ +\text{Income from Government}^{\text{Corporations}}_{\text{IncExp}} &\\ +\text{Income from RUK}^{\text{Corporations}}_{\text{IncExp}} &\\ +\text{Income from ROW}^{\text{Corporations}}_{\text{IncExp}} &\end{aligned} \tag{2.6.22}$$

$$53507 = 29456 + 6401 + 5722 + 5964 + 5964$$

19. **Profit Income (OVA)**

The figure of "Gross Operating Surplus" || "Total Intermediate Demand" from the IO Tables is deducted by the Profit Income (OVA) of both Households and Government (Cells 3 and 31) (Scottish Government, 2013c; ONS, 2011c).

$$\begin{aligned}\text{Profit Income} = &\\ \text{Gross Operating Surplus}\|\text{Total Intermediate Demand} &\\ -\text{Profit Income}^{\text{Households}}_{\text{IncExp}} - \text{Profit Income}^{\text{Government}}_{\text{IncExp}} &\end{aligned} \tag{2.6.23}$$

$$29456 = 38441 - 5289 - 3697$$

20. **Income from Households**

Corresponding Figure: Equal to Household's Payments to Corporations (Cell 12), which is derived as a Balancing Item.

$$\text{Income from Households} = \text{Payments to Corporations}^{\text{Households}}_{\text{IncExp}} \tag{2.6.24}$$

$$6401 = 6401$$

21. **Income from Government**

Corresponding Figure: Equal to Government's Payments to Corporations (Cell 39), which is derived as a Balancing Item.

$$\text{Income from Government} = \text{Payments to Corporations}^{\text{Government}}_{\text{IncExp}} \tag{2.6.25}$$

$$5722 = 5722$$

22. **Income from RUK**

The Scottish share of UK Property and Entrepreneurial Income (see equation* 2.6.86) is multiplied by the corporate share of OVA. Half of this total is attributed to the Income from RUK and the other half to the Income from ROW (Cell 23). The UK Property and Entrepreneurial Income is part of the Gross National Income at market prices presented in the ONS's National Accounts, i.e. the Blue Book. In the Blue Book this figure gives the receipts of the UK from the ROW. Here we estimate that as a Scottish share of that total figure, half of the property and income receipts for Scotland originate from RUK and the other half from ROW (Scottish Government, 2013c; ONS, 2013b).

$$\begin{aligned} \text{Income from RUK} &= \\ 1/2 * \text{Corporate OVA Share} \\ *\text{Scottish Share of UK Property and Entrepreneurial Income} \end{aligned} \tag{2.6.26}$$

$$5964 = 84.8\% * 14070 * 1/2$$

23. **Income from ROW**

The Scottish share of UK property and entrepreneurial income (see 2.6.86) is multiplied by the corporate share of OVA (Scottish Government, 2013c; ONS, 2013b). Half of this total is shared to the Income from ROW and the other half to the Income from RUK (Cell 22).

$$\text{Income from ROW} = \frac{1}{2} * \text{Corporate OVA Share} * \text{Scottish Share of UK Property and Entrepreneurial Income} \tag{2.6.27}$$

$$5964 = 84.8\% * 14070 * 1/2$$

24. **Expenditure**

Totals Figure: Sum of cells below (Cell 25 to 29).

$$\begin{aligned}\text{Expenditure} = \\ \text{Payments to Households}^{\text{Corporations}}_{\text{IncExp}} \\ +\text{Payments to Government}^{\text{Corporations}}_{\text{IncExp}} \\ +\text{Transfers to RUK}^{\text{Corporations}}_{\text{IncExp}} \\ +\text{Transfers to ROW}^{\text{Corporations}}_{\text{IncExp}} \\ +\text{Payments to Capital}^{\text{Corporations}}_{\text{IncExp}}\end{aligned} \tag{2.6.28}$$

$$53507 = 15103 + 5248 + 3768 + 4560 + 24828$$

25. **Payments to Households**

Corresponding Figure: Equal to Household Income from Corporations (Cell 4).

$$\text{Payments to Households} = \text{Income from Corporations}^{\text{Households}}_{\text{IncExp}} \tag{2.6.29}$$

$$15103 = 15103$$

26. **Payments to Government**

These are the annualised taxes paid by corporations to the Scottish Government. The source for these entries is GERS. The taxes are: Corporation Tax, Half Insurance Premium Tax, Landfill Tax, Non-Domestic Rates, Other Taxes and Royalties, Interest and Dividends (Scottish Government, 2013b).

$$\begin{aligned}\text{Payments to Government} =\\ 1/4 * (\text{Corporation Tax}_{\text{08-09}} + \text{Half Insurance Premium Tax}_{\text{08-09}}\\ + \text{Landfill Tax}_{\text{08-09}} + \text{Non-Domestic Rates}_{\text{08-09}}\\ + \text{Other Taxes and Royalties}_{\text{08-09}} + \text{Interest and Dividends}_{\text{08-09}})\\ + 3/4 * (\text{Corporation Tax}_{\text{09-10}} + \text{Half Insurance Premium Tax}_{\text{09-10}}\\ + \text{Landfill Tax}_{\text{09-10}} + \text{Non-Domestic Rates}_{\text{09-10}}\\ + \text{Other Taxes and Royalties}_{\text{09-10}} + \text{Interest and Dividends}_{\text{09-10}})\end{aligned} \tag{2.6.30}$$

$$5248 = 1/4 * (2841 + 96 + 82 + 1736 + 250 + 608)$$
$$+3/4(2680 + 95 + 85 + 1822 + 212 + 233)$$

27. **Transfers to RUK**

This is the Corporations' Profit Income (OVA) (Cell 19) multiplied by the share of companies operating in Scotland but owned by a RUK entity's profits not directly re-invested. This share is derived from the "Businesses in Scotland Publication" from the Scottish Government (ONS, 2013b; Scottish Government, 2011b).

$$\text{Transfers to RUK} = \text{OVA Repatriated} * \text{\%age of UK-owned firms} \quad (2.6.31)$$

$$3768 = 29456 * 13\%$$

28. **Transfers to ROW**

This is the Corporations' Profit Income (OVA) (Cell 19) multiplied by the share of companies operating in Scotland but owned by a ROW entity's profits not directly re-invested. This share is derived from the "Businesses in Scotland Publication" from the Scottish Government (ONS, 2013b; Scottish Government, 2011b).

$$\text{Transfers to ROW} = \text{OVA Repatriated} * \text{\%age of ROW-owned firms} \tag{2.6.32}$$

$$4560 = 29456 * 15\%$$

29. **Payments to Capital (Savings)**

    Balancing Item: This figure is the Corporations' Total Income (Cell 18) minus the sum of (Cells 25 to 28) from the Corporations' Expenditure Account.

$$\begin{aligned} \text{Payments to Capital} = &\\ \text{Income}^{\text{Corporations}}_{\text{IncExp}} &\\ -\text{Payments to Households}^{\text{Corporations}}_{\text{IncExp}} &\\ -\text{Payments to Government}^{\text{Corporations}}_{\text{IncExp}} &\\ -\text{Transfers to RUK}^{\text{Corporations}}_{\text{IncExp}} &\\ -\text{Transfers to ROW}^{\text{Corporations}}_{\text{IncExp}} & \end{aligned} \tag{2.6.33}$$

$$24828 = 53507 - 15103 - 5248 - 3768 - 4560$$

Government

30. **Income**

Totals Figure: Sum of cells below (Cells 31 to 35).

$$\begin{aligned} \text{Income} = \\ \text{Profit Income}^{\text{Government}}_{\text{IncExp}} \\ +\text{Net Commodity Tax}^{\text{Government}}_{\text{IncExp}} \\ +\text{Income from Households}^{\text{Government}}_{\text{IncExp}} \\ +\text{Income from Corporations}^{\text{Government}}_{\text{IncExp}} \end{aligned} \tag{2.6.34}$$

$$63530 = 3697 + 13165 + 21379 + 5248 + 20041$$

31. **Profit Income (OVA)**

Equal to "Gross Operating Surplus" for all public sectors in the IO Tables (see Cell 30). The Public Sectors are: Water and Sewerage, Public Administration and Defence, Education, Health, Residential Care and Social Work (Scottish Government, 2013c).

$$
\begin{aligned}
\text{Profit Income} = {} & \\
& \text{Gross Operating Surplus}||\text{Water and Sewerage}|| \\
& +\text{Gross Operating Surplus}||\text{Public Administration and Defence} \\
& +\text{Gross Operating Surplus}||\text{Education} \\
& +\text{Gross Operating Surplus}||\text{Health} \\
& +\text{Gross Operating Surplus}||\text{Residential Care} \\
& +\text{Gross Operating Surplus}||\text{Social Work}
\end{aligned}
\tag{2.6.35}
$$

$$3697 = 710 + 865 + 463 + 817 + 590 + 253$$

32. **Net Commodity Taxes**

This cell is the sum of "Taxes less Subsidies on Production" || "Total Intermediate Demand" and "Taxes less Subsidies on Production" || "Total Demand for Products" from the IO Tables (Scottish Government, 2013c).

$$
\begin{aligned}
\text{Net Commodity Taxes} = {} & \\
& \text{Taxes less Subsidies on Production}||\text{Total Intermediate Demand} \\
& +\text{Taxes less Subsidies on Production}||\text{Total Demand for Products}
\end{aligned}
\tag{2.6.36}
$$

$$13165 = 1232 + 11933$$

33. **Income from Households**

Corresponding Figure: Equal to Households' Payments to Government (Cell 13).

$$\text{Income from Households} = \text{Payments to Government}^{\text{Households}}_{\text{IncExp}} \tag{2.6.37}$$

$$21379 = 21379$$

34. **Income from Corporations**

Corresponding Figure: Equal to Corporations' Payments to Government (Cell 26).

$$\text{Income from Corporations} = \text{Payments to Government}^{\text{Corporations}}_{\text{IncExp}} \tag{2.6.38}$$

$$5248 = 5248$$

35. **Income from RUK**

Balancing Item: Total Government Income Balancing Total (Cell 36) minus the sum of Profit Income (Cell 31), Net Commodity Taxes (Cell 32), Income from Households (Cell 33) and Income from Corporations (Cell 34).

$$\begin{aligned}\text{Income from RUK} &= \\ &\text{Total Government Income Balancing} \\ &-\text{Profit Income}^{\text{Government}}_{\text{IncExp}} \\ &-\text{Net Commodity Taxes}^{\text{Government}}_{\text{IncExp}} \\ &-\text{Income from Households}^{\text{Government}}_{\text{IncExp}} \\ &-\text{Income from Corporations}^{\text{Government}}_{\text{IncExp}}\end{aligned} \tag{2.6.39}$$

$$20041 = 63530 - 3697 - 13165 - 21379 - 5248$$

36. **Total Government Income Balancing Total**

Corresponding Figure: Equal to Total Government Expenditure Balancing Total (Cell 43).

$$\begin{aligned}\text{Total Government Income} &= \\ &\text{Total Government Expenditure Balancing Total}^{\text{Government}}_{\text{IncExp}}\end{aligned} \tag{2.6.40}$$

$$63530 = 63530$$

37. **Expenditure**

Totals Figure: Sum of cells below (38 to 42).

$$\begin{aligned} \text{Expenditure} = & \\ & \text{IO Expenditure}^{\text{Government}}_{\text{IncExp}} \\ & + \text{Payments to Corporations}^{\text{Government}}_{\text{IncExp}} \\ & + \text{Payments to Households}^{\text{Government}}_{\text{IncExp}} \\ & + \text{Transfers to RUK}^{\text{Government}}_{\text{IncExp}} \\ & + \text{Payments to Capital}^{\text{Government}}_{\text{IncExp}} \end{aligned} \tag{2.6.41}$$

$$63530 = 29486 + 5722 + 19835 + 8368 + 119$$

38. **IO Expenditure**

This is the “Total Intermediate Consumption at basic prices” || “Central Government” || and “Total Intermediate Consumption at basic prices” || “Local Governments” from the IO Tables (Scottish Government, 2013c).

$$
\begin{aligned}
\text{IO Expenditure} = &\\
&\text{Total Intermediate Consumption at basic prices}||\text{Central Government} \\
&+\text{Total Intermediate Consumption at basic prices}||\text{Local Government}
\end{aligned}
\tag{2.6.42}
$$

$$29486 = 19296 + 10190$$

39. **Payments to Corporations**

    Balancing Item: Total Government Expenditure Balancing Total (Cell 44) minus IO Expenditure (Cell 38), Payments to Households (Cell 40), Transfers to RUK (Cell 41) and Payments to Capital (Savings) (Cell 42).

$$
\begin{aligned}
\text{Payments to Corporations} = &\\
&\text{Total Government Expenditure Balancing Total}^{\text{Government}}_{\text{IncExp}} \\
&-\text{IO Expenditure}^{\text{Government}}_{\text{IncExp}} \\
&+\text{Payments to Households}^{\text{Government}}_{\text{IncExp}} \\
&+\text{Transfers to RUK}^{\text{Government}}_{\text{IncExp}} \\
&+\text{Payments to Capital}^{\text{Government}}_{\text{IncExp}}
\end{aligned}
\tag{2.6.43}
$$

$$5722 = 63530 - 29486 - 19835 - 8368 - 119$$

40. **Payments to Households**

Corresponding Figure: Households' Income from Government (Cell 5).

$$\text{Payments to Households} = \text{Income from Government}^{\text{Households}}_{\text{IncExp}} \quad (2.6.44)$$

$$19835 = 19835$$

41. **Transfers to RUK**

This is the annualised estimated non-identifiable Government Expenditure, based on the Scottish population share of the UK Total non-identifiable public spending. These figures are taken from GERS and approximately 60% of the £8,368 are made up of "Public Sector Debt Interested" and "Defence" spending made by the UK on behalf of Scotland. (Scottish Government, 2013b).

$$\begin{aligned} \text{Transfers to RUK} = \\ 1/4 * \text{Estimated Non-Identifiable Expenditure}_{\text{08-09}} \\ +3/4 * \text{Estimated Non-Identifiable Expenditure}_{\text{09-10}} \end{aligned} \quad (2.6.45)$$

$$8368 = 1/4 * 8174 + 3/4 * 8432$$

42. **Payments to Capital (Savings)**

This cell is calculated using the IO Table entries for all public sectors. It is their sum of "Gross Fixed Capital Formation" as given in the IO Tables, from which the sum of "Taxes less Subsidies on Production" for those sectors is subtracted (Scottish Government, 2013c).

$$\begin{aligned}
&\text{Payments to Capital} = \\
&(\text{Water and Sewerage}\|\text{Gross Fixed Capital Formation} \\
&+\text{Public Administration and Defence}\|\text{Gross Fixed Capital Formation} \\
&+\text{Education}\|\text{Gross Fixed Capital Formation} \\
&+\text{Health}\|\text{Gross Fixed Capital Formation} \\
&+\text{Residential Care}\|\text{Gross Fixed Capital Formation} \\
&+\text{Social Work}\|\text{Gross Fixed Capital Formation}) \\
&-(\text{Water and Sewerage}\|\text{Taxes less Subsidies on Production} \\
&+\text{Public Administration and Defence}\|\text{Taxes less Subsidies on Production} \\
&+\text{Education}\|\text{Taxes less Subsidies on Production} \\
&+\text{Health}\|\text{Taxes less Subsidies on Production} \\
&+\text{Residential Care}\|\text{Taxes less Subsidies on Production} \\
&+\text{Social Work}\|\text{Taxes less Subsidies on Production})
\end{aligned} \tag{2.6.46}$$

$$\begin{aligned}
119 = &(1 + 174 + 7 + 0 + 0 + 1) \\
&-(28 + 0 + 18 + 11 + 3 + 4)
\end{aligned}$$

43. **Total Government Expenditure Balancing Total**

This is the Control Total, which is then imposed on the Total Government Income (Cell 36). This figure has two components. First, the annualised "Total Identifiable Expenditure" and the "Total Non-Identifiable Expenditure" of the Public Sector in Scotland are added together (Scottish Government, 2013b). Second, the annualised "Total managed expenditure", "Total Identifiable"- and "Total non-identifiable Expenditure" of the UK are summed together and multiplied by the Scottish population share (see equation* 2.6.81). The latter is then subtracted from the former in order to arrive at an estimate for total public sector spending in Scotland (Treasury, 2012; ONS, 2010b).

$$\begin{aligned}
&\text{Total Government Expenditure} = \\
&(1/4 * \text{Total Identifiable Expenditure}_{08-09} \\
&+3/4 * \text{Total Identifiable Expenditure}_{09-10}) \\
&+(1/4 * \text{Total Non-Identifiable Expenditure}_{08-09} \\
&+3/4 * \text{Total Non-Identifiable Expenditure}_{09-10}) \\
&(1/4 * \text{Scottish Population Share} \\
&*(\text{Total Managed Expenditure}^{\text{UK}}_{08-09} \\
&-\text{Total Identifiable Expenditure}^{\text{UK}}_{08-09} \\
&-\text{Total Managed Non-Identifiable}^{\text{UK}}_{08-09})) \\
&(1/4 * \text{Scottish Population Share} \\
&*(\text{Total Managed Expenditure}^{\text{UK}}_{09-10} \\
&-\text{Total Identifiable Expenditure}^{\text{UK}}_{09-10} \\
&-\text{Total Managed Non-Identifiable}^{\text{UK}}_{09-10}))
\end{aligned} \tag{2.6.47}$$

$$
\begin{aligned}
63530 = (1/4 * (50779 + 8174)) + (3/4 * (53617 + 8432)) \\
+(1/4 * 8.41\% * (629745 - 515734 - 87697)) \\
+(3/4 * 8.41\% * (670150 - 559134 - 84021))
\end{aligned}
$$

Capital

44. **Income**

Totals Figure: Sum of cells below, which gives the balance of the main transactors' savings with any income from RUK/ROW investment in Scotland (Cells 45 to 48).

$$\text{Income} = \text{Households}^{\text{Capital}}_{\text{IncExp}} + \text{Corporations}^{\text{Capital}}_{\text{IncExp}} + \text{Government}^{\text{Capital}}_{\text{IncExp}} + \text{RUK/ROW}^{\text{Capital}}_{\text{IncExp}} \quad (2.6.48)$$

$$19930 = 5202 + 24695 + 119 + (-10086)$$

45. **Households**

Corresponding Figure: Households' Payments to Capital (Savings) (Cell 16).

$$\text{Households} = \text{Payments to Capital}^{\text{Households}}_{\text{IncExp}} \quad (2.6.49)$$

$$5070 = 5070$$

46. **Corporate**

Corresponding Figure: Corporations' Payments to Capital (Savings) (Cell 29), which is derived as a Balancing Item.

$$\text{Corporate} = \text{Payments to Capital}^{\text{Corporations}}_{\text{IncExp}} \tag{2.6.50}$$

$$24828 = 24828$$

47. **Government**

Corresponding Figure: Government's Payments to Capital (Savings) (Cell 42).

$$\text{Government} = \text{Payments to Capital}^{\text{Government}}_{\text{IncExp}} \tag{2.6.51}$$

$$119 = 119$$

48. **RUK/ROW**

Corresponding Figure: Surplus/Deficit of the External Expenditure Account (Cell 66).

$$\begin{aligned} \text{RUK/ROW} = \\ \text{Total Income}_{\text{IncExp}}^{\text{External}} \\ -\text{Total Expenditure}_{\text{IncExp}}^{\text{External}} \end{aligned} \tag{2.6.52}$$

$$-10087 = 90808 - 100896$$

49. **Expenditure**

Corresponding Figure: IO Expenditure (Cell 50).

$$\begin{aligned} \text{Expenditure} = \\ \text{IO Expenditure}_{\text{IncExp}}^{\text{Capital}} \end{aligned} \tag{2.6.53}$$

$$19930 = 19930$$

50. **IO Expenditure**

This figure gives the net balance of savings of the main transactors in Scotland. Here it is calculated as the sum of “Total Intermediate Consumption at basic prices" || "Total Gross Capital Formation" and "Taxes less Subsidies on Products" || "Total Gross Capital Formation" from the IO Tables (Scottish Government, 2013c).

$$\text{IO Expenditure} = \text{Total Intermediate Consumption at basic prices}\|\text{Total Gross Capital Formation} + \text{Taxes Less Subsidies on Products}\|\text{Total Gross Capital Formation} \tag{2.6.54}$$

$$19930 = 18453 + 1495$$

External

51. **RUK Income from Scotland**

Totals Figure: This is the sum of the two cells below: Goods & Services (Cell 52) and Transfers (Cell 53).

$$\begin{aligned}\text{RUK Income from Scotland} = \\ \text{Goods \& Services from RUK}^{\text{External}}_{\text{IncExp}} \\ +\text{Transfers to RUK}^{\text{External}}_{\text{IncExp}}\end{aligned} \tag{2.6.55}$$

$$67133 = 54759 + 12374$$

52. **Goods & Services from RUK**

This is the Scottish "Total Demand for Products" from RUK as given in the IO Tables (Scottish Government, 2013c).

$$\begin{aligned}\text{Goods \& Services from RUK} = \\ \text{Imports from Rest of UK}||\text{Total Demand for Products}\end{aligned} \tag{2.6.56}$$

$$54759 = 54759$$

53. **Transfers to RUK**

This is the sum of the previously calculated cells: Households' Transfers to RUK (Cell 14), the Corporations' Transfers to RUK (Cell 27) and the Government's Transfers to RUK (Cell 41).

$$\begin{aligned} \text{Transfers to RUK} = \\ \text{Transfers to RUK}^{\text{Households}}_{\text{IncExp}} \\ +\text{Transfers to RUK}^{\text{Corporations}}_{\text{IncExp}} \\ +\text{Transfers to RUK}^{\text{Government}}_{\text{IncExp}} \end{aligned} \tag{2.6.57}$$

$$12374 = 238 + 3768 + 8368$$

54. **ROW Income from Scotland**

Totals Figure: This is the sum of the two cells below: Goods & Services (Cell 55) and Transfers (Cell 56).

$$\begin{aligned} \text{ROW Income from Scotland} = \\ \text{Goods \& Services from ROW}^{\text{External}}_{\text{IncExp}} \\ +\text{Transfers to ROW}^{\text{External}}_{\text{IncExp}} \end{aligned} \tag{2.6.58}$$

$$23676 = 18997 + 4697$$

55. **Goods & Services from ROW**

This is the "ROW" || "Total Demand for Products" from the IO Tables (Scottish Government, 2013c).

$$\text{Goods \& Services from ROW} = \text{Imports from Rest of UK}\|\text{Total Demand for Products} \tag{2.6.59}$$

$$18997 = 18997$$

56. **Transfers to ROW**

This is the sum of the Households' Transfers to ROW (Cell 15) and the Corporations' Transfers to ROW (Cell 28).

$$\text{Transfers to ROW} = \text{Transfers to ROW}^{\text{Households}}_{\text{IncExp}} + \text{Transfers to RUK}^{\text{Corporations}}_{\text{IncExp}} \tag{2.6.60}$$

$$4679 = 119 + 4560$$

57. **Total Income**

Totals Figure: This is the sum of the two cells: UK income from Scotland (Cell 51) and ROW income from Scotland (Cell 54).

$$\begin{aligned} \text{Total Income} = \\ \text{RUK Income from Scotland}^{\text{External}}_{\text{IncExp}} \\ +\text{ROW Income from Scotland}^{\text{External}}_{\text{IncExp}} \end{aligned} \tag{2.6.61}$$

$$90808 = 67133 + 23676$$

58. **RUK Expenditure in Scotland**

Totals Figure: This is the sum of the two cells below: Goods & Services (Cell 59) and Transfers (Cell 60).

$$\begin{aligned} \text{RUK Expenditure in Scotland} = \\ \text{Goods \& Services to RUK}^{\text{External}}_{\text{IncExp}} \\ +\text{Transfers from RUK}^{\text{External}}_{\text{IncExp}} \end{aligned} \tag{2.6.62}$$

$$70597 = 42739 + 27858$$

59. **Goods & Services to RUK**

This is the "Total Intermediate Consumption at basic prices" || "Rest of UK exports" from the IO Tables (Scottish Government, 2013c).

$$\text{Goods \& Services to RUK} = \tag{2.6.63}$$
$$\text{Total Intermediate Consumption at basic prices}||\text{Rest of UK Exports}$$

$$42739 = 42739$$

60. **Transfers from RUK**

This is the sum of the Households' Transfers from RUK (Cell 6), the Corporations' Income from RUK (Cell 22) and the Government's Income from RUK (Cell 35).

$$\begin{aligned} \text{Transfers from RUK} &= \\ \text{Transfers from RUK}^{\text{Households}}_{\text{IncExp}} & \\ +\text{Income from RUK}^{\text{Corporations}}_{\text{IncExp}} & \\ +\text{Income from RUK}^{\text{Government}}_{\text{IncExp}} & \end{aligned} \tag{2.6.64}$$

$$27858 = 1853 + 5964 + 20041$$

61. **ROW Expenditure in Scotland**

Totals Figure: This is the sum of the two cells below: Goods & Services (Cell 62) and Transfers (Cell 63).

$$\begin{aligned}\text{ROW Expenditure in Scotland} =& \\ \text{Goods \& Services to ROW}^{\text{External}}_{\text{IncExp}}& \\ +\text{Transfers from ROW}^{\text{External}}_{\text{IncExp}}&\end{aligned} \tag{2.6.65}$$

$$27378 = 19178 + 8201$$

62. **Goods & Services to ROW**

This is the "Total Intermediate Consumption at basic prices" || "Rest of World Exports" from the IO Tables (Scottish Government, 2013c).

$$\begin{aligned}\text{Goods \& Services to ROW} =& \\ \text{Total Intermediate Consumption at basic prices}& \\ \text{Rest of World Exports}&\end{aligned} \tag{2.6.66}$$

$$19178 = 19178$$

63. **Transfers**

This is the sum of Households' Transfers from ROW (Cell 7) and Corporations' Income from ROW (Cell 23).

$$\text{Transfers from ROW} = \text{Transfers from ROW}^{\text{Households}}_{\text{IncExp}} + \text{Income from ROW}^{\text{Corporations}}_{\text{IncExp}} \tag{2.6.67}$$

$$8201 = 2237 + 5964$$

64. **Tourist Expenditure in Scotland**

This is the sum of the "Total Intermediate Consumption at basic prices" || "Final Consumption Expenditure of Non-resident Household Expenditure in Scotland" and the "Taxes less Subsidies on Products" || "Final Consumption Expenditure of Non-resident Household Expenditure in Scotland" from the IO Tables (Scottish Government, 2013c).

$$\begin{aligned}\text{Tourist Expenditure in Scotland} &= \\ \text{Total Intermediate Consumption at basic prices} \\ \|\text{Final Consumption Expenditure Non-Resident} \\ \text{Household Expenditure in Scotland} \\ +\text{Taxes Less Subsidies on Products} \\ \|\text{Final Consumption Expenditure Non-Resident} \\ \text{Household Expenditure in Scotland}\end{aligned} \tag{2.6.68}$$

$$2921 = 2599 + 322$$

65. **Total Expenditure**

This is the sum of the above cells: RUK Expenditure in Scotland (Cell 58), ROW Expenditure in Scotland (Cell 61) and Tourist Expenditure in Scotland (Cell 64).

$$\begin{aligned}\text{Total Expenditure} =&\\ \text{UK Expenditure in Scotland}^{\text{External}}_{\text{IncExp}}&\\ +\text{ROW Expenditure in Scotland}^{\text{External}}_{\text{IncExp}}&\\ +\text{Tourist Expenditure in Scotland}^{\text{External}}_{\text{IncExp}}&\end{aligned} \tag{2.6.69}$$

$$100896 = 70597 + 27378 + 2921$$

66. **Surplus/Deficit**

This is the balance of the External Account's Total Income (Cell 57) minus the account's Total expenditure (Cell 65).

$$\begin{aligned}\text{Surplus/Deficit} =&\\ \text{Total Income}^{\text{External}}_{\text{IncExp}}&\\ -\text{Total Expenditure}^{\text{External}}_{\text{IncExp}}&\end{aligned} \tag{2.6.70}$$

$$-10087 = 90808 - 100896$$

Goods and Services Trade Balance

67. **RUK**

This is the balance of the RUK Expenditure in Scotland's Goods and Services (Cell 59) minus the RUK Income from Scotland's Goods and Services (Cell 52).

$$\text{Goods \& Services Trade Balance with RUK} =$$
$$\text{RUK Goods \& Services Expenditure in Scotland}^{\text{External}}_{\text{IncExp}}$$
$$-\text{RUK Goods \& Services Income from Scotland}^{\text{External}}_{\text{IncExp}} \tag{2.6.71}$$

$$-12020 = 42739 - 54759$$

68. **ROW**

This is the balance of the ROW Expenditure in Scotland's Goods and Services (Cell 62) minus the ROW Income from Scotland's Goods and Services (Cell 55).

$$\text{Goods \& Services Trade Balance with ROW} =$$
$$\text{ROW Goods \& Services Expenditure in Scotland}^{\text{External}}_{\text{IncExp}}$$
$$-\text{ROW Goods \& Services Income from Scotland}^{\text{External}}_{\text{IncExp}} \tag{2.6.72}$$

$$181 = 19178 - 18997$$

Total Balance of Payments

69. **RUK**

The External Account's RUK Expenditure in Scotland (Cell 58) and the Tourist Expenditure in Scotland (Cell 64) are added together. The resulting figure is then multiplied by the share attributed to RUK versus ROW tourists from the International Passenger Survey (ONS, 2010a) and subtracted by RUK Income from Scotland (Cell 51).

$$\begin{aligned} \text{Total Balance of Payments RUK} = \\ \text{RUK Expenditure in Scotland}^{\text{External}}_{\text{IncExp}} \\ +(\text{RUK Share of Tourist Expenditure in Scotland} \\ *\text{Tourist Expenditure in Scotland}^{\text{External}}_{\text{IncExp}}) \\ -\text{RUK Income from Scotland}^{\text{External}}_{\text{IncExp}} \end{aligned} \tag{2.6.73}$$

$$5217 = 70597 + (0.6 * 2921) - 67133$$

70. **ROW**

The External Account's ROW Expenditure in Scotland (Cell 61) and the Tourist Expenditure in Scotland (Cell 64) are summed together. This is then multiplied by the share attributed to ROW versus RUK tourists from the International Passenger Survey (ONS, 2010a) and subtracted by ROW Income from Scotland (Cell 54).

$$\begin{aligned}
\text{Total Balance of Payments ROW} = \\
\text{ROW Expenditure in Scotland}^{\text{External}}_{\text{IncExp}} \\
+(\text{ROW Share of Tourist Expenditure in Scotland} \\
*\text{Tourist Expenditure in Scotland}^{\text{External}}_{\text{IncExp}}) \\
-\text{ROW Income from Scotland}^{\text{External}}_{\text{IncExp}}
\end{aligned} \tag{2.6.74}$$

$$4871 = 27378 + (0.4 * 2921) - 23676$$

71. **Total BOP**

Totals Figure: This is the sum of the two cells above (Cells 69 & 70).

$$\begin{aligned}
\text{Total Balance of Payments} = \\
\text{RUK Total Balance of Payments} + \text{ROW Total Balance of Payments}
\end{aligned} \tag{2.6.75}$$

$$10087 = 5217 + 4871$$

External Balance

72. **RUK Total Flows Balance**

This is the balance of UK Income from Scotland (Cell 51) minus UK expenditure in Scotland (Cell 58).

$$\text{RUK Total Flows Balance} = \tag{2.6.76}$$
$$\text{RUK Income from Scotland} - \text{RUK Expenditure in Scotland}$$

$$-3464 = 67133 - 70597$$

73. **ROW Total Flows Balance**

This is the balance of ROW income from Scotland (Cell 54) minus ROW expenditure in Scotland (Cell 61).

$$\text{ROW Total Flows Balance} = \tag{2.6.77}$$
$$\text{ROW Income from Scotland} - \text{ROW Expenditure in Scotland}$$

$$-3703 = 23676 - 27378$$

74. **Tourist Balance**

Corresponding figure: The External Account's Tourist Expenditure in Scotland (Cell 64).

$$\text{Tourist Balance} = \qquad (2.6.78)$$

$$-\text{Tourist Expenditure in Scotland}^{\text{External}}_{\text{IncExp}}$$

$$-2921 = -2921$$

75. **RUK/ROW Surplus/(Deficit), Lending/(Borrowing) with Scotland**

Totals Figure: This is the sum of the three cells above (Cells 72 to 74).

$$\text{RUK/ROW Total External Balance} =$$

$$\begin{aligned} &\text{RUK Total Flows Balance}^{\text{External Balance}}_{\text{IncExp}} \\ &+\text{ROW Total Flows Balance}^{\text{External Balance}}_{\text{IncExp}} \\ &+\text{Tourist Balance}^{\text{External Balance}}_{\text{IncExp}} \end{aligned} \qquad (2.6.79)$$

$$-10087 = (-3462) + (-3703) + (-2921)$$

Shares

76. **Scottish GDP Share**

    This is the Scottish GDP share over Total UK GDP (Scottish Government, 2013a; ONS, 2013b).

$$\begin{aligned} \text{Scottish GDP Share} = \\ \text{Scottish GDP at market prices} \\ \div \text{UK GDP at market prices} \end{aligned} \tag{2.6.80}$$

$$8.22\% = 115167/1401863$$

77. **Scottish Population Share**

    This is the Scottish population share over Total UK population (ONS, 2010b).

$$\begin{aligned} \text{Scottish Population Share} = \\ \text{Population Estimate Scotland} \\ \div \text{Population Estimate UK} \end{aligned} \tag{2.6.81}$$

$$8.41\% = 5194/61792$$

78. **Scottish Household Share**

This is the share of Scottish Households and Dwellings over Households in the whole UK (ONS, 2012).

$$
\begin{aligned}
&\text{Scottish Household Share} = \\
&(\text{Households and Dwellings Estimate for Scotland}_{2001} * 3/11) \\
&+(\text{Households and Dwellings Estimate for Scotland}_{2011} * 8/11) \\
&\div(\text{Households Estimate for the UK}_{2001} * 3/11) \\
&+(\text{Households Estimate for the UK}_{2011} * 8/11)
\end{aligned}
\tag{2.6.82}
$$

$$9\% = (2.2 * 3/11 + 2.4 * 8/11) \div (24.5 * 3/11 + 26.3 * 8/11)$$

79. **Scottish Share of Total UK OVA**

This is the Scottish OVA taken from the IO Tables (Scottish Government, 2013a) over the UK OVA (ONS, 2013b).

$$
\begin{aligned}
&\text{Scottish Share of Total UK OVA} = \\
&\text{Scottish OVA} \div \text{UK OVA}
\end{aligned}
\tag{2.6.83}
$$

$$8.31\% = 38441/462590$$

80. **Scottish Share of Total Household OVA**

This is the share of Scottish Households' OVA over the sum of Household OVA (Cell 3) and Corporate OVA (Cell 19) (ONS, 2011c; Scottish Government, 2013e).

$$\begin{aligned}\text{Scottish Share of Total Household OVA} =& \\ &\text{Scottish Household OVA} \\ \div(\text{Scottish Household OVA} + \text{Scottish Corporate OVA})&\end{aligned} \tag{2.6.84}$$

$$15\% = 5289/(5289 + 29456)$$

81. **Scottish Share of Total Corporate OVA**

This is the share of Scottish Corporations' OVA over the sum of Household OVA (Cell 3) and Corporate OVA (Cell 19) (ONS, 2011c; Scottish Government, 2013e).

$$\begin{aligned}\text{Scottish Share of Total Corporate OVA} =& \\ &\text{Scottish Corporate OVA} \\ \div(\text{Scottish Household OVA} + \text{Scottish Corporate OVA})&\end{aligned} \tag{2.6.85}$$

$$85\% = 29456/(5289 + 29456)$$

82. **Scottish Share of UK Property and Entrepreneurial Income**

This figure is calculated by multiplying the share of Scottish over UK OVA (Scottish Government, 2013c; ONS, 2013b) with the UK Property and Entrepreneurial Income (ONS, 2013b).

$$\text{Scottish Share of UK Property and Entrepreneurial Income} = (\text{Scottish OVA}/\text{UK OVA}) * \text{UK Property and Entrepreneurial Income} \tag{2.6.86}$$

$$14070 = (38441/462590) * 169313$$

9.4 Appendix 3

Table 9.4.2: Non-Identifiable Spending Scotland

GERS Shares - Public Admin	
Scottish Total	3,434
UK Total	7,193
Total	10,627
Local Share	22.6%
Central Share	77.4%
Scottish Share	25.0%
UK Share	52.4%
Scottish UK Ratio	0.32
UK Scottish Ratio	0.68
GERS Shares - Health	
Scottish Total	10,441
UK Total	131
Total	10,572
Local Share	0.0%
Central Share	100.0%
Scottish Share	98.8%
UK Share	1.2%
Scottish UK Ratio	0.99
UK Scottish Ratio	0.01
GERS Shares - Recreation, culture and religion	
Scottish Total	1,043
UK Total	413
Total	1,456
Local Share	93.4%
Central Share	6.6%
Scottish Share	4.8%
UK Share	1.9%
Scottish UK Ratio	0.72
UK Scottish Ratio	0.28
GERS Shares - Education	
Scottish Total	7,680
UK Total	28
Total	7,708

Continued on next page

Non-Identifiable Spending Scotland – continued from previous page	
Local Share	84.0%
Central Share	16.0%
Scottish Share	16.0%
UK Share	0.1%
Scottish UK Ratio	1.00
UK Scottish Ratio	0.00
GERS Shares - Social Protection	
Scottish Total	4,769
UK Total	15,039
Total	19,808
Scottish Share	0.24
UK Share	0.76
Identifable Expenditure	
Scottish Government	20,251
Share UK Gov of Total Indentifiable	29.7%
Share Scottish Gov of Total Indentifiable	38.3%
Share Local Gov of Total Indentifiable	32.1%
Scottish UK Ratio	0.56
UK Scottish Ratio	0.44

Table 9.4.1: Income-Expenditure Accounts for Scotland (in £million)

HOUSEHOLDS			
1. **Total Income**	**107,877**	10. **Total Expenditure**	**107,877**
2. Income from Employment	63,561	11. IO Expenditure	74,669
3. Profit Income (OVA)	5,289	12. Payments to Corporations	7,031
4. Income from Corporations	15,103	13. Payments to UK Taxes	18,788
5. Income from UK Government	13,519	14. Payments to Scottish Taxes	-
6. Income from Scottish Government	-	15. Payments to Local Taxes	1,961
7. Income from Local Government	6,316	16. Transfers to RUK	238
8. Transfers from RUK	1,853	17. Transfers to ROW	119
9. Transfers from ROW	2,237	18. Payments to Capital	5,070
CORPORATIONS			
19. **Total Income**	**53,507**	27. **Total Expenditure**	**53,507**
20. Profit Income (OVA)	29,456	28. Payments to Households	15,103
21. Income from Households	7,031	29. Payments to UK Taxes	3,269
22. Income from UK Government	2,660	30. Payments to Scottish Taxes	-
23. Income from Scottish Government	3,062	31. Payments to Local Taxes	1,801
24. Income from Local Government	-	32. Transfers to RUK	3,768
25. Income from RUK	7,798	33. Transfers to ROW	4,560
26. Income from ROW	3,499	34. Payments to Capital	25,007
UK GOVERNMENT			
35. **Total Income**	**55,862**	41. **Total Expenditure**	**55,862**
36. Profit income (OVA)	529	42. IO Expenditure	5,924
37. UK Taxes	35,221	43. Payments to Corporations	2,660
		44. Payments to Households	13,519
		45. Transfers to RUK	6,626
38. Transfers from Scottish Government	-	46. Transfers to ROW	1,741
39. Transfers from Local Government	-	47. Transfers to Scottish Government	25,303
40. Income from RUK	20,112	48. Transfers to Local Government	-
		49. Payments to Capital 89	
SCOTTISH GOVERNMENT			
50. **Total Income**	**27,082**	56. **Total Expenditure**	**27,082**
51. Profit income (OVA)	1,780	57. IO Expenditure	13,371
52. Scottish Taxes	-	58. Payments to Corporations	3,062
		59. Payments to Households	-
		60. Transfers to RUK	-
53. Transfers from UK Government	25,303	61. Transfers to ROW	-
54. Transfers from Local Government	-	62. Transfers to UK Government	-
55. Income from RUK	-	63. Transfers to Local Government	10,644
		64. Payments to Capital	5
LOCAL GOVERNMENT			
65. **Total Income**	**16,531**	71. **Total Expenditure**	**16,531**
66. Profit income (OVA)	1,388	72. IO Expenditure	10,190
67. Local Taxes	3,761	73. Payments to Corporations	-
		74. Payments to Households	6,316
		75. Transfers to RUK	-
68. Transfers from UK Government	-	76. Transfers to ROW	-
69. Transfers from Scottish Government	10,644	77. Transfers to UK Government	-
70. Income from RUK	738	78. Transfers to Scottish Government	-
		79. Payments to Capital	25

Table 9.4.3: Non-Identifiable Spending Scotland

	RUK	ROW	Total
General public services			
Public and common services	438		438
International services		637	637
Public sector debt interest	1842	789	2631
Defence	2830	314	3144
Public order and safety	183		183
Economic affairs			
Enterprise and economic development	519		519
Science and technology	47		47
Employment policies	2		2
Agriculture, forestry and fisheries	0		0
Transport	27		27
Environment protection	144		144
Housing and community amenities	0		0
Health	83		83
Recreation, culture and religion	333		333
Education and training	3		3
Social protection	290		290
Accounting adjustments	-112		-112
Total	6626	1741	8367

9.5 Appendix 4

Table 9.5.1: K Matrix, Household Consumption by Spending Category and HH Type, Source: LCFS (in £million)

	HH1	HH2	HH3	HH4	HH5	HH6	HH7	Total
Food & non-alcoholic drinks:	1.84	1.61	1.16	0.21	0.21	0.89	0.35	6.27
Alcoholic drink, tobacco & narcotics	0.55	0.32	0.24	0.06	0.05	0.23	0.08	1.54
Clothing & footwear	0.94	0.66	0.32	0.05	0.03	0.43	0.24	2.67
Housing, fuel & power	2.17	1.37	1.27	0.15	0.19	0.86	0.22	6.24
Household goods & services	1.11	1.13	0.58	0.07	0.07	0.34	0.10	3.41
Health	0.19	0.09	0.09	0.00	0.01	0.10	0.01	0.50
Transport	3.16	2.02	0.93	0.05	0.09	1.18	0.35	7.77
Communication	0.48	0.35	0.24	0.04	0.04	0.20	0.08	1.41
Recreation and Culture	2.78	1.84	1.18	0.14	0.14	0.85	0.30	7.23
Education	0.19	0.25	0.03	0.01	0.00	0.12	0.05	0.65
Restaurants and Hotels	1.79	1.13	0.54	0.07	0.06	0.69	0.23	4.50
Other Goods and Services	1.25	1.34	0.62	0.05	0.07	0.57	0.18	4.08
Total	16.47	12.12	7.20	0.90	0.95	6.45	2.18	

Table 9.5.2: A_1 Matrix, HHFCE 42 Products to LCFS 12 Spending Categories

	1. Food & non-alcoholic drinks	2. Alcoholic drink, tobacco & narcortics	3. Clothing & footwear	4. Housing, fuel & power	5. Household goods & services	6. Health	7. Transport	8. Communication	9. Recreation and Culture	10. Education	11. Restaurants and Hotels	12. Other goods & services
1. Food	1	-	-	-	-	-	-	-	-	-	-	-
2. Non-alcoholic beverages	1	-	-	-	-	-	-	-	-	-	-	-
3. Alcoholic beverages	-	1	-	-	-	-	-	-	-	-	-	-
4. Tobacco	-	1	-	-	-	-	-	-	-	-	-	-
5. Narcotics	-	1	-	-	-	-	-	-	-	-	-	-
6. Clothing	-	-	1	-	-	-	-	-	-	-	-	-
7. Footwear	-	-	1	-	-	-	-	-	-	-	-	-
8. Actual rentals for households	-	-	-	1	-	-	-	-	-	-	-	-
9. Imputed rentals for households	-	-	-	1	-	-	-	-	-	-	-	-
10. Maintenance and repair of the dwelling	-	-	-	1	-	-	-	-	-	-	-	-
11. Water supply and miscell. dwelling services	-	-	-	1	-	-	-	-	-	-	-	-
12. Electricity, gas and other fuels	-	-	-	1	-	-	-	-	-	-	-	-
13. Furniture, furnishings, carpets etc	-	-	-	-	1	-	-	-	-	-	-	-
14. Household textiles	-	-	-	-	1	-	-	-	-	-	-	-
15. Household appliances	-	-	-	-	1	-	-	-	-	-	-	-
16. Glassware, tableware and household utensils	-	-	-	-	1	-	-	-	-	-	-	-
17. Tools and equipment for house and garden	-	-	-	-	1	-	-	-	-	-	-	-
18. Goods and services for routine household maint.	-	-	-	-	1	-	-	-	-	-	-	-
19. Medical products, appliances and equipment	-	-	-	-	-	1	-	-	-	-	-	-
20. Out-patient services	-	-	-	-	-	1	-	-	-	-	-	-
21. Hospital services	-	-	-	-	-	1	-	-	-	-	-	-
22. Purchase of vehicles	-	-	-	-	-	-	1	-	-	-	-	-
23. Operation of personal transport equipment	-	-	-	-	-	-	1	-	-	-	-	-
24. Transport services	-	-	-	-	-	-	1	-	-	-	-	-
25. Postal services	-	-	-	-	-	-	-	1	-	-	-	-
26. Telephone and telefax equipment	-	-	-	-	-	-	-	1	-	-	-	-
27. Telephone and telefax services	-	-	-	-	-	-	-	1	-	-	-	-
28. Audio-visual, photog. and info processing equip.	-	-	-	-	-	-	-	-	1	-	-	-
29. Other major durables for recreation and culture	-	-	-	-	-	-	-	-	1	-	-	-
30. Other recr. items and equip.t, gardens and pets	-	-	-	-	-	-	-	-	1	-	-	-
31. Recreational and cultural services	-	-	-	-	-	-	-	-	1	-	-	-
32. Newspapers, books and stationery	-	-	-	-	-	-	-	-	1	-	-	-
33. Package holidays	-	-	-	-	-	-	-	-	1	-	-	-
34. Education	-	-	-	-	-	-	-	-	-	1	-	-
35. Restaurants and hotels	-	-	-	-	-	-	-	-	-	-	1	-
36. Personal care	-	-	-	-	-	-	-	-	-	-	-	1
37. Prostitution	-	-	-	-	-	-	-	-	-	-	-	1
38. Personal effects n.e.c	-	-	-	-	-	-	-	-	-	-	-	1
39. Social protection	-	-	-	-	-	-	-	-	-	-	-	1
40. Insurance	-	-	-	-	-	-	-	-	-	-	-	1
41. Financial services n.e.c.	-	-	-	-	-	-	-	-	-	-	-	1
42. Other services n.e.c.	-	-	-	-	-	-	-	-	-	-	-	1

Table 9.5.3: L_A-Matrix, Aggregated HHFCE Product-by-Spending Category (in £million)

	1. Food & non-alcoholic drinks	2. Alcohol. drink, tobac. & narcot.	3. Clothing & footwear	4. Housing, fuel & power	5. Household goods & services	6. Health	7. Transport	8. Communication	9. Recreation and Culture	10. Education	11. Restaurants and Hotels	12. Other Goods and Services	Total
1. Prod. of agriculture, hunting and related services	7,274	-	-	-	-	-	-	-	2,050	-	-	-	9,324
2. Prod. of forestry, logging and related services	-	-	-	24	-	-	-	-	138	-	-	-	162
3. Fish and other fishing and aquaculture prod.; others	142	-	-	-	-	-	-	-	-	-	-	-	142
5. Coal and lignite	-	-	-	566	-	-	-	-	-	-	-	-	566
6. & 7. Extraction Of Crude Petrol, Nat. Gas & Metal Ores	-	-	-	-	-	-	-	-	-	-	-	-	-
8. Other mining and quarrying prod.	-	-	-	-	-	-	-	-	24	-	-	11	35
9. Mining support services	-	-	-	-	-	-	-	-	-	-	-	-	-
10.1 Preserved meat and meat prod.	11,739	-	-	-	-	-	-	-	-	-	-	-	11,739
10.2-3 Processed and preserved fish, fruit and vegetables	7,507	-	-	-	-	-	-	-	-	-	-	-	7,507
10.4 Vegetable and animal oils and fats	757	-	-	-	-	-	-	-	-	-	-	-	757
10.5 Dairy products	7,392	-	-	-	-	-	-	-	-	-	-	-	7,392
10.6 Grain mill products, starches and starch prod.	1,743	-	-	-	-	-	-	-	-	-	-	-	1,743
10.7 Bakery and farinaceous products	4,545	-	-	-	-	-	-	-	-	-	-	-	4,545
10.8 Other food products	9,049	-	-	-	-	-	-	-	-	-	-	-	9,049
10.9 Prepared animal feeds	-	-	-	-	-	-	-	-	1,887	-	-	-	1,887
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮						
80. Security and investigation services	-	-	-	-	-	-	-	-	-	-	-	50	50
81. Services to buildings and landscape	-	-	-	-	12	-	-	-	-	-	-	-	12
82. Office administrative, support and others	-	-	-	-	19	-	-	-	-	-	-	317	336
84. Public admin, defence services; social security	-	-	-	293	-	352	524	-	-	-	-	425	1,594
85. Education services	-	-	-	-	-	-	-	-	-	6,750	-	46	6,796
86. Human health services	-	-	-	-	-	3,505	-	-	-	-	-	2,792	6,297
87. & 88. Residential Care & Social Work Activities	-	-	-	-	-	-	-	-	-	-	-	5,649	5,649
90. Creative, arts and entertainment services	-	-	-	-	-	-	-	-	2,420	-	-	-	2,420
91. Libraries, museums and others	-	-	-	-	-	-	-	-	1,421	-	-	-	1,421
92. Gambling and betting services	-	-	-	-	-	-	-	-	5,897	-	-	-	5,897
93. Sports, amusement and recreation services	-	-	-	-	-	-	-	-	4,241	-	-	-	4,241
94. Services furnished by membership organisations	-	-	-	-	-	-	860	-	-	-	-	1170	2,030
95. Repair of computers and personal and hh goods	-	-	133	-	539	-	-	-	214	-	-	378	1,264
96. Other personal services	-	-	429	-	12	-	-	-	-	-	-	9,571	10,012
97. Services of hh as employers of dom. personnel	-	-	-	-	3,391	-	-	-	-	-	-	-	3,391
Total	53,515	28,674	29,930	95,450	30,915	7,882	76,698	10,161	60,232	6,750	55,406	75,304	

Table 9.5.4: M-Matrix, Transformed HHFCE, Industry-by-Spending Category (in £million)

	1. Food & non-alcoholic drinks	2. Alcohol. drink, tobac. & narcot.	3. Clothing & footwear	4. Housing, fuel & power	5. Household goods & services	6. Health	7. Transport	8. Communication	9. Recreation and Culture	10. Education	11. Restaurants and Hotels	12. Other Goods and Services	Total
1. Agriculture	7,274	-	-	-	-	-	-	-	2,050	-	-	-	9,324
2. Forestry planting	22	-	-	-	-	-	-	-	-	-	-	-	22
3. Forestry harvesting	-	-	-	24	-	-	-	-	138	-	-	-	162
4. Fishing	55	-	-	-	-	-	-	-	-	-	-	-	55
5. Aquaculture	65	-	-	-	-	-	-	-	-	-	-	-	65
6. Coal & lignite	-	-	-	566	-	-	-	-	-	-	-	-	566
7. Oil & gas extract., metals	-	-	-	-	-	-	-	-	-	-	-	-	-
8. Other mining	-	-	-	-	-	-	-	-	24	-	-	11	35
9. Mining Support	-	-	-	-	-	-	-	-	-	-	-	-	-
10. Meat processing	11,739	-	-	-	-	-	-	-	-	-	-	-	11,739
11. Fish & fruit processing	7,507	-	-	-	-	-	-	-	-	-	-	-	7,507
12. Dairy prod., oils & fats proc.	8,149	-	-	-	-	-	-	-	-	-	-	-	8,149
13. Grain milling & starch	1,743	-	-	-	-	-	-	-	-	-	-	-	1,743
14. Bakery & farinaceous	4,545	-	-	-	-	-	-	-	-	-	-	-	4,545
15. Other food	9,049	-	-	-	-	-	-	-	-	-	-	-	9,049
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮						
90. Building & landsc. services	-	-	-	-	12	-	-	-	-	-	-	-	12
91. Business support services	-	-	-	-	19	-	-	-	-	-	-	317	336
92. Public admin. & defence	-	-	-	293	-	352	524	-	-	-	-	425	1,594
93. Education	-	-	-	-	-	-	-	-	-	6,750	-	46	6,796
94. Health	-	-	-	-	-	3,505	-	-	-	-	-	2,792	6,297
95. Residential care	-	-	-	-	-	-	-	-	-	-	-	2,694	2,694
96. Social work	-	-	-	-	-	-	-	-	-	-	-	2,955	2,955
97. Creative services	-	-	-	-	-	-	-	-	2,420	-	-	-	2,420
98. Cultural services	-	-	-	-	-	-	-	-	1,421	-	-	-	1,421
99. Gambling	-	-	-	-	-	-	-	-	5,897	-	-	-	5,897
100. Sports & recreation	-	-	-	-	-	-	-	-	4,241	-	-	-	4,241
101. Membership organisations	-	-	-	-	-	-	860	-	-	-	-	1,170	2,030
102. Repairs - personal and hh	-	-	133	-	539	-	-	-	214	-	-	378	1,264
103. Other personal services	-	-	429	-	12	-	-	-	-	-	-	9,571	10,012
104. Households as employers	-	-	-	-	3,391	-	-	-	-	-	-	-	3,391
Total	53,515	28,674	29,930	95,450	30,915	7,882	76,698	10,161	60,232	6,750	55,406	75,304	

Table 9.5.5: B Matrix ‘Bridge’-Matrix (in shares)

	1. Food & non-alcoholic drinks	2. Alcoholic drink, tobacco & narcotics	3. Clothing & footwear	4. Housing, fuel & power	5. Household goods & services	6. Health	7. Transport	8. Communication	9. Recreation and Culture	10. Education	11. Restaurants and Hotels	12. Other Goods and Services
1. Agriculture	0.14	-	-	-	-	-	-	-	0.03	-	-	-
2. Forestry planting	-	-	-	-	-	-	-	-	-	-	-	-
3. Forestry harvesting	-	-	-	-	-	-	-	-	-	-	-	-
4. Fishing	-	-	-	-	-	-	-	-	-	-	-	-
5. Aquaculture	-	-	-	-	-	-	-	-	-	-	-	-
6. Coal & lignite	-	-	-	0.01	-	-	-	-	-	-	-	-
7. Oil & gas extraction, metal ores	-	-	-	-	-	-	-	-	-	-	-	-
8. Other mining	-	-	-	-	-	-	-	-	-	-	-	-
9. Mining Support	-	-	-	-	-	-	-	-	-	-	-	-
10. Meat processing	0.22	-	-	-	-	-	-	-	-	-	-	-
11. Fish & fruit processing	0.14	-	-	-	-	-	-	-	-	-	-	-
12. Dairy products, oils & fats processing	0.15	-	-	-	-	-	-	-	-	-	-	-
13. Grain milling & starch	0.03	-	-	-	-	-	-	-	-	-	-	-
14. Bakery & farinaceous	0.08	-	-	-	-	-	-	-	-	-	-	-
15. Other food	0.17	-	-	-	-	-	-	-	-	-	-	-
16. Animal feeds	-	-	-	-	-	-	-	-	0.03	-	-	-
17. Spirits & wines	-	0.29	-	-	-	-	-	-	-	-	-	-
18. Beer & malt	-	0.02	-	-	-	-	-	-	-	-	-	-
19. Soft Drinks	0.06	-	-	-	-	-	-	-	-	-	-	-
20. Tobacco	-	0.44	-	-	-	-	-	-	-	-	-	-
21. Textiles	-	-	0.04	-	0.21	-	-	-	0.01	-	-	-
22. Wearing apparel	-	-	0.78	-	-	-	-	-	-	-	-	-
23. Leather goods	-	-	0.15	-	-	-	-	-	0.01	-	-	-
24. Wood and wood products	-	-	-	-	-	-	-	-	-	-	-	-
25. Paper & paper products	-	-	-	-	-	-	-	-	0.01	-	-	0.03
26. Printing and recording	-	-	-	-	-	-	-	-	0.02	-	-	-
27. Coke, petroleum & petrochemicals	-	-	-	0.01	-	-	0.20	-	-	-	-	-
28. Paints, varnishes and inks etc	-	-	-	-	-	-	-	-	-	-	-	-
29. Cleaning & toilet preparations	-	-	-	-	0.08	-	-	-	-	-	-	0.09
30. Other chemicals	-	-	-	-	-	-	-	-	0.01	-	-	-
31. Inorganic chemicals, dyestuffs & agrochemicals	-	-	-	-	-	-	-	-	0.01	-	-	-
32. Pharmaceuticals	-	0.26	-	-	-	0.26	-	-	-	-	-	-
33. Rubber & Plastic	-	-	-	-	0.03	0.03	0.01	-	0.01	-	-	-
34. Cement lime & plaster	-	-	-	-	-	-	-	-	-	-	-	-
35. Glass, clay & stone etc	-	-	-	-	0.06	-	-	-	-	-	-	-
36. Iron & Steel	-	-	-	-	-	-	-	-	-	-	-	-
37. Other metals & casting	-	-	-	-	-	-	-	-	-	-	-	-
38. Fabricated metal	-	-	-	-	0.06	-	-	-	-	-	-	-
39. Computers, electronics & opticals	-	-	-	-	-	0.06	-	0.05	0.16	-	-	-
40. Electrical equipment	-	-	-	-	0.15	-	-	-	0.02	-	-	0.01
41. Machinery & equipment	-	-	-	-	0.01	-	-	-	0.02	-	-	-
42. Motor Vehicles	-	-	-	-	-	-	0.31	-	0.01	-	-	-
43. Other transport equipment	-	-	-	-	-	0.02	0.02	-	0.04	-	-	-
44. Furniture	-	-	-	-	0.22	-	-	-	-	-	-	-
45. Other manufacturing	-	-	0.01	-	0.04	0.14	-	-	0.09	-	-	0.05

Continued on next page

B-**Matrix (in shares) – continued from previous page**

	1. Food & non-alcoholic drinks	2. Alcoholic drink, tobacco & narcotics	3. Clothing & footwear	4. Housing, fuel & power	5. Household goods & services	6. Health	7. Transport	8. Communication	9. Recreation and Culture	10. Education	11. Restaurants and Hotels	12. Other Goods and Services
46. Repair & maintenance	-	-	-	-	-	-	-	-	-	-	-	-
47. Electricity	-	-	-	0.08	-	-	-	-	-	-	-	-
48. Gas etc	-	-	-	0.06	-	-	-	-	-	-	-	-
49. Water and sewerage	-	-	-	0.02	-	-	-	-	-	-	-	-
50. Waste	-	-	-	0.03	-	-	-	-	-	-	-	-
51. Remediation & waste management	-	-	-	-	-	-	-	-	-	-	-	-
52. Construction - buildings	-	-	-	-	-	-	-	-	-	-	-	-
53. Construction - civil engineering	-	-	-	-	-	-	-	-	-	-	-	-
54. Construction - specialised	-	-	-	-	-	-	-	-	-	-	-	-
55. Wholesale & Retail - vehicles	-	-	-	-	-	-	0.12	-	-	-	-	-
56. Wholesale - excl vehicles	-	-	-	-	-	-	-	-	-	-	-	-
57. Retail - excl vehicles	-	-	-	-	-	-	-	-	-	-	-	-
58. Rail transport	-	-	-	-	-	-	0.03	-	-	-	-	-
59. Other land transport	-	-	-	-	-	-	0.08	-	-	-	-	-
60. Water transport	-	-	-	-	-	-	0.02	-	-	-	-	-
61. Air transport	-	-	-	-	-	-	0.09	-	-	-	-	-
62. Support services for transport	-	-	-	-	-	-	0.01	-	-	-	-	-
63. Post & courier	-	-	-	-	-	-	-	0.10	-	-	-	-
64. Accommodation	-	-	-	-	-	-	-	-	-	-	0.20	-
65. Food & beverage services	-	-	-	-	-	-	-	-	-	-	0.80	-
66. Publishing services	-	-	-	-	-	-	-	-	0.15	-	-	-
67. Film video & TV etc	-	-	-	-	-	-	-	-	0.04	-	-	-
68. Broadcasting	-	-	-	-	-	-	-	-	0.03	-	-	-
69. Telecommunications	-	-	-	-	-	-	-	0.86	-	-	-	-
70. Computer services	-	-	-	-	-	-	-	-	-	-	-	-
71. Information services	-	-	-	-	-	-	-	-	-	-	-	-
72. Financial services	-	-	-	-	-	-	-	-	-	-	-	0.25
73. Insurance & pensions	-	-	-	-	-	-	-	-	-	-	-	0.25
74. Auxiliary financial services	-	-	-	-	-	-	-	-	-	-	-	0.02
75. Real estate - own	-	-	-	0.77	-	-	-	-	-	-	-	-
76. Imputed rent	-	-	-	-	-	-	-	-	-	-	-	-
77. Real estate - fee or contract	-	-	-	-	-	-	-	-	-	-	-	-
78. Legal activities	-	-	-	-	-	-	-	-	-	-	-	-
79. Accounting & tax services	-	-	-	-	-	-	-	-	-	-	-	-
80. Head office & consulting services	-	-	-	-	-	-	-	-	-	-	-	-
81. Architectural services etc	-	-	-	-	-	-	-	-	-	-	-	-
82. Research & development	-	-	-	-	-	-	-	-	-	-	-	-
83. Advertising & market research	-	-	-	-	-	-	-	-	-	-	-	-
84. Other professional services	-	-	-	-	-	-	-	-	0.01	-	-	-
85. Veterinary services	-	-	-	-	-	-	-	-	0.02	-	-	-
86. Rental and leasing services	-	-	-	-	-	-	0.08	-	0.02	-	-	-
87. Employment services	-	-	-	-	-	-	-	-	-	-	-	-
88. Travel & related services	-	-	-	-	-	-	-	-	-	-	-	-
89. Security & investigation	-	-	-	-	-	-	-	-	-	-	-	-
90. Building & landscape services	-	-	-	-	-	-	-	-	-	-	-	-
91. Business support services	-	-	-	-	-	-	-	-	-	-	-	-
92. Public administration & defence	-	-	-	-	-	0.04	0.01	-	-	-	-	0.01

Continued on next page

B**-Matrix (in shares) – continued from previous page**

	1. Food & non-alcoholic drinks	2. Alcoholic drink, tobacco & narcotics	3. Clothing & footwear	4. Housing, fuel & power	5. Household goods & services	6. Health	7. Transport	8. Communication	9. Recreation and Culture	10. Education	11. Restaurants and Hotels	12. Other Goods and Services
93. Education	-	-	-	-	-	-	-	-	-	1.00	-	-
94. Health	-	-	-	-	-	0.44	-	-	-	-	-	0.04
95. Residential care	-	-	-	-	-	-	-	-	-	-	-	0.04
96. Social work	-	-	-	-	-	-	-	-	-	-	-	0.04
97. Creative services	-	-	-	-	-	-	-	-	0.04	-	-	-
98. Cultural services	-	-	-	-	-	-	-	-	0.02	-	-	-
99. Gambling	-	-	-	-	-	-	-	-	0.10	-	-	-
100. Sports & recreation	-	-	-	-	-	-	-	-	0.07	-	-	-
101. Membership organisations	-	-	-	-	-	-	0.01	-	-	-	-	0.02
102. Repairs - personal and household	-	-	-	-	0.02	-	-	-	-	-	-	0.01
103. Other personal services	-	-	0.01	-	-	-	-	-	-	-	-	0.13
104. Households as employers	-	-	-	-	0.11	-	-	-	-	-	-	-
Total	1	1	1	1	1	1	1	1	1	1	1	1

Table 9.5.6: hh_T-Matrix, Total Household Consumption Expenditure by HH Type, UK level (in £m)

	HH1	HH2	HH3	HH4	HH5	HH6	HH7	Total
1. Agriculture	0.34	0.28	0.20	0.03	0.15	0.15	0.06	1.21
2. Forestry planting	-	-	-	-	-	-	-	-
3. Forestry harvesting	0.01	-	-	-	-	-	-	0.02
4. Fishing	-	-	-	-	-	-	-	0.01
5. Aquaculture	-	-	-	-	-	-	-	0.01
6. Coal & lignite	0.01	0.01	0.01	-	0.01	0.01	-	0.04
7. Oil & gas extraction, metal ores								
8. Other mining	-	-	-	-	-	-	-	-
9. Mining Support								
10. Meat processing	0.40	0.35	0.25	0.05	0.20	0.20	0.08	1.52
11. Fish & fruit processing	0.26	0.23	0.16	0.03	0.12	0.12	0.05	0.97
12. Dairy products, oils & fats processing	0.28	0.25	0.18	0.03	0.14	0.14	0.05	1.06
13. Grain milling & starch	0.06	0.05	0.04	0.01	0.03	0.03	0.01	0.23
14. Bakery & farinaceous	0.16	0.14	0.10	0.02	0.08	0.08	0.03	0.59
15. Other food	0.31	0.27	0.20	0.04	0.15	0.15	0.06	1.17
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	
90. Building & landscape services	-	-	-	-	-	-	-	-
91. Business support services	0.01	0.01	-	-	-	-	-	0.02
92. Public administration & defence	0.04	0.03	0.02	-	0.02	0.02	-	0.13
93. Education	0.19	0.25	0.03	0.01	0.12	0.12	0.05	0.77
94. Health	0.13	0.09	0.06	-	0.06	0.06	0.01	0.43
95. Residential care	0.04	0.05	0.02	-	0.02	0.02	0.01	0.16
96. Social work	0.05	0.05	0.02	-	0.02	0.02	0.01	0.18
97. Creative services	0.11	0.07	0.05	0.01	0.03	0.03	0.01	0.32
98. Cultural services	0.07	0.04	0.03	-	0.02	0.02	0.01	0.19
99. Gambling	0.27	0.18	0.12	0.01	0.08	0.08	0.03	0.78
100. Sports & recreation	0.20	0.13	0.08	0.01	0.06	0.06	0.02	0.56
101. Membership organisations	0.05	0.04	0.02	-	0.02	0.02	0.01	0.17
102. Repairs - personal and household	0.04	0.04	0.02	-	0.01	0.01	-	0.13
103. Other personal services	0.17	0.18	0.08	0.01	0.08	0.08	0.03	0.63
104. Households as employers	0.12	0.12	0.06	0.01	0.04	0.04	0.01	0.40
Total	16.47	12.12	7.20	0.90	6.45	6.45	2.18	51.77

Table 9.5.7: hh_F Matrix, Total Household Consumption Expenditure by HH Type (in shares)

	HH1	HH2	HH3	HH4	HH5	HH6	HH7
1. Agriculture	0.28	0.23	0.16	0.03	0.12	0.12	0.05
2. Forestry planting	0.26	0.23	0.17	0.03	0.13	0.13	0.05
3. Forestry harvesting	0.35	0.23	0.15	0.02	0.11	0.11	0.04
4. Fishing	0.26	0.23	0.17	0.03	0.13	0.13	0.05
5. Aquaculture	0.26	0.23	0.17	0.03	0.13	0.13	0.05
6. Coal & lignite	0.31	0.20	0.18	0.02	0.12	0.12	0.03
7. Oil & gas extraction, metal ores	0.31	0.24	0.14	0.02	0.12	0.12	0.04
8. Other mining	0.34	0.24	0.15	0.02	0.11	0.11	0.04
9. Mining Support	0.31	0.24	0.14	0.02	0.12	0.12	0.04
10. Meat processing	0.26	0.23	0.17	0.03	0.13	0.13	0.05
11. Fish & fruit processing	0.26	0.23	0.17	0.03	0.13	0.13	0.05
12. Dairy products, oils & fats processing	0.26	0.23	0.17	0.03	0.13	0.13	0.05
13. Grain milling & starch	0.26	0.23	0.17	0.03	0.13	0.13	0.05
14. Bakery & farinaceous	0.26	0.23	0.17	0.03	0.13	0.13	0.05
15. Other food	0.26	0.23	0.17	0.03	0.13	0.13	0.05
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
90. Building & landscape services	0.30	0.31	0.16	0.02	0.09	0.09	0.03
91. Business support services	0.27	0.29	0.14	0.01	0.12	0.12	0.04
92. Public administration & defence	0.33	0.22	0.13	0.01	0.14	0.14	0.03
93. Education	0.25	0.33	0.04	0.01	0.15	0.15	0.07
94. Health	0.31	0.21	0.15	0.01	0.15	0.15	0.02
95. Residential care	0.27	0.29	0.14	0.01	0.12	0.12	0.04
96. Social work	0.27	0.29	0.14	0.01	0.12	0.12	0.04
97. Creative services	0.35	0.23	0.15	0.02	0.11	0.11	0.04
98. Cultural services	0.35	0.23	0.15	0.02	0.11	0.11	0.04
99. Gambling	0.35	0.23	0.15	0.02	0.11	0.11	0.04
100. Sports & recreation	0.35	0.23	0.15	0.02	0.11	0.11	0.04
101. Membership organisations	0.32	0.26	0.12	0.01	0.13	0.13	0.04
102. Repairs - personal and household	0.31	0.28	0.15	0.02	0.11	0.11	0.04
103. Other personal services	0.27	0.29	0.13	0.01	0.13	0.13	0.04
104. Households as employers	0.30	0.31	0.16	0.02	0.09	0.09	0.03
Average	0.31	0.24	0.14	0.02	0.12	0.12	0.04

Table 9.5.8: HH Matrix, Disaggregated Household Account in the 2009 IxI Table for Scotland (in £million)

	HH1	HH2	HH3	HH4	HH5	HH6	HH7	Total
1. Agriculture	210	171	121	20	91	91	35	739
2. Forestry planting	1	1	-	-	-	-	-	2
3. Forestry harvesting	8	5	3	-	2	2	1	22
4. Fishing	2	2	1	-	1	1	-	8
5. Aquaculture	1	1	1	-	1	1	-	4
6. Coal & lignite	1	1	1	-	-	-	-	4
7. Oil & gas extraction, metal ores	-	-	-	-	-	-	-	-
8. Other mining	2	2	1	-	1	1	-	7
9. Mining Support	25	19	12	1	10	10	3	80
10. Meat processing	112	98	71	13	54	54	21	422
11. Fish & fruit processing	70	61	44	8	34	34	13	265
12. Dairy products, oils & fats processing	68	60	43	8	33	33	13	258
13. Grain milling & starch	5	5	3	1	3	3	1	20
14. Bakery & farinaceous	105	91	66	12	51	51	20	395
15. Other food	32	28	20	4	16	16	6	123
16. Animal feeds	9	6	4	-	3	3	1	25
17. Spirits & wines	72	42	31	7	30	30	10	222
18. Beer & malt	13	7	6	1	5	5	2	39
19. Soft Drinks	50	44	32	6	24	24	9	189
20. Tobacco	-	-	-	-	-	-	-	-
21. Textiles	47	45	23	3	16	16	5	155
22. Wearing apparel	50	35	17	3	23	23	13	163
23. Leather goods	9	6	3	-	4	4	2	28
24. Wood and wood products	23	17	11	1	8	8	3	70
25. Paper & paper products	4	4	2	-	2	2	1	14
26. Printing and recording	14	9	6	1	4	4	1	39
27. Coke, petroleum & petrochemicals	266	170	80	4	99	99	29	748
28. Paints, varnishes and inks etc	2	1	1	-	1	1	-	6
29. Cleaning & toilet preparations	9	9	4	-	3	3	1	30
30. Other chemicals	17	12	7	1	5	5	2	50
31. Inorganic chemicals, dyestuffs & agrochemicals	3	2	1	-	1	1	-	8
32. Pharmaceuticals	5	3	2	-	2	2	1	14
33. Rubber & Plastic	25	19	11	1	9	9	2	75
34. Cement lime & plaster	1	-	-	-	-	-	-	2
35. Glass, clay & stone etc	14	14	7	1	4	4	1	45
36. Iron & Steel	-	-	-	-	-	-	-	-
37. Other metals & casting	-	-	-	-	-	-	-	-
38. Fabricated metal	29	28	15	2	9	9	3	94
39. Computers, electronics & opticals	55	36	24	3	17	17	6	159
40. Electrical equipment	13	13	7	1	4	4	1	43
41. Machinery & equipment	15	11	7	1	4	4	2	43
42. Motor Vehicles	75	48	22	1	28	28	8	210
43. Other transport equipment	78	51	30	3	26	26	8	223
44. Furniture	45	45	23	3	14	14	4	147
45. Other manufacturing	87	65	39	4	30	30	10	265
46. Repair & maintenance	23	18	11	1	9	9	3	73
47. Electricity	640	404	373	45	253	253	64	2032
48. Gas etc	175	110	102	12	69	69	18	555
49. Water and sewerage	304	192	177	21	120	120	31	966
50. Waste	5	3	3	-	2	2	-	14
51. Remediation & waste management	-	-	-	-	-	-	-	-
52. Construction - buildings	7	4	4	-	3	3	1	21
53. Construction - civil engineering	12	8	7	1	5	5	1	38

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Disaggregated Household Account in the 2009 IxI Table for Scotland (in £million) – continued from previous page

	HH1	HH2	HH3	HH4	HH5	HH6	HH7	Total
54. Construction - specialised	109	69	64	8	43	43	11	346
55. Wholesale & Retail - vehicles	292	186	85	5	109	109	32	818
56. Wholesale - excl vehicles	802	617	370	45	310	310	101	2556
57. Retail - excl vehicles	2614	2009	1206	147	1011	1011	329	8326
58. Rail transport	160	102	47	3	60	60	18	449
59. Other land transport	206	131	60	3	77	77	23	577
60. Water transport	55	35	16	1	21	21	6	155
61. Air transport	193	123	57	3	72	72	21	541
62. Support services for transport	20	13	6	-	7	7	2	57
63. Post & courier	24	17	12	2	10	10	4	77
64. Accommodation	397	251	119	15	152	152	52	1139
65. Food & beverage services	1115	705	335	42	428	428	145	3198
66. Publishing services	78	51	33	4	24	24	9	222
67. Film video & TV etc	50	33	21	2	15	15	5	142
68. Broadcasting	29	19	13	1	9	9	3	84
69. Telecommunications	293	209	143	25	118	118	45	950
70. Computer services	9	7	4	1	3	3	1	29
71. Information services	1	1	-	-	-	-	-	3
72. Financial services	168	181	84	7	77	77	24	618
73. Insurance & pensions	601	648	299	26	276	276	85	2211
74. Auxiliary financial services	20	22	10	1	9	9	3	74
75. Real estate - own	820	518	477	57	324	324	83	2603
76. Imputed rent	1991	1530	919	112	770	770	250	6342
77. Real estate - fee or contract	1	2	1	-	1	1	-	5
78. Legal activities	5	6	3	-	2	2	1	19
79. Accounting & tax services	1	1	-	-	-	-	-	3
80. Head office & consulting services	2	2	1	-	1	1	-	7
81. Architectural services etc	14	9	4	-	5	5	2	40
82. Research & development	1	1	1	-	-	-	-	4
83. Advertising & market research	-	-	-	-	-	-	-	1
84. Other professional services	8	5	3	-	2	2	1	22
85. Veterinary services	64	43	27	3	20	20	7	184
86. Rental and leasing services	92	59	29	2	33	33	10	258
87. Employment services	4	4	2	-	2	2	1	13
88. Travel & related services	29	18	8	-	11	11	3	80
89. Security & investigation	1	1	-	-	-	-	-	3
90. Building & landscape services	2	2	1	-	1	1	-	6
91. Business support services	7	8	4	-	3	3	1	26
92. Public administration & defence	128	86	52	4	53	53	13	388
93. Education	607	796	106	19	377	377	160	2,442
94. Health	369	250	179	11	179	179	29	1,196
95. Residential care	207	223	103	9	95	95	29	763
96. Social work	191	206	95	8	88	88	27	702
97. Creative services	69	45	29	3	21	21	8	196
98. Cultural services	68	45	29	3	21	21	7	194
99. Gambling	167	110	71	8	51	51	18	478
100. Sports & recreation	229	151	97	12	70	70	25	653
101. Membership organisations	85	67	31	2	34	34	10	264
102. Repairs - personal and household	18	16	8	1	6	6	2	58
103. Other personal services	243	255	118	11	112	112	37	887
104. Households as employers	72	73	37	5	22	22	6	238
Total	15,567	11,986	6,897	810	6,267	6,267	2,007	49,802

Table 9.5.9: Estimated IncExp Accounts - Household type (in £million)

HOUSEHOLD 1					
1. **Income**	**29,499**		8. **Expenditure**	**29,499**	
2. Income from Employment	25,042	85%	9. IO Expenditure	23,359	79%
3. Profit Income (OVA)	170	1%	10. Payments to Corporations	1	0%
4. Income from Corporations	1,596	5%	11. Payments to Government	6,137	21%
5. Income from Government	1,162	4%	12. Transfers to RUK	1	0%
6. Transfers from RUK	693	2%	13. Transfers to ROW	1	0%
7. Transfers from ROW	836	3%	14. Payments to Capital	-	-%
HOUSEHOLD 2					
1. **Income**	**24,356**		8. **Expenditure**	**24,356**	
2. Income from Employment	19,762	81%	9. IO Expenditure	18,166	75%
3. Profit Income (OVA)	64	0%	10. Payments to Corporations	1	-%
4. Income from Corporations	575	2%	11. Payments to Government	6,188	25%
5. Income from Government	2,977	12%	12. Transfers to RUK	-	-%
6. Transfers from RUK	443	2%	13. Transfers to ROW	-	-%
7. Transfers from ROW	534	2%	14. Payments to Capital	-	-%
HOUSEHOLD 3					
1. **Income**	**10,074**		8. **Expenditure**	**10,074**	
2. Income from Employment	7	0%	9. IO Expenditure	9,852	98%
3. Profit Income (OVA)	72	1%	10. Payments to Corporations	-	-%
4. Income from Corporations	3,162	31%	11. Payments to Government	220	2%
5. Income from Government	6,595	65%	12. Transfers to RUK	1	0%
6. Transfers from RUK	108	1%	13. Transfers to ROW	-	-%
7. Transfers from ROW	130	1%	14. Payments to Capital	-	-%
HOUSEHOLD 4					
1. **Income**	**1,423**		8. **Expenditure**	**1,423**	
2. Income from Employment	890	63%	9. IO Expenditure	1,163	82%
3. Profit Income (OVA)	-	-%	10. Payments to Corporations	-	-%
4. Income from Corporations	16	1%	11. Payments to Government	260	18%
5. Income from Government	483	34%	12. Transfers to RUK	-	-%
6. Transfers from RUK	16	1%	13. Transfers to ROW	-	-%
7. Transfers from ROW	19	1%	14. Payments to Capital	-	-%
HOUSEHOLD 5					
1. **Income**	**10,968**		8. **Expenditure**	**10,968**	
2. Income from Employment	949	9%	9. IO Expenditure	9,436	86%
3. Profit Income (OVA)	171	2%	10. Payments to Corporations	-	-%
4. Income from Corporations	3,730	34%	11. Payments to Government	1,532	14%
5. Income from Government	5,517	50%	12. Transfers to RUK	-	-%
6. Transfers from RUK	272	2%	13. Transfers to ROW	-	-%
7. Transfers from ROW	329	3%	14. Payments to Capital	-	-%
HOUSEHOLD 6					
1. **Income**	**12,508**		8. **Expenditure**	**12,508**	
2. Income from Employment	9,663	77%	9. IO Expenditure	9,640	77%
3. Profit Income (OVA)	43	0%	10. Payments to Corporations	-	-%
4. Income from Corporations	693	6%	11. Payments to Government	2,867	23%
5. Income from Government	1,593	13%	12. Transfers to RUK	-	-%
6. Transfers from RUK	234	2%	13. Transfers to ROW	-	-%
7. Transfers from ROW	282	2%	14. Payments to Capital	-	-%
HOUSEHOLD 7					
1. **Income**	**4,236**		8. **Expenditure**	**4,236**	
2. Income from Employment	3,429	81%	9. IO Expenditure	3,053	72%
3. Profit Income (OVA)	9	0%	10. Payments to Corporations	-	-%
4. Income from Corporations	77	2%	11. Payments to Government	1,183	28%
5. Income from Government	560	13%	12. Transfers to RUK	-	-%
6. Transfers from RUK	73	2%	13. Transfers to ROW	-	-%
7. Transfers from ROW	88	2%	14. Payments to Capital	-	-%
HOUSEHOLD TOTAL					
1. **Income**	**93,063**		8. **Expenditure**	**93,063**	
2. Income from Employment	59,741	64%	9. IO Expenditure	74,669	80%
3. Profit Income (OVA)	529	1%	10. Payments to Corporations	3	0%
4. Income from Corporations	9,848	11%	11. Payments to Government	18,387	20%
5. Income from Government	18,887	20%	12. Transfers to RUK	2	0%
6. Transfers from RUK	1,839	2%	13. Transfers to ROW	1	0%
7. Transfers from ROW	2,219	2%	14. Payments to Capital	1	0%

Table 9.5.10: Comparison: IncExp Accounts - Household type (in £million)

SAM HOUSEHOLD ACCOUNT TOTAL					
1. **Income**	**107,877**		8. **Expenditure**	**107,877**	
2. Income from Employment	63,561	59%	9. IO Expenditure	74,669	69%
3. Profit Income (OVA)	5,289	5%	10. Payments to Corporations	6,401	6%
4. Income from Corporations	15,103	14%	11. Payments to Government	21,379	20%
5. Income from Government	19,835	18%	12. Transfers to RUK	238	0%
6. Transfers from RUK	1,853	2%	13. Transfers to ROW	119	0%
7. Transfers from ROW	2,237	2%	14. Payments to Capital	5,070	5%
ESTIMATED HOUSEHOLD ACCOUNT TOTAL					
1. **Income**	**93,063**		8. **Expenditure**	**93,063**	
2. Income from Employment	59,741	64%	9. IO Expenditure	74,669	80%
3. Profit Income (OVA)	529	1%	10. Payments to Corporations	3	0%
4. Income from Corporations	9,848	11%	11. Payments to Government	18,387	20%
5. Income from Government	18,887	20%	12. Transfers to RUK	2	0%
6. Transfers from RUK	1,839	2%	13. Transfers to ROW	1	0%
7. Transfers from ROW	2,219	2%	14. Payments to Capital	1	0%
VARIATION					
1. **Income**	**-14,814**		8. **Expenditure**	**-14,814**	
2. Income from Employment	-3,820		9. IO Expenditure	0	
3. Profit Income (OVA)	-4,760		10. Payments to Corporations	-6,398	
4. Income from Corporations	-5,254		11. Payments to Government	-2,992	
5. Income from Government	-947		12. Transfers to RUK	-236	
6. Transfers from RUK	-15		13. Transfers to ROW	-118	
7. Transfers from ROW	-18		14. Payments to Capital	-5,069	

Table 9.5.11: Shares IncExp Accounts - Household type

HOUSEHOLD 1			
1. Income	0.32	8. Expenditure	0.32
2. Income from Employment	0.42	9. IO Expenditure	0.31
3. Profit Income (OVA)	0.32	10. Payments to Corporations	0.48
4. Income from Corporations	0.16	11. Payments to Government	0.33
5. Income from Government	0.06	12. Transfers to RUK	0.47
6. Transfers from RUK	0.38	13. Transfers to ROW	0.47
7. Transfers from ROW	0.38	14. Payments to Capital	0.49
HOUSEHOLD 2			
1. Income	0.26	8. Expenditure	0.26
2. Income from Employment	0.33	9. IO Expenditure	0.24
3. Profit Income (OVA)	0.12	10. Payments to Corporations	0.32
4. Income from Corporations	0.06	11. Payments to Government	0.34
5. Income from Government	0.16	12. Transfers to RUK	0.13
6. Transfers from RUK	0.24	13. Transfers to ROW	0.13
7. Transfers from ROW	0.24	14. Payments to Capital	0.27
HOUSEHOLD 3			
1. Income	0.11	8. Expenditure	0.11
2. Income from Employment	0.00	9. IO Expenditure	0.13
3. Profit Income (OVA)	0.14	10. Payments to Corporations	0.02
4. Income from Corporations	0.32	11. Payments to Government	0.01
5. Income from Government	0.35	12. Transfers to RUK	0.21
6. Transfers from RUK	0.06	13. Transfers to ROW	0.21
7. Transfers from ROW	0.06	14. Payments to Capital	0.07
HOUSEHOLD 4			
1. Income	0.02	8. Expenditure	0.02
2. Income from Employment	0.01	9. IO Expenditure	0.02
3. Profit Income (OVA)	0.00	10. Payments to Corporations	0.00
4. Income from Corporations	0.00	11. Payments to Government	0.01
5. Income from Government	0.03	12. Transfers to RUK	0.06
6. Transfers from RUK	0.01	13. Transfers to ROW	0.06
7. Transfers from ROW	0.01	14. Payments to Capital	0.02
HOUSEHOLD 5			
1. Income	0.12	8. Expenditure	0.12
2. Income from Employment	0.02	9. IO Expenditure	0.13
3. Profit Income (OVA)	0.32	10. Payments to Corporations	0.00
4. Income from Corporations	0.38	11. Payments to Government	0.08
5. Income from Government	0.29	12. Transfers to RUK	0.02
6. Transfers from RUK	0.15	13. Transfers to ROW	0.02
7. Transfers from ROW	0.15	14. Payments to Capital	0.00
HOUSEHOLD 6			
1. Income	0.13	8. Expenditure	0.13
2. Income from Employment	0.16	9. IO Expenditure	0.13
3. Profit Income (OVA)	0.08	10. Payments to Corporations	0.13
4. Income from Corporations	0.07	11. Payments to Government	0.16
5. Income from Government	0.08	12. Transfers to RUK	0.11
6. Transfers from RUK	0.13	13. Transfers to ROW	0.11
7. Transfers from ROW	0.13	14. Payments to Capital	0.09
HOUSEHOLD 7			
1. Income	0.05	8. Expenditure	0.05
2. Income from Employment	0.06	9. IO Expenditure	0.04
3. Profit Income (OVA)	0.02	10. Payments to Corporations	0.04
4. Income from Corporations	0.01	11. Payments to Government	0.06
5. Income from Government	0.03	12. Transfers to RUK	0.01
6. Transfers from RUK	0.04	13. Transfers to ROW	0.01
7. Transfers from ROW	0.04	14. Payments to Capital	0.06
HOUSEHOLD TOTAL			
1. Income	1.00	8. Expenditure	1.00
2. Income from Employment	1.00	9. IO Expenditure	1.00
3. Profit Income (OVA)	1.00	10. Payments to Corporations	1.00
4. Income from Corporations	1.00	11. Payments to Government	1.00
5. Income from Government	1.00	12. Transfers to RUK	1.00
6. Transfers from RUK	1.00	13. Transfers to ROW	1.00
7. Transfers from ROW	1.00	14. Payments to Capital	1.00

Table 9.5.12: Disaggregated IncExp Accounts - Household type (in £million)

HOUSEHOLD 1					
1. **Income**	**36,206**		8. **Expenditure**	**36,206**	
2. Income from Employment	26,643	74%	9. IO Expenditure	23,359	65%
3. Profit Income (OVA)	1,698	5%	10. Payments to Corporations	3,047	8%
4. Income from Corporations	5,103	14%	11. Payments to Government	7,135	20%
5. Income from Government	1,220	3%	12. Transfers to RUK	112	0%
6. Transfers from RUK	699	2%	13. Transfers to ROW	56	0%
7. Transfers from ROW	843	2%	14. Payments to Capital	2,497	7%
HOUSEHOLD 2					
1. **Income**	**28,834**		8. **Expenditure**	**28,834**	
2. Income from Employment	21,026	73%	9. IO Expenditure	18,166	63%
3. Profit Income (OVA)	644	2%	10. Payments to Corporations	2,043	7%
4. Income from Corporations	3,053	11%	11. Payments to Government	7,195	25%
5. Income from Government	3,126	11%	12. Transfers to RUK	31	0%
6. Transfers from RUK	446	2%	13. Transfers to ROW	15	0%
7. Transfers from ROW	539	2%	14. Payments to Capital	1,384	5%
HOUSEHOLD 3					
1. **Income**	**10,664**		8. **Expenditure**	**10,664**	
2. Income from Employment	7	0%	9. IO Expenditure	9,852	92%
3. Profit Income (OVA)	718	7%	10. Payments to Corporations	150	1%
4. Income from Corporations	2,773	26%	11. Payments to Government	256	2%
5. Income from Government	6,926	65%	12. Transfers to RUK	50	0%
6. Transfers from RUK	108	1%	13. Transfers to ROW	25	0%
7. Transfers from ROW	131	1%	14. Payments to Capital	331	3%
HOUSEHOLD 4					
1. **Income**	**1,604**		8. **Expenditure**	**1,604**	
2. Income from Employment	947	59%	9. IO Expenditure	1,163	72%
3. Profit Income (OVA)	-	-%	10. Payments to Corporations	10	1%
4. Income from Corporations	116	7%	11. Payments to Government	302	19%
5. Income from Government	507	32%	12. Transfers to RUK	14	1%
6. Transfers from RUK	16	1%	13. Transfers to ROW	7	0%
7. Transfers from ROW	19	1%	14. Payments to Capital	109	7%
HOUSEHOLD 5					
1. **Income**	**11,266**		8. **Expenditure**	**11,266**	
2. Income from Employment	1,009	9%	9. IO Expenditure	9,436	84%
3. Profit Income (OVA)	1,710	15%	10. Payments to Corporations	24	0%
4. Income from Corporations	2,147	19%	11. Payments to Government	1,781	16%
5. Income from Government	5,794	51%	12. Transfers to RUK	4	0%
6. Transfers from RUK	275	2%	13. Transfers to ROW	2	0%
7. Transfers from ROW	331	3%	14. Payments to Capital	19	0%
HOUSEHOLD 6					
1. **Income**	**14,314**		8. **Expenditure**	**14,314**	
2. Income from Employment	10,280	72%	9. IO Expenditure	9,640	67%
3. Profit Income (OVA)	430	3%	10. Payments to Corporations	856	6%
4. Income from Corporations	1,410	10%	11. Payments to Government	3,333	23%
5. Income from Government	1,673	12%	12. Transfers to RUK	27	0%
6. Transfers from RUK	236	2%	13. Transfers to ROW	14	0%
7. Transfers from ROW	284	2%	14. Payments to Capital	444	3%
HOUSEHOLD 7					
1. **Income**	**4,989**		8. **Expenditure**	**4,989**	
2. Income from Employment	3,648	73%	9. IO Expenditure	3,053	61%
3. Profit Income (OVA)	88	2%	10. Payments to Corporations	271	5%
4. Income from Corporations	501	10%	11. Payments to Government	1,376	28%
5. Income from Government	589	12%	12. Transfers to RUK	2	0%
6. Transfers from RUK	74	1%	13. Transfers to ROW	1	0%
7. Transfers from ROW	89	2%	14. Payments to Capital	287	6%
HOUSEHOLD TOTAL					
1. **Income**	**107,877**		8. **Expenditure**	**107,877**	
2. Income from Employment	63,561	59%	9. IO Expenditure	74,669	69%
3. Profit Income (OVA)	5,289	5%	10. Payments to Corporations	6,401	6%
4. Income from Corporations	15,103	14%	11. Payments to Government	21,379	20%
5. Income from Government	19,835	18%	12. Transfers to RUK	238	0%
6. Transfers from RUK	1,853	2%	13. Transfers to ROW	119	0%
7. Transfers from ROW	2,237	2%	14. Payments to Capital	5,070	5%

9.6 Appendix 5

Type I Output Multiplier

The Type I output multiplier (the "simple output multiplier") enables the estimation of knock-on effects throughout the economy of a change in final demand (Miller & Blair, 2009). The data used for this multiplier are the inter-industry linkages in the IxI table. That is the matrix made up of only the rows and columns of the inter-industry flows (see Figure below). It must be noted that the IxI, and thereby also the SAM tables, used for the calculations contain no data for industries 7 (Oil & gas extraction, metal ores) and 20 (Tobacco). Thus the total number of industries used here is 102, rather than the full 104 industries (under SIC 2007 code).

The first step in deriving IO multipliers is to construct the technical coefficient matrix, also referred to as the A-matrix. This matrix is calculated by dividing each entry of the inter-industry flows of the IO Tables by the relevant column total, i.e. the total expenditure in each sector (Miller & Blair, 2009). Following the calculation outlined below, the Leontief Inverse is calculated. The column-sums of which are the output multiplier for each sector. Below is a brief outline of how the A-matrix of technical coefficients and the Leontief Inverse are derived.

First, the individual column entries of the inter-industry flows from the IO tables are divided by the relevant column total. For example, the first sector in the 2009 Scottish IxI table is Agriculture. The figure for the inter-industry flow from Agriculture to Agriculture is £339m and the column total ("Total output at basic prices") for Agriculture is £2,584.3m. This results in the technical coefficient being estimated at 0.131 (this figure corresponds to the a_{11} in the equation below). Note that the A-matrix below is also labelled as A_{II}. The capital i's here are for the industry-by-industry coefficients.

$$A = \begin{pmatrix} a_{1,1} & \cdots & a_{1,j} \\ \vdots & \ddots & \vdots \\ a_{i,1} & \cdots & a_{i,j} \end{pmatrix}$$

The next step in order to be able to calculate the Leontief Inverse, is to construct the $(I - A)$-matrix. This matrix simply uses an identity matrix and subtracts the A-matrix from it. The resultant matrix from this calculation has positive values on the diagonal (i.e. the inter-industry flow entries for the individual sectors between themselves). All other entries are negative. Following the example above, the identity matrix gives the value 1 for the Agriculture-Agriculture entry. This is then subtracted by the technical coefficient a_{11} at 0.131. The $(I-A)$-matrix entry (corresponding to $1-a_{11}$) is calculated at 0.869.

$$I = \begin{pmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{pmatrix}$$

$$I - A = \begin{pmatrix} 1 - a_{1,1} & \cdots & 0 - a_{1,j} \\ \vdots & \ddots & \vdots \\ 0 - a_{i,1} & \cdots & 1 - a_{i,j} \end{pmatrix}$$

The last step for the calculation of the Leontief Inverse is inverting the $(I - A)$-matrix, thus deriving $L = (I - A)^{-1}$. The value for the Agriculture-Agriculture entry for the Leontief Inverse is calculated at 1.156 for the Type I output multiplier.

$$L = (I - A)^{-1} = Inverse \begin{pmatrix} 1 - a_{1,1} & \cdots & 0 - a_{1,j} \\ \vdots & \ddots & \vdots \\ 0 - a_{i,1} & \cdots & 1 - a_{i,j} \end{pmatrix}$$

The total output multiplier for the Agriculture sector is computed at 1.608 (see Table 9.6.1). The Type I output multiplier gives the total value of production for all sectors required to satisfy a £1m increase in one sector. The Type I incorporates two distinct output effects. First, the direct effect shows the increase in production needed in sector i to satisfy the initial increase in final demand of £1m in sector i's output. Second, the indirect effect gives the increase in output that is generated as linkage effects in the production of intermediate inputs (Miller & Blair, 2009).

For example, if the final demand of the agriculture sector increases by £1m then the direct effect is a £1m increase in the Agriculture sector output (to satisfy the increase in final demand). The indirect effect is the additional output response by all other sectors, including the agriculture sector, to the initial shock. This second effect highlights the interdependencies of the various sectors in order to satisfy a final demand increase in one sector (Miller & Blair, 2009).

These multiplier effects are observed since sectors buy/sell intermediate inputs to one another. Therefore increase in sales in one sector increases output in others, this imposes a linear relationship between demand and output. IO analysis shows that, first, all output can be attributed to final demand, since all intermediate demand is endogenised. Second, as outlined above, multipliers show how a change in final demand results in the change in vector of outputs. The sum of these changes gives the value of the respective multiplier (Miller & Blair, 2009).

Output Multiplier

	Type I	Type II			SAM
		Miller&Blair	Batey1	Batey2	
1. Agriculture	1.608	1.996	1.918	1.802	1.964
2. Forestry planting	1.615	2.111	2.011	1.863	1.972
3. Forestry harvesting	1.961	2.517	2.405	2.239	2.367
4. Fishing	1.611	1.995	1.918	1.803	1.933
5. Aquaculture	1.625	1.956	1.890	1.790	1.916
6. Coal & lignite	1.671	2.118	2.028	1.894	1.983
8. Other mining	1.435	1.985	1.874	1.709	1.786
9. Mining Support	1.501	1.858	1.786	1.679	1.847
10. Meat processing	1.917	2.410	2.311	2.163	2.250
11. Fish & fruit processing	1.695	2.229	2.122	1.962	2.044
12. Dairy products, oils & fats processing	1.923	2.478	2.366	2.200	2.300
13. Grain milling & starch	1.803	2.300	2.200	2.051	2.134
14. Bakery & farinaceous	1.426	2.088	1.955	1.756	1.840
15. Other food	1.609	2.189	2.072	1.898	1.980
16. Animal feeds	1.589	2.086	1.986	1.837	1.897
17. Spirits & wines	1.299	1.779	1.682	1.538	1.694
18. Beer & malt	1.367	1.814	1.724	1.590	1.746
19. Soft Drinks	1.493	2.057	1.944	1.774	1.872
21. Textiles	1.436	2.110	1.974	1.772	1.830
22. Wearing apparel	1.465	2.241	2.085	1.852	1.907
23. Leather goods	1.497	2.137	2.008	1.816	1.890
24. Wood and wood products	1.801	2.481	2.345	2.140	2.223
25. Paper & paper products	1.662	2.210	2.100	1.936	2.010
26. Printing and recording	1.378	2.232	2.060	1.804	1.883
27. Coke, petroleum & petrochemicals	1.204	1.312	1.290	1.258	1.321
28. Paints, varnishes and inks etc	1.421	1.972	1.861	1.696	1.756
29. Cleaning & toilet preparations	1.460	2.203	2.054	1.831	1.895
30. Other chemicals	1.251	2.099	1.928	1.674	1.765
31. Inorganic chemicals, dyestuffs & agrochemicals	1.314	1.939	1.814	1.626	1.716
32. Pharmaceuticals	1.349	2.018	1.884	1.683	1.776
33. Rubber & Plastic	1.491	2.266	2.110	1.878	1.948
34. Cement lime & plaster	1.594	2.257	2.124	1.925	1.997
35. Glass, clay & stone etc	1.473	2.207	2.059	1.839	1.915
36. Iron & Steel	1.401	2.067	1.933	1.734	1.803
37. Other metals & casting	1.449	2.032	1.915	1.740	1.831
38. Fabricated metal	1.481	2.251	2.096	1.865	1.941
39. Computers, electronics & opticals	1.416	1.980	1.866	1.697	1.767
40. Electrical equipment	1.483	2.183	2.042	1.832	1.896
41. Machinery & equipment	1.519	2.304	2.146	1.911	1.983
42. Motor Vehicles	1.515	2.178	2.045	1.846	1.907
43. Other transport equipment	1.647	2.264	2.140	1.955	2.026
44. Furniture	1.574	2.284	2.141	1.928	1.999
45. Other manufacturing	1.403	2.301	2.121	1.851	1.913
46. Repair & maintenance	1.427	2.164	2.016	1.795	1.877
47. Electricity	2.053	2.405	2.335	2.229	2.345
48. Gas etc	1.260	1.544	1.487	1.401	1.482
49. Water and sewerage	1.287	1.733	1.643	1.509	1.708
50. Waste	1.493	2.195	2.054	1.843	1.941
51. Remediation & waste management	2.780	3.343	3.230	3.061	3.214
52. Construction - buildings	1.766	2.401	2.273	2.083	2.200
53. Construction - civil engineering	1.731	2.450	2.305	2.090	2.202
54. Construction - specialised	1.530	2.288	2.136	1.908	2.020
55. Wholesale & Retail - vehicles	1.335	2.116	1.959	1.725	1.815
56. Wholesale - excl vehicles	1.521	2.253	2.106	1.886	1.990
57. Retail - excl vehicles	1.352	2.139	1.981	1.745	1.858
58. Rail transport	1.764	2.582	2.418	2.172	2.265
59. Other land transport	1.400	2.033	1.906	1.716	1.810

Continued on next page

Table Appendix 5B – continued from previous page

	Type I	Type II Miller&Blair	Batey1	Batey2	SAM
60. Water transport	1.657	2.138	2.042	1.897	1.980
61. Air transport	1.467	1.920	1.829	1.693	1.792
62. Support services for transport	1.541	2.195	2.063	1.867	1.994
63. Post & courier	1.278	2.351	2.135	1.813	1.893
64. Accommodation	1.352	2.065	1.922	1.708	1.814
65. Food & beverage services	1.362	2.082	1.937	1.721	1.816
66. Publishing services	1.279	2.140	1.967	1.709	1.790
67. Film video & TV etc	1.454	2.100	1.970	1.777	1.869
68. Broadcasting	1.386	2.043	1.911	1.714	1.819
69. Telecommunications	1.393	2.067	1.931	1.729	1.859
70. Computer services	1.250	2.115	1.941	1.682	1.789
71. Information services	1.185	1.987	1.826	1.585	1.719
72. Financial services	1.222	1.785	1.671	1.503	1.665
73. Insurance & pensions	1.859	2.359	2.258	2.108	2.234
74. Auxiliary financial services	1.282	2.138	1.966	1.709	1.796
75. Real estate - own	1.465	1.768	1.707	1.616	1.817
76. Imputed rent	1.151	1.220	1.206	1.186	1.387
77. Real estate - fee or contract	1.503	2.198	2.059	1.850	1.971
78. Legal activities	1.241	2.069	1.903	1.655	1.781
79. Accounting & tax services	1.202	2.118	1.934	1.659	1.786
80. Head office & consulting services	1.391	2.267	2.091	1.828	1.914
81. Architectural services etc	1.437	2.239	2.078	1.838	1.953
82. Research & development	1.423	2.534	2.311	1.977	2.057
83. Advertising & market research	1.250	2.019	1.864	1.634	1.772
84. Other professional services	1.330	2.039	1.896	1.684	1.801
85. Veterinary services	1.364	2.197	2.029	1.780	1.918
86. Rental and leasing services	1.324	1.911	1.793	1.617	1.751
87. Employment services	1.301	2.351	2.140	1.825	1.918
88. Travel & related services	1.520	1.936	1.852	1.728	1.786
89. Security & investigation	1.155	2.378	2.132	1.765	1.853
90. Building & landscape services	1.388	2.329	2.140	1.857	1.964
91. Business support services	1.285	1.985	1.844	1.634	1.769
92. Public administration & defence	1.410	2.240	2.073	1.824	1.903
93. Education	1.189	2.478	2.219	1.832	1.914
94. Health	1.362	2.290	2.103	1.825	1.902
95. Residential care	1.320	2.330	2.127	1.824	1.950
96. Social work	1.236	2.496	2.242	1.864	1.959
97. Creative services	1.474	2.398	2.212	1.935	2.005
98. Cultural services	1.356	2.382	2.176	1.868	1.948
99. Gambling	1.414	1.933	1.828	1.673	1.822
100. Sports & recreation	1.407	2.332	2.146	1.869	1.950
101. Membership organisations	1.436	2.329	2.150	1.882	1.970
102. Repairs - personal and household	1.357	2.121	1.967	1.738	1.822
103. Other personal services	1.233	1.947	1.804	1.590	1.732
104. Households as employers	1.000	2.405	2.122	1.701	1.799

Summary statistics

Mean	1.465	2.156	2.017	1.810	1.910
Min	1.000	1.220	1.206	1.186	1.321
Max	2.780	3.343	3.230	3.061	3.214

9.7 Appendix 6

Table 9.7.1: Total Final Demand by 25 Sectors - 2009 Scottish SAM in £m

1. Agriculture, forestry and fishing	3,398
2. Mining	6,320
3. Food, drink and tobacco	8,456
4. Textile, leather, wood & paper	3,101
5. Chemicals	6,676
6. Rubber, plastic, cement and iron	2,171
7. Computer, electrical and transp. equip.	15,018
8. Electricity, gas and water	12,632
9. Construction	19,227
10. Wholesale and retail	18,846
11. Land transport	3,869
12. Water transport	671
13. Air Transport	1,183
14. Post and support transport services	4,564
15. Accommodation	2,291
16. Food & beverage services	3,951
17. Telecommunication	3,817
18. Computer and information services	2,082
19. Financial services	18,592
20. Real estate	11,091
21. professional services	17,400
22. Research and development	593
23. Public administration	39,923
24. Recreational services	2,861
25. Other services	2,188
Total	210,920
Average	8,437

Table 9.7.2: Total Exogenous Demand by 25 Sectors - 2009 Scottish SAM in £m

1. Agriculture, forestry and fishing	1,015
2. Mining	5,176
3. Food, drink and tobacco	4,709
4. Textile, leather, wood and paper	1,180
5. Chemicals	4,139
6. Rubber, plastic, cement and iron	619
7. Computer, electrical and transp. equip.	7,522
8. Electricity, gas and water	2,541
9. Construction	11,764
10. Wholesale and retail	3,889
11. Land transport	644
12. Water transport	340
13. Air Transport	329
14. Post and support transport services	982
15. Accommodation	672
16. Food & beverage services	375
17. Telecommunication	780
18. Computer and information services	1,359
19. Financial services	10,300
20. Real estate	608
21. Professional services	7,389
22. Research and development	349
23. Public administration	6,795
24. Recreational services	337
25. Other services	136
Total	73,949

Table 9.7.3: Base year employment by 25 Sectors (thousands FTE)

1. Agriculture, forestry and fishing	51,467
2. Mining	24,763
3. Food, drink and tobacco	46,079
4. Textile, leather, wood and paper	30,497
5. Chemicals	9,652
6. Rubber, plastic, cement and iron	15,979
7. Computer, electrical and transp. equip.	93,751
8. Electricity, gas and water	33,030
9. Construction	170,528
10. Wholesale and retail	307,936
11. Land transport	51,642
12. Water transport	2,569
13. Air Transport	3,985
14. Post and support transport services	46,183
15. Accommodation	47,245
16. Food & beverage services	91,343
17. Telecommunication	35,639
18. Computer and information services	30,765
19. Financial services	86,289
20. Real estate	25,992
21. Professional services	305,218
22. Research and development	8,030
23. Public administration	610,655
24. Recreational services	53,918
25. Other services	46,774

Table 9.7.4: Employment-Output Coefficient

1. Agriculture, forestry and fishing	15.14
2. Mining	3.92
3. Food, drink and tobacco	5.45
4. Textile, leather, wood and paper	9.83
5. Chemicals	1.45
6. Rubber, plastic, cement and iron	7.36
7. Computer, electrical and transp. equip.	6.24
8. Electricity, gas and water	2.61
9. Construction	8.87
10. Wholesale and retail	16.34
11. Land transport	13.35
12. Water transport	3.83
13. Air Transport	3.37
14. Post and support transport services	10.12
15. Accomodation	20.62
16. Food & beverage services	23.12
17. Telecomunication	9.34
18. Computer and information services	14.77
19. Financial services	4.64
20. Real estate	2.34
21. Professional services	17.54
22. Research and development	13.55
23. Public administration	15.30
24. Recreational services	18.85
25. Other services	21.37

Figure 9.7.1: SAM Model Comparison: Indirect and Induced Employment Effects - “Food, drink and tobacco” Sector Shock

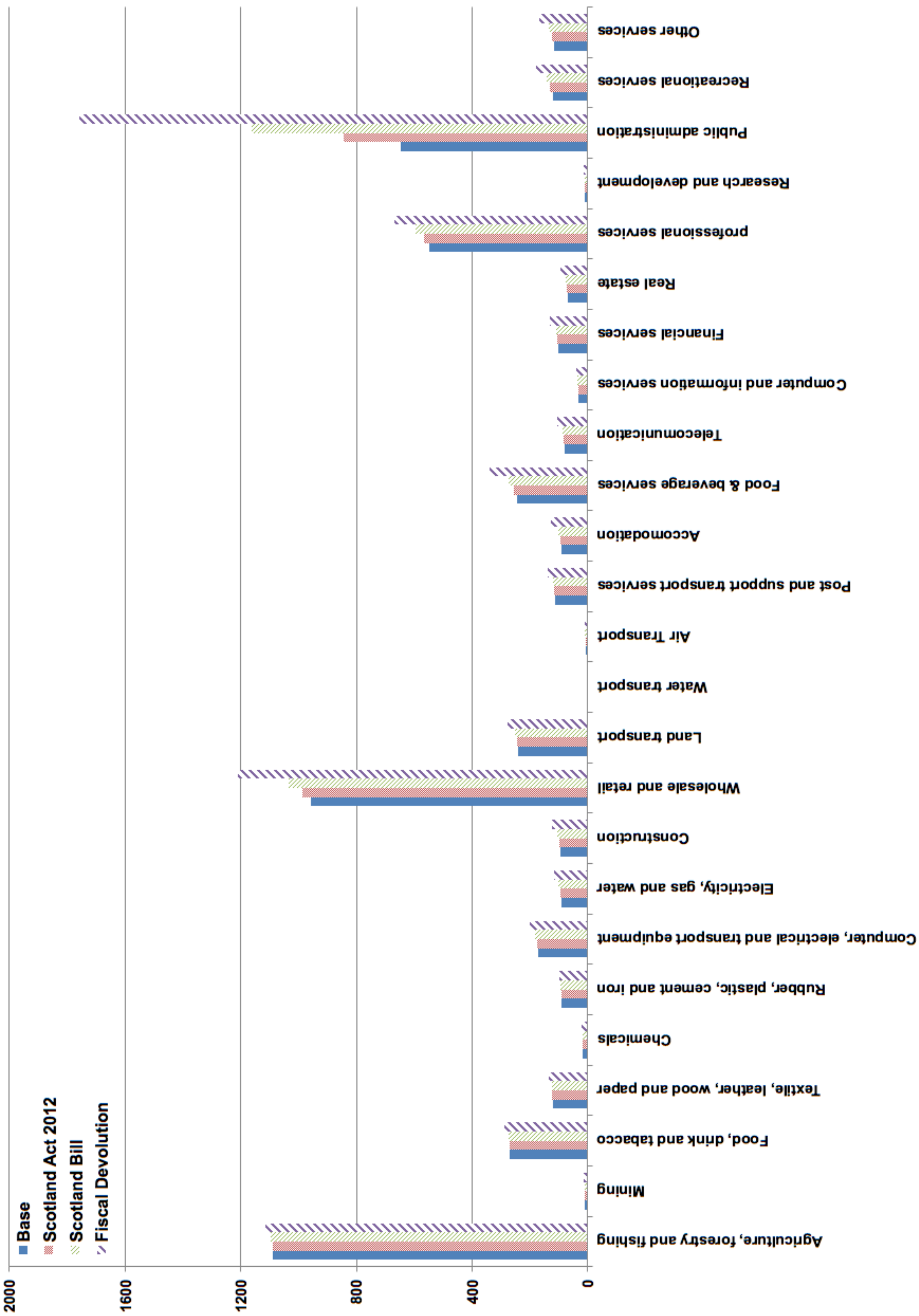

Table 9.7.5:
Government Endogenised Multiplier - Scotland Act 2012
£500m External Demand Shock on the "Food, drink and tobacco" Sector

	Indirect & Induced Output Effect	Indirect & Induced Employment Effect	%age Change to SAM
1. Agriculture, forestry and fishing	72.01	1090.64	2.12%
2. Mining	3.01	11.79	0.05%
3. Food, drink and tobacco	49.68	270.69	0.59%
4. Textile, leather, wood and paper	12.49	122.85	0.40%
5. Chemicals	12.28	17.75	0.18%
6. Rubber, plastic, cement and iron	12.60	92.76	0.58%
7. Computer, electrical and transp. equip.	27.97	174.62	0.19%
8. Electricity, gas and water	36.75	96.09	0.29%
9. Construction	11.14	98.81	0.06%
10. Wholesale and retail	60.34	985.89	0.32%
11. Land transport	18.30	244.29	0.47%
12. Water transport	0.90	3.43	0.13%
13. Air Transport	2.48	8.36	0.21%
14. Post and support transport services	11.45	115.88	0.25%
15. Accommodation	4.62	95.24	0.20%
16. Food & beverage services	11.11	256.89	0.28%
17. Telecommunication	8.79	82.06	0.23%
18. Computer and information services	2.23	32.96	0.11%
19. Financial services	22.44	104.16	0.12%
20. Real estate	30.38	71.19	0.27%
21. Professional services	32.24	565.47	0.19%
22. Research and development	0.85	11.47	0.14%
23. Public administration	55.20	844.32	0.14%
24. Recreational services	6.91	130.32	0.24%
25. Other services	5.75	122.96	0.26%
Total	511.92	5650.87	8.03%
Average	20.48	226.03	0.32%

Table 9.7.6:
Government Endogenised Multiplier - Scotland Bill
£500m External Demand Shock on the "Food, drink and tobacco" Sector

	Indirect & Induced Output Effect	Indirect & Induced Employment Effect	%age Change to SAM
1. Agriculture, forestry and fishing	72.33	1095.43	2.13%
2. Mining	3.12	12.22	0.05%
3. Food, drink and tobacco	50.37	274.45	0.60%
4. Textile, leather, wood and paper	12.79	125.74	0.41%
5. Chemicals	12.78	18.48	0.19%
6. Rubber, plastic, cement and iron	12.76	93.91	0.59%
7. Computer, electrical and transp. equip.	29.13	181.82	0.19%
8. Electricity, gas and water	38.82	101.50	0.31%
9. Construction	11.87	105.27	0.06%
10. Wholesale and retail	63.31	1034.50	0.34%
11. Land transport	18.92	252.60	0.49%
12. Water transport	0.94	3.61	0.14%
13. Air Transport	2.64	8.88	0.22%
14. Post and support transport services	11.99	121.31	0.26%
15. Accommodation	4.99	103.01	0.22%
16. Food & beverage services	11.90	275.22	0.30%
17. Telecommunication	9.41	87.89	0.25%
18. Computer and information services	2.36	34.86	0.11%
19. Financial services	23.78	110.35	0.13%
20. Real estate	32.60	76.40	0.29%
21. Professional services	33.88	594.26	0.19%
22. Research and development	0.91	12.39	0.15%
23. Public administration	76.04	1163.17	0.19%
24. Recreational services	7.63	143.87	0.27%
25. Other services	6.23	133.07	0.28%
Total	551.51	6164.24	8.37%
Average	22.06	246.57	0.33%

Table 9.7.7:
Government Endogenised Multiplier - Fiscal Devolution
£500m External Demand Shock on the “Food, drink and tobacco” Sector

	Indirect & Induced Output Effect	Indirect & Induced Employment Effect	%age Change to SAM
1. Agriculture, forestry and fishing	73.51	1113.30	2.16%
2. Mining	3.45	13.54	0.05%
3. Food, drink and tobacco	52.89	288.20	0.63%
4. Textile, leather, wood and paper	13.67	134.42	0.44%
5. Chemicals	14.25	20.60	0.21%
6. Rubber, plastic, cement and iron	13.23	97.36	0.61%
7. Computer, electrical and transp. equip.	32.24	201.27	0.21%
8. Electricity, gas and water	45.01	117.70	0.36%
9. Construction	14.07	124.81	0.07%
10. Wholesale and retail	74.04	1209.74	0.39%
11. Land transport	20.81	277.77	0.54%
12. Water transport	1.11	4.24	0.17%
13. Air Transport	3.17	10.68	0.27%
14. Post and support transport services	13.64	137.99	0.30%
15. Accommodation	6.18	127.53	0.27%
16. Food & beverage services	14.66	338.87	0.37%
17. Telecommunication	11.39	106.33	0.30%
18. Computer and information services	2.69	39.78	0.13%
19. Financial services	28.29	131.32	0.15%
20. Real estate	40.78	95.56	0.37%
21. Professional services	38.15	669.15	0.22%
22. Research and development	1.06	14.32	0.18%
23. Public administration	114.90	1757.53	0.29%
24. Recreational services	9.43	177.74	0.33%
25. Other services	7.77	166.07	0.36%
Total	650.38	7375.82	9.37%
Average	26.02	295.03	0.37%

Figure 9.7.2: SAM Model Comparison: Indirect and Induced Employment Effects - "Public Administration" Sector Shock

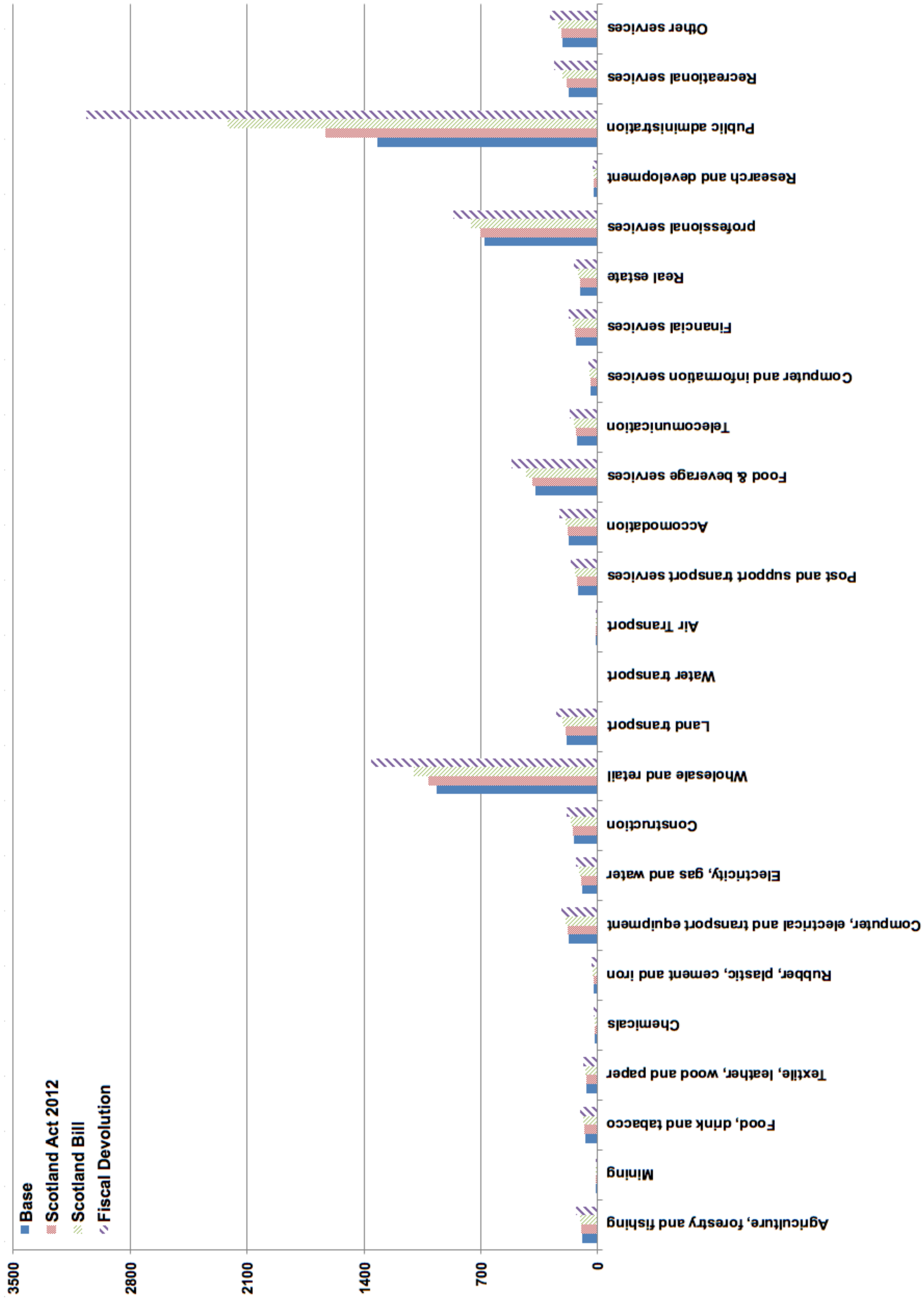

Table 9.7.8:
Government Endogenised Multiplier - Scotland Act 2012
£500m External Demand Shock on the “Public Administration” Sector

	Indirect & Induced Output Effect	Indirect & Induced Employment Effect	%age Change to SAM
1. Agriculture, forestry and fishing	6.41	97.11	0.19%
2. Mining	2.41	9.43	0.04%
3. Food, drink and tobacco	14.25	77.65	0.17%
4. Textile, leather, wood and paper	6.90	67.87	0.22%
5. Chemicals	12.24	17.70	0.18%
6. Rubber, plastic, cement and iron	3.67	27.00	0.17%
7. Computer, electrical and transp. equip.	28.52	178.03	0.19%
8. Electricity, gas and water	38.00	99.35	0.30%
9. Construction	16.84	149.34	0.09%
10. Wholesale and retail	62.03	1013.58	0.33%
11. Land transport	14.58	194.64	0.38%
12. Water transport	0.98	3.77	0.15%
13. Air Transport	3.29	11.08	0.28%
14. Post and support transport services	12.42	125.70	0.27%
15. Accommodation	8.64	178.29	0.38%
16. Food & beverage services	17.03	393.70	0.43%
17. Telecommunication	13.83	129.17	0.36%
18. Computer and information services	2.94	43.50	0.14%
19. Financial services	29.12	135.16	0.16%
20. Real estate	45.78	107.29	0.41%
21. Professional services	40.10	703.41	0.23%
22. Research and development	1.86	25.26	0.31%
23. Public administration	106.51	1629.18	0.27%
24. Recreational services	9.86	185.79	0.34%
25. Other services	10.29	220.02	0.47%
Total	508.53	5823.02	6.46%
Average	20.34	232.92	0.26%

Table 9.7.9:
Government Endogenised Multiplier - Scotland Bill
£500m External Demand Shock on the “Public Administration” Sector

	Indirect & Induced Output Effect	Indirect & Induced Employment Effect	%age Change to SAM
1. Agriculture, forestry and fishing	6.99	105.90	0.21%
2. Mining	2.61	10.22	0.04%
3. Food, drink and tobacco	15.52	84.56	0.18%
4. Textile, leather, wood and paper	7.44	73.20	0.24%
5. Chemicals	13.18	19.06	0.20%
6. Rubber, plastic, cement and iron	3.96	29.13	0.18%
7. Computer, electrical and transp. equip.	30.64	191.29	0.20%
8. Electricity, gas and water	41.80	109.30	0.33%
9. Construction	18.18	161.22	0.09%
10. Wholesale and retail	67.50	1102.87	0.36%
11. Land transport	15.73	209.94	0.41%
12. Water transport	1.07	4.10	0.16%
13. Air Transport	3.57	12.03	0.30%
14. Post and support transport services	13.41	135.70	0.29%
15. Accommodation	9.34	192.58	0.41%
16. Food & beverage services	18.49	427.38	0.47%
17. Telecommunication	14.98	139.90	0.39%
18. Computer and information services	3.18	47.00	0.15%
19. Financial services	31.57	146.54	0.17%
20. Real estate	49.86	116.86	0.45%
21. Professional services	43.12	756.42	0.25%
22. Research and development	1.99	26.96	0.34%
23. Public administration	144.96	2217.33	0.36%
24. Recreational services	11.18	210.74	0.39%
25. Other services	11.16	238.61	0.51%
Total	581.44	6768.81	7.09%
Average	23.26	270.75	0.28%

Table 9.7.10:
Government Endogenised Multiplier - Fiscal Devolution
£500m External Demand Shock on the "Public Administration" Sector

	Indirect & Induced Output Effect	Indirect & Induced Employment Effect	%age Change to SAM
1. Agriculture, forestry and fishing	8.70	131.81	0.26%
2. Mining	3.09	12.11	0.05%
3. Food, drink and tobacco	19.17	104.48	0.23%
4. Textile, leather, wood and paper	8.72	85.71	0.28%
5. Chemicals	15.29	22.10	0.23%
6. Rubber, plastic, cement and iron	4.63	34.11	0.21%
7. Computer, electrical and transp. equip.	35.13	219.28	0.23%
8. Electricity, gas and water	50.74	132.66	0.40%
9. Construction	21.36	189.42	0.11%
10. Wholesale and retail	83.03	1356.74	0.44%
11. Land transport	18.45	246.26	0.48%
12. Water transport	1.31	5.01	0.19%
13. Air Transport	4.35	14.63	0.37%
14. Post and support transport services	15.79	159.77	0.35%
15. Accommodation	11.06	228.00	0.48%
16. Food & beverage services	22.47	519.52	0.57%
17. Telecommunication	17.83	166.53	0.47%
18. Computer and information services	3.66	54.07	0.18%
19. Financial services	38.11	176.87	0.20%
20. Real estate	61.72	144.63	0.56%
21. Professional services	49.26	864.06	0.28%
22. Research and development	2.19	29.72	0.37%
23. Public administration	200.18	3062.00	0.50%
24. Recreational services	13.76	259.37	0.48%
25. Other services	13.39	286.31	0.61%
Total	723.39	8505.17	8.53%
Average	28.94	340.21	0.34%

Table 9.7.11: SIC07 Aggregation Matrix - SIC07 1 to 32

	1. Agriculture, forestry and fishing	2. Mining	3. Food, drink and tobacco	4. Textile, leather, wood and paper	5. Chemicals
1. Agriculture	1	-	-	-	-
2. Forestry planting	1	-	-	-	-
3. Forestry harvesting	1	-	-	-	-
4. Fishing	1	-	-	-	-
5. Aquaculture	1	-	-	-	-
6. Coal & lignite	-	1	-	-	-
7. Oil & gas extraction, metal ores	-	1	-	-	-
8. Other mining	-	1	-	-	-
9. Mining Support	-	1	-	-	-
10. Meat processing	-	-	1	-	-
11. Fish & fruit processing	-	-	1	-	-
12. Dairy products, oils & fats	-	-	1	-	-
13. Grain milling & starch	-	-	1	-	-
14. Bakery & farinaceous	-	-	1	-	-
15. Other food	-	-	1	-	-
16. Animal feeds	-	-	1	-	-
17. Spirits & wines	-	-	1	-	-
18. Beer & malt	-	-	1	-	-
19. Soft Drinks	-	-	1	-	-
20. Tobacco	-	-	1	-	-
21. Textiles	-	-	-	1	-
22. Wearing apparel	-	-	-	1	-
23. Leather goods	-	-	-	1	-
24. Wood and wood products	-	-	-	1	-
25. Paper & paper products	-	-	-	1	-
26. Printing and recording	-	-	-	1	-
27. Coke, petroleum & petrochemicals	-	-	-	-	1
28. Paints, varnishes and inks etc	-	-	-	-	1
29. Cleaning & toilet preparations	-	-	-	-	1
30. Other chemicals	-	-	-	-	1
31. Inorganic chemicals, dyestuffs & agrochem.	-	-	-	-	1
32. Pharmaceuticals	-	-	-	-	1

	6. Rubber, plastic, cement and iron	7. Computer, electrical and transport eq.	8. Electricity, gas and water	9. Construction	10. Wholesale and retail	11. Land transport	12. Water transport	13. Air Transport
33. Rubber & Plastic	1	-	-	-	-	-	-	-
34. Cement lime & plaster	1	-	-	-	-	-	-	-
35. Glass, clay & stone etc	1	-	-	-	-	-	-	-
36. Iron & Steel	1	-	-	-	-	-	-	-
37. Other metals & casting	1	-	-	-	-	-	-	-
38. Fabricated metal	-	1	-	-	-	-	-	-
39. Computers, electronics & opticals	-	1	-	-	-	-	-	-
40. Electrical equipment	-	1	-	-	-	-	-	-
41. Machinery & equipment	-	1	-	-	-	-	-	-
42. Motor Vehicles	-	1	-	-	-	-	-	-
43. Other transp. equip.	-	1	-	-	-	-	-	-
44. Furniture	-	1	-	-	-	-	-	-
45. Other manufacturing	-	1	-	-	-	-	-	-
46. Repair & maintenance	-	1	-	-	-	-	-	-
47. Electricity	-	-	1	-	-	-	-	-
48. Gas etc	-	-	1	-	-	-	-	-
49. Water and sewerage	-	-	1	-	-	-	-	-
50. Waste	-	-	1	-	-	-	-	-
51. Remediation & waste management	-	-	1	-	-	-	-	-
52. Construction - buildings	-	-	-	1	-	-	-	-
53. Construction - civil engineering	-	-	-	1	-	-	-	-
54. Construction - specialised	-	-	-	1	-	-	-	-
55. Wholesale & Retail - vehicles	-	-	-	-	1	-	-	-
56. Wholesale - excl vehicles	-	-	-	-	1	-	-	-
57. Retail - excl vehicles	-	-	-	-	1	-	-	-
58. Rail transport	-	-	-	-	-	1	-	-
59. Other land transport	-	-	-	-	-	1	-	-
60. Water transport	-	-	-	-	-	-	1	-
61. Air transport	-	-	-	-	-	-	-	1

	14. Post and support transport services	15. Accommodation	16. Food & beverage services	17. Telecommunication	18. Computer and information services	19. Financial services	20. Real estate	21. Professional services	22. Research and development	23. Public administration	24. Recreational services	25. Other services
62. Support services for transport	1	-	-	-	-	-	-	-	-	-	-	-
63. Post & courier	1	-	-	-	-	-	-	-	-	-	-	-
64. Accommodation	-	1	-	-	-	-	-	-	-	-	-	-
65. Food & beverage services	-	-	1	-	-	-	-	-	-	-	-	-
66. Publishing services	-	-	-	1	-	-	-	-	-	-	-	-
67. Film video & TV etc	-	-	-	1	-	-	-	-	-	-	-	-
68. Broadcasting	-	-	-	1	-	-	-	-	-	-	-	-
69. Telecommunications	-	-	-	1	-	-	-	-	-	-	-	-
70. Computer services	-	-	-	-	1	-	-	-	-	-	-	-
71. Information services	-	-	-	-	1	-	-	-	-	-	-	-
72. Financial services	-	-	-	-	-	1	-	-	-	-	-	-
73. Insurance & pensions	-	-	-	-	-	1	-	-	-	-	-	-
74. Auxiliary financial services	-	-	-	-	-	1	-	-	-	-	-	-
75. Real estate - own	-	-	-	-	-	-	1	-	-	-	-	-
76. Imputed rent	-	-	-	-	-	-	1	-	-	-	-	-
77. Real estate - fee or contract	-	-	-	-	-	-	1	-	-	-	-	-
78. Legal activities	-	-	-	-	-	-	-	1	-	-	-	-
79. Accounting & tax services	-	-	-	-	-	-	-	1	-	-	-	-
80. Head office & consulting services	-	-	-	-	-	-	-	1	-	-	-	-
81. Architectural services etc	-	-	-	-	-	-	-	1	-	-	-	-
82. Research & development	-	-	-	-	-	-	-	-	1	-	-	-
83. Advertising & market research	-	-	-	-	-	-	-	1	-	-	-	-
84. Other professional services	-	-	-	-	-	-	-	1	-	-	-	-
85. Veterinary services	-	-	-	-	-	-	-	1	-	-	-	-
86. Rental and leasing services	-	-	-	-	-	-	-	1	-	-	-	-
87. Employment services	-	-	-	-	-	-	-	1	-	-	-	-
88. Travel & related services	-	-	-	-	-	-	-	1	-	-	-	-
89. Security & investigation	-	-	-	-	-	-	-	1	-	-	-	-
90. Building & landscape services	-	-	-	-	-	-	-	1	-	-	-	-
91. Business support services	-	-	-	-	-	-	-	1	-	-	-	-
92. Public administration & defence	-	-	-	-	-	-	-	-	-	1	-	-
93. Education	-	-	-	-	-	-	-	-	-	1	-	-
94. Health	-	-	-	-	-	-	-	-	-	1	-	-
95. Residential care	-	-	-	-	-	-	-	-	-	1	-	-
96. Social work	-	-	-	-	-	-	-	-	-	1	-	-
97. Creative services	-	-	-	-	-	-	-	-	-	-	1	-
98. Cultural services	-	-	-	-	-	-	-	-	-	-	1	-
99. Gambling	-	-	-	-	-	-	-	-	-	-	1	-
100. Sports & recreation	-	-	-	-	-	-	-	-	-	-	1	-
101. Membership organisations	-	-	-	-	-	-	-	-	-	-	-	1
102. Repairs - personal and household	-	-	-	-	-	-	-	-	-	-	-	1
103. Other personal services	-	-	-	-	-	-	-	-	-	-	-	1
104. Households as employers	-	-	-	-	-	-	-	-	-	-	-	1

9.8 Appendix 7

Table 9.8.1: Mathematical Summary: AMOS Model Structure

Prices		
Import price	$PM_{i,t} = \epsilon_t\, PWM_i(1 + MTAX_i)$	(9.8.1)
Export price	$PE_{i,t} = \epsilon_t\, PWE_i(1 - TE_i)$	(9.8.2)
	$PE_i = \epsilon\, PWE_i(1 - TE_i)$	(9.8.3)
Commodity price	$PQ_{i,t} = \frac{PR_{i,t}R_{i,t} + PM_{i,t}M_{i,t}}{R_{i,t} + M_{i,t}}$	(9.8.4)
National commodity price	$PIR_{j,t} = \frac{\sum_i VR_{i,j,t}PR_{j,t} + \sum_i VI_{i,j,t}\overline{PI_j}}{\sum_i VIR_{i,j,t}}$	(9.8.5)
Value added price	$PY_{j,t}a^Y_j = PX_{j,t}(1 - btax_j - sub_j - dep_j) - \sum_i a^V_{i,j}PQ_{j,t}$	(9.8.6)
User cost of capital	$UCK_t = Pk_t(ir + \delta)$	(9.8.7)
Consumption price	$PC_t^{1-\sigma^C} = \sum_j \sum_h \delta^f_{j,h} PQ_{j,t}^{1-\sigma^C}$	(9.8.8)

Continued on next page

Price of government consumption

$$Pgov_t^{1-\sigma^G} = \sum_j \delta_j^g PQ_{j,t}^{1-\sigma^g} \tag{9.8.9}$$

After tax wage

$$w_t^b = \frac{w_t}{(1 + sscee + sscer)(1 + ire)} \tag{9.8.10}$$

Wage setting

$$\begin{cases} ln[\frac{w_t}{cpi_t}] = \omega - \epsilon \, ln(u_t) & (Regional\, Bargain.) \\ \frac{w_t}{cpi_t} = \frac{w_{t=0}}{cpi_{t=0}} & (Fixed\, Real\, Wage) \\ w_t = w_{t=0} & (National\, Bargain.) \end{cases} \tag{9.8.11}$$

Rate of return to capital

$$rk_j = PY_j \delta_j^k A^{\rho_j} (\frac{Y_j}{K_j})^{1-\rho_j} \tag{9.8.12}$$

Capital good price

$$Pk = \frac{\sum_j PQ_j \sum_j KM_{i,j}}{\sum_i \sum_j KM_{i,j}} \tag{9.8.13}$$

Production Technology

Total output

$$X_{i,t} = min(\frac{Y_{j,t}}{a_i^Y}; \frac{V_{i,j,t}}{a_{i,j}^V}) \tag{9.8.14}$$

$$Y_{i,t} = \alpha_i^Y X_{i,t} \tag{9.8.15}$$

$$V_{i,t} = \alpha_{i,j}^V X_{i,t} \tag{9.8.16}$$

Continued on next page

Value added

$$Y_i = A(\xi_{i,t})\,[\delta_i^k K_{i,t}^{\rho_{i,t}} + \delta_i^l L_{i,t}^{\rho_{i,t}}]^{\frac{1}{\varrho_i}} \tag{9.8.17}$$

$$L_{j,t} = (A(\xi_{j,t})_i^{\rho}\,\delta_j^l \frac{PY_{j,t}}{w_t})^{\frac{1}{\rho_j}} Y_{j,t} \tag{9.8.18}$$

Trade

Total intermediate inputs

$$VV_{i,j,t} = \gamma_{i,j}^{vv}(\delta_{i,j}^{vm} VM_{i,t}^{\rho_{i,t}{}^A} + \delta_{i,j}^{vir} VIR_{i,t}^{\rho_i{}^A})^{\frac{1}{\rho_i{}^A}} \tag{9.8.19}$$

$$\frac{VM_{i,j,t}}{VIR_{i,j,t}} = \left[\left(\frac{\delta_{i,j}^{vm}}{\delta_{i,j}^{vir}}\right)\left(\frac{PIR_{i,t}}{PM_{i,t}}\right)\right]^{\frac{1}{1-\rho_i{}^A}} \tag{9.8.20}$$

National intermediate inputs

$$VIR_{i,j,t} = \gamma_{i,j}^{vir}(\delta_{i,j}^{vi} VI_{i,t}^{\rho_i{}^A} + \delta_{i,j}^{vr} VR_{i,t}^{\rho_i{}^A})^{\frac{1}{\rho_i{}^A}} \tag{9.8.21}$$

$$\frac{VR_{i,j,t}}{VI_{i,j,t}} = \left[\left(\frac{\delta_{i,j}^{vr}}{\delta_{i,j}^{vi}}\right)\left(\frac{PI_{i,t}}{PR_{i,t}}\right)\right]^{\frac{1}{1-\rho_i{}^A}} \tag{9.8.22}$$

Total exports

$$E_{i,t} = \overline{E_i}(\frac{PE_{i,t}}{PR_{i,t}})^{\sigma_i^X} \tag{9.8.23}$$

Regional Demand

$$\begin{aligned} R_{i,t} &= \sum_j VR_{i,j,t} + QHR_{i,h,t} \\ &+ QVR_{i,t} + QGR_{i,t} + QHK_{i,t} \end{aligned} \tag{9.8.24}$$

Total production

Continued on next page

$$X_{i,t} = R_{i,t} + E_{i,t} \tag{9.8.25}$$

Households and other non-government institutions

$$\sum_{t=0}^{\infty} (1+\rho)^{-t} \frac{C_t^{1-\sigma} - 1}{1-\sigma} \tag{9.8.26}$$

$$\frac{C_t}{C_{t+1}} = \left[\frac{PC_t\,(1+\rho)}{PC_{t+1}\,(1+r)} \right]^{-\left(\frac{1}{\sigma}\right)} \tag{9.8.27}$$

Wealth

$$W_t = NFW_t + FW_t \tag{9.8.28}$$

Non-financial wealth

$$\begin{aligned} NFW_t(1+r_t) = NFW_{t+1} \\ + \sum_h dtr_h(ssce + ire) \sum_j L_{j,t} w_t \\ + \sum_h \sum_{dnginsp} TRSF_{h,dnginsp,t} + \sum_h TRG_h PC_t \\ + \sum_h REM_h \epsilon_t - \sum_{dnginsp} \sum_h TRSF_{dnginsp,h,t} \end{aligned} \tag{9.8.29}$$

Financial wealth

$$\begin{aligned} FW_t(1+r_t) = FW_{t+1} + \\ d^K_{dngins} rk_{i,t} \sum_i K_i - \sum_h SAV_h \end{aligned} \tag{9.8.30}$$

Continued on next page

Total non-government institutional income

$$\begin{aligned} YNG_{dngins,t} = {} & d^L_{dngins} w_t \sum_i L_i \\ & + d^K_{dngins} rk_{i,t} \sum_i K_i \\ & + d^h_{dngins} rh_{i,t} \sum_i H_i \\ & + \sum_{dnginsp} TRSF_{dngins,dnginsp,t} \\ & + PC_t TRG_{dngins} + \epsilon_t REM_{dngins} \end{aligned} \quad (9.8.31)$$

Transfers from non-governmental institutions

$$TRSF_{dngins,dnginsp,t} = PC_t \overline{TRSF_{dngins,dnginsp}} \quad (9.8.32)$$

Institution Savings (non- government)

$$SAV_{dngins,t} = mps_{dngins} YNG_{dngins,t} \quad (9.8.33)$$

CES Household consumption

$$QH_{i,h,t} = (\delta^f_{i,h})^{\rho^C_i} \left(\frac{PC_{i,t}}{PQ_{i,t}} \right)^{\rho^C_i} C_t \quad (9.8.34)$$

Armington household consumption

$$QH_{i,h,t} = \gamma^{hr}_{i,h} \left[\delta^{hr}_{i,h} QHR^{\rho^A_i}_{i,h,t} + \delta^{hm}_{i,h} QHM^{\rho^A_i}_{i,h,t} \right]^{\frac{1}{\rho^A_i}} \quad (9.8.35)$$

$$\frac{QHR_{i,h,t}}{QHM_{i,h,t}} = \left[\left(\frac{\delta^{hr}_{i,h}}{\delta^{hm}_{i,h}} \right) \left(\frac{PM_{i,t}}{PR_{i,t}} \right) \right]^{\frac{1}{1-{\rho_i}^A}} \quad (9.8.36)$$

Government

Continued on next page

Fiscal Deficit

$$FD_t = \sum_i QG_{i,t}PQ_{i,t} + \overline{GSAV} + \sum_{dngins} TRG_{dngins,t}PC_t - (d_g^k \sum_i rk_{i,t}K_{i,t} + d_g^h \sum_i rh_{i,t}H_{i,t} + \sum_{i,t} IMT_{i,t} + \sum_h dtr_h + (ssce + ire)\sum_j L_{j,t}w_t + \overline{FE}\epsilon_t) \quad (9.8.37)$$

$$QG_{i,t} = \gamma_i^g (\delta_i^{gr} QGR_{i,t}^{\rho_i^A} + \delta_i^{gm} QGM_{i,t}^{\rho_i^A})^{\frac{1}{\rho_i^A}} \quad (9.8.38)$$

$$\frac{QGR_{i,t}}{QGM_{i,t}} = \left[\left(\frac{\delta_i^{gr}}{\delta_i^{gm}}\right)\left(\frac{PM_{i,t}}{PR_{i,t}}\right)\right]^{\frac{1}{1-\rho_i{}^A}} \quad (9.8.39)$$

Investment Demand

Investment by sector of origin

$$QV_{i,t} = \sum_i KM_{i,j}J_{j,t} \quad (9.8.40)$$

Total investment

$$QV_{i,t} = \gamma_i^v (\delta_i^{qvm} QVM_{i,t}^{\rho_i^A} + \delta_i^{qvr} QVIR_{i,t}^{\rho_i^A})^{\frac{1}{\rho_i^A}} \quad (9.8.41)$$

$$\frac{QVM_{i,t}}{QVIR_{i,t}} = \left[\left(\frac{\delta_i^{qvm}}{\delta_i^{qvir}}\right)\left(\frac{PIR_{i,t}}{PM_{i,t}}\right)\right]^{\frac{1}{1-\rho_i{}^A}} \quad (9.8.42)$$

National investment

$$QVIR_{i,t} = \gamma_i^{vir}\left[\delta_i^{qvi} QVI_i^{\rho_i^A} + \delta_i^{qvr} QVR_{i,t}^{\rho_i^A}\right]^{\frac{1}{\rho_i^A}} \quad (9.8.43)$$

Continued on next page

$$\frac{QVR_{i,t}}{QVI_{i,t}} = \left[\left(\frac{\delta_i^{qvr}}{\delta_i^{qvi}}\right)\left(\frac{PI_{i,t}}{PR_{i,t}}\right)\right]^{\frac{1}{1-\rho_i{}^A}} \quad (9.8.44)$$

Investment path

$$J_{i,t} = I_{i,t}\left(1 - bb - tk + \frac{\beta}{2}\frac{(\frac{I_{i,t}}{K_{i,t}} - \alpha)^2}{\frac{I_{i,t}}{K_{i,t}}}\right) \quad (9.8.45)$$

$$\frac{I_t}{K_t} = \alpha + \frac{1}{\beta}\left[\frac{\lambda_{i,t}}{PK_t} - (1 - bb - tk)\right] \quad (9.8.46)$$

$$\dot{\lambda}_{i,t} = \lambda i, t(r_t + \sigma) - R^k_{i,t} \quad (9.8.47)$$

$$\theta(x_t) = \frac{\beta}{2}(x_t - \alpha)^2, and x_t = \frac{I_t}{K_t} \quad (9.8.48)$$

$$R^k_{i,t} = rk_t - PK_t\left[\frac{I_{i,t}}{K_{i,t}}\right]^2 \theta'_t(I/K) \quad (9.8.49)$$

Factors accumulation

Capital stock

$$KS_{i,t+1} = (1 - \delta)KS_{i,t} + I_{i,t} \quad (9.8.50)$$

Net in-migration

$$LS_{i,t+1} = \left(1 + \left(\zeta - v^u[ln(u_t) - ln(\overline{u}^N)] + v^w\left[ln\frac{w_t}{cpi_t} - ln\frac{w^N}{cpi^N}\right]\right)\right) LS_{i,t} \quad (9.8.51)$$

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$$K_{i,t} = KS_{i,t} \quad (9.8.52)$$

$$LS_t(1-u_t) = \sum_j L_{j,t} \quad (9.8.53)$$

Taxes and subsidies

$$IBT_{i,t} = btax_i X_{i,t} PX_{i,t} \quad (9.8.54)$$

Import tax

$$IMT_{j,t} = \sum_i MTAX_j VM_{i,j,t} PM_{i,t} \quad (9.8.55)$$

Production subsidy

$$SUBSY_{i,t} = SUB_i X_{i,t} PX_{i,t} \quad (9.8.56)$$

Current Account

Total import demand

$$\begin{aligned} M_{i,t} &= \sum_j VI_{i,j,t} + \sum_j VM_{i,j,t} \\ &+ \sum_h QHM_{i,h,t} + QGM_{i,t} QVI_{i,t} + QVM_{i,t} \end{aligned} \quad (9.8.57)$$

Trade Balance

$$\begin{aligned} TB_t &= \sum_i M_{i,t} PM_{i,t} - \sum_i E_{i,t} PE_{i,t} \\ &+ \epsilon_t \left(\sum_{dngins} \overline{REM_{dngins}} + \overline{FE} \right) \end{aligned} \quad (9.8.58)$$

Assets

Continued on next page

Value of firms

$$VF_{i,t} = \lambda_{i,t} K_{i,t} \tag{9.8.59}$$

Foreign debt

$$D_{t+1} = (1 + r - \tau) D_t + TB_t \tag{9.8.60}$$

Government debt

$$\begin{gathered} Pgov_{t+1} GD_{t+1} \\ = \left[1 + r - \tau g + \left(\frac{Pc_{t+1}}{Pc_t} \right) - 1 \right] \\ GD_t \, Pgov_t + FD_t \end{gathered} \tag{9.8.61}$$

Steady-state conditions

$$KS_{i,T} = I_{i,t} \delta \tag{9.8.62}$$

$$R^k_{i,T} = \lambda_{i,T} (r_T + \delta) \tag{9.8.63}$$

$$FD_T = - \left[r - \tau g + \left(\frac{Pc_{t+1}}{Pc_t} \right) - 1 \right] Pgov_T GD_T \tag{9.8.64}$$

$$TB_T = (-r - \tau) D_T \tag{9.8.65}$$

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Non-financial wealth

$$NFW_T r_t = \sum_h dtr_h(ssce + ire) \sum_j L_{j,T} w_T + \sum_h \sum_{dnginsp} TRSF_{h,dnginsp,T} + \sum TRG_h PC_T + \sum_h REM_h \epsilon_T - \sum_{dnginsp} \sum_h TRSF_{dnginsp,h,T} \tag{9.8.66}$$

Financial wealth

$$FW_t r_T = d^K_{dngins} rk_{i,t} \sum_i K_i - \sum_h SAV_{h,T} \tag{9.8.67}$$

Short-run conditions

$$KS_{i,t=1} = KS_{i,t=0} \tag{9.8.68}$$

$$LS_{t=1} = LS_{t=0} \tag{9.8.69}$$

$$GD_{t=1} = GD_{t=0} \tag{9.8.70}$$

$$D_{t=1} = D_{t=0} \tag{9.8.71}$$

Table 9.8.2: Index for AMOS Summary

Subscripts

i, j	Sectors
t	Time
ins	Institutions
$dins$	Domestic institutions
$dngins$	Domestic non-government institutions
h	Households
g	Government

Endogenous Variables

$PX_{i,t}$	Output Price
$PY_{i,t}$	Value Added Price
$PQ_{i,t}$	Commodity Price
$PR_{i,t}$	Regional Price
$PIR_{i,t}$	National Commodity Price (Scotland + RUK)
$PI_{i,t}$	RUK Price
$rk_{i,t}$	Shadow price of capital
w_t	Regional Nominal wage
w_t^b	After tax wage
PK_t	Capital good Price
UCK_t	User Cost of Capital
λ_i	Shadow price of capital
PC_t	Aggregate Consumption Price
$PGov_t$	Aggregate Price of Government consumption goods
ϵ_t	exchange rate (fixed)

Continued on next page

Endogenous Variables

$X_{i,t}$	Regional Supply
$R_{i,t}$	Regional Supply
$M_{i,t}$	Imports
$E_{i,t}$	Total Exports
$L_{i,t}$	Labour demand
$K_{i,t}$	Physical capital demand
$KS_{i,t}$	Capital stock
$LS_{i,t}$	Labour supply
$VV_{i,t}$	Total intermediate inputs
$VM_{i,t}$	ROW intermediate inputs
$VR_{i,t}$	Regional Intermediate Inputs
$VI_{i,t}$	RUK Intermediate Inputs
$VIR_{i,t}$	National Intermediate Inputs (Scotland + RUK)
$QGR_{i,t}$	Regional government consumption
$QGM_{i,t}$	Imported government expenditures
C_t	Regional government expenditures
$QH_{i,h,t}$	ROW investment demand
$QHR_{i,h,t}$	Regional household consumption
$QHM_{i,h,t}$	Regional household consumption
$QV_{i,t}$	Investment by origin
$QVR_{i,t}$	Regional investment by sector of origin
$QVM_{i,t}$	ROW investment demand
$QVIR_{i,t}$	National investment (Scotland + RUK)
$QVI_{i,t}$	RUK investment demand
$I_{j,t}$	Investment by sector of destination j
$J_{j,t}$	Investment by destination j with adjustment cost
u_t	Regional unemployment rate

Continued on next page

$R^k_{i,t}$	Marginal Net Revenue of capital
$SAV_{dngins,t}$	Domestic non-government saving
$YNG_{dngins,t}$	Domestic non-government income
$TRSF_{dngins,dnginsp,t}$	Transfer among dngins
$HTAX_t$	Total household tax
TB_t	Current account Balance
$SUBSY_t$	Production subsidy

Exogenous Variables

$\overline{REM_t}$	Remittance for dngins
$\overline{FE_t}$	Remittance for the Government
$QG_{i,t}$	Government expenditure
$GSAV_t$	Government savings
r_t	Interest rate

Elasticities

σ	Constant elasticity of marginal utility
ϱ_j	Elasticity between labour and capital in sector j
ρ^A_t	Elasticity in Armington function
σ^x_t	Elasticity of export with respect to term of trade
μ	Elasticity of real wage with respect to the unemployment rate
υ^u	Elasticity of migration to the unemployment differential
υ^w	Elasticity of migration to the real wage differential

Parameters

$a^V_{i,j}$	Input-Output coefficient for i used in j
a^Y_i	Share of value added in production

Continued on next page

$\delta_j^{k,l}$	Shares of capital and labour in the value-added function
$\delta_{i,j}^{vm,vir,vr,vi}$	Share parameters in CES function for intermediate goods
$\delta_{i,j}^{qvm,qvir,qvr,qvi}$	Share parameters in CES function for investment goods
$\delta_{i,h}^{hr,hm}$	Share parameters in CES function for household consumption
$\delta_i^{gr,gm}$	Share parameters in CES function for government consumption
$\gamma_{i,j}^{vv,vir}$	Shift parameter in CES functions for intermediate goods
γ_i^f	Shift parameter in CES functions for household consumption goods
γ_i^g	Shift parameter in CES functions for government consumption
$btax_i$	Business tax
sub_i	Rate of Production subsidy
$MTAX_i$	Rate of Import Tax
$KM_{i,j}$	Physical capital matrix
mps_{dngins}	Institution rate of savings
$ssce$	Rate of social security paid by employees
$sscer$	Rate of social security paid by employers
ire	Rate of direct household tax
cre	Rate of household consumption tax
ρ	Pure rate of consumer time preference
bb	Rate of distortion or incentive to investment
δ	Depreciation rate

9.9 Appendix 8

Table 9.9.1: Taxation and Benefit Overview

	UK	Scandinavia	Denmark	Finland	Norway	Sweden
Tax Revenue as % of GDP in 2009	32.3	43.3	46.4	40.9	42.0	44.0
Social Security as % of GDP in 2009	6.4	10.9	-	12.2	9.8	10.8
Value Added Tax in 2009	20	24.8	25	24	25	25
Average Rate of Income Tax Paid in 2009	32.4	40.6	38.6	43.1	37.3	42.9
Unionisation Rates in 2012	26%	64%	67%	68%	53%	68%

(OECD, 2014; Barth, Moene, & Willumsen, 2014)

Figure 9.9.1: Adjustment Paths: Conventional - Macro

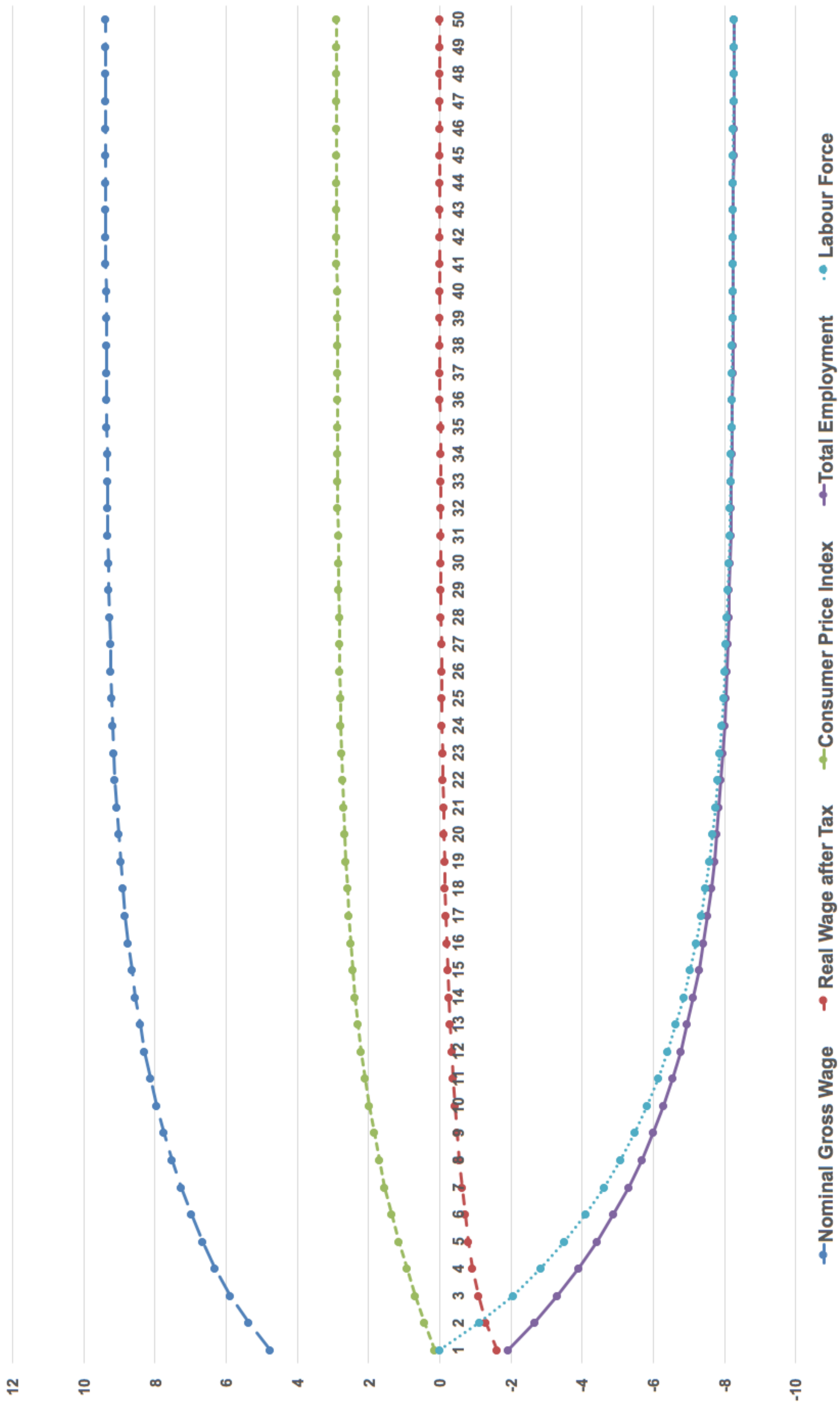


Figure 9.9.2: Adjustment Paths: Conventional - Micro

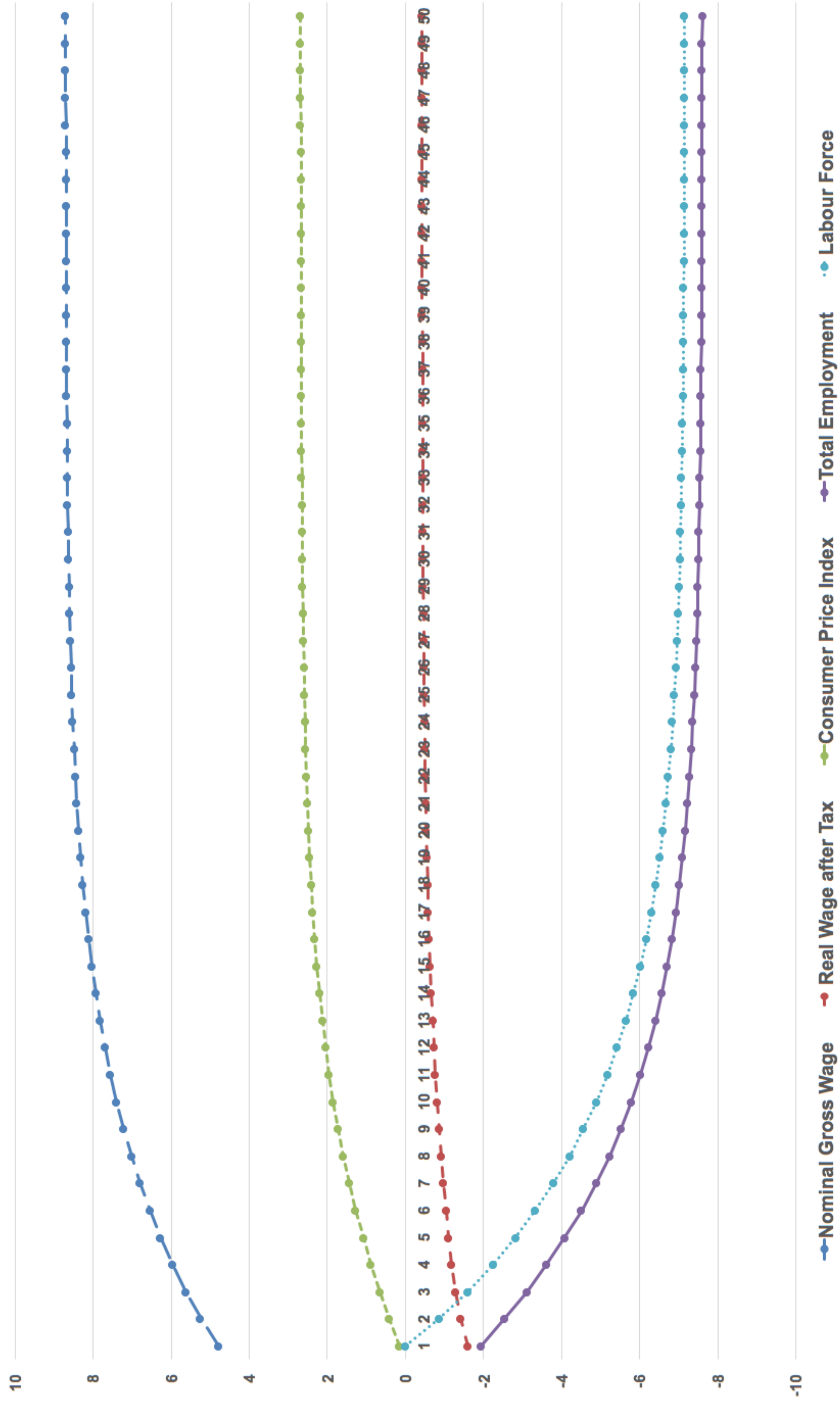


Figure 9.9.3: Adjustment Paths: Social Wage

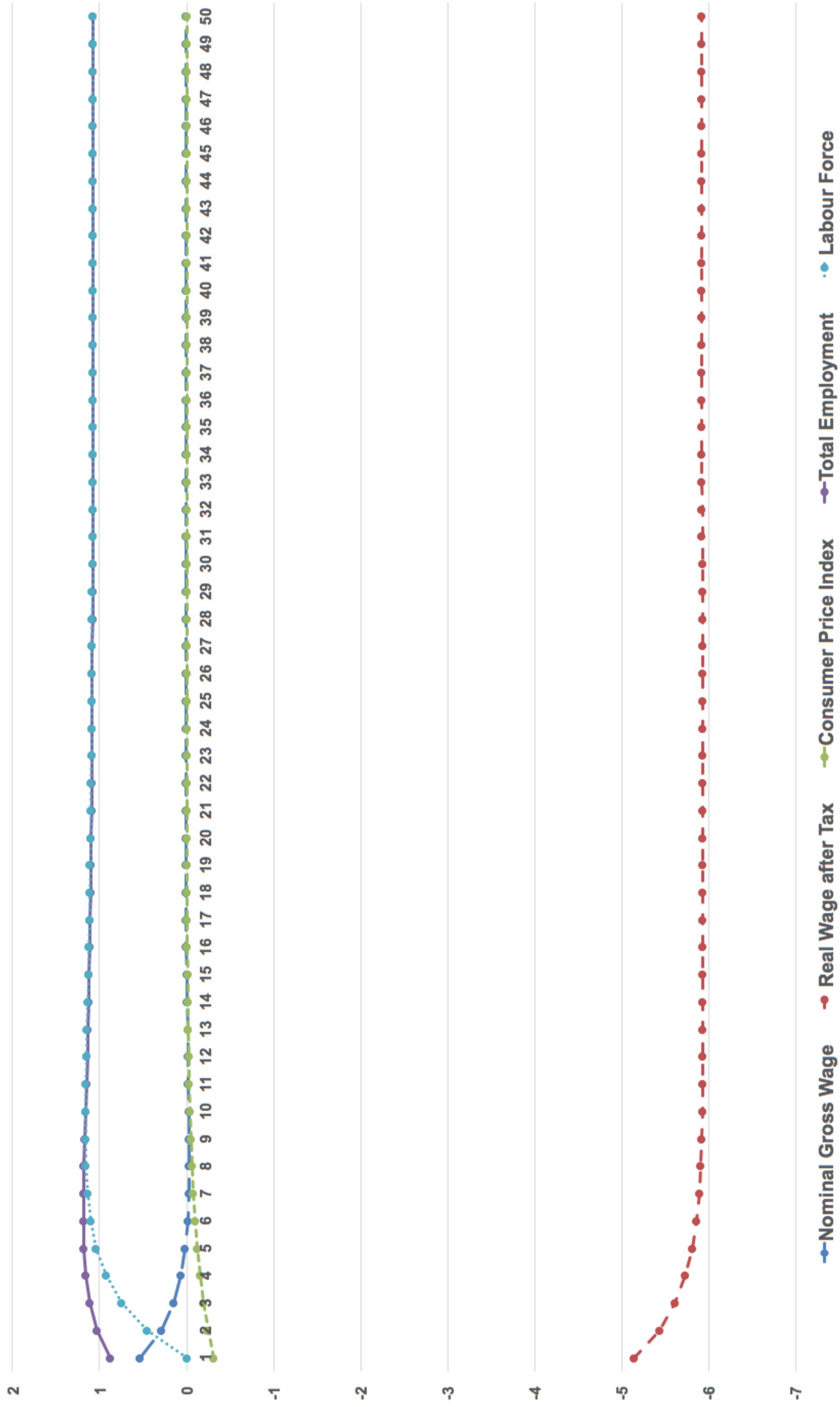
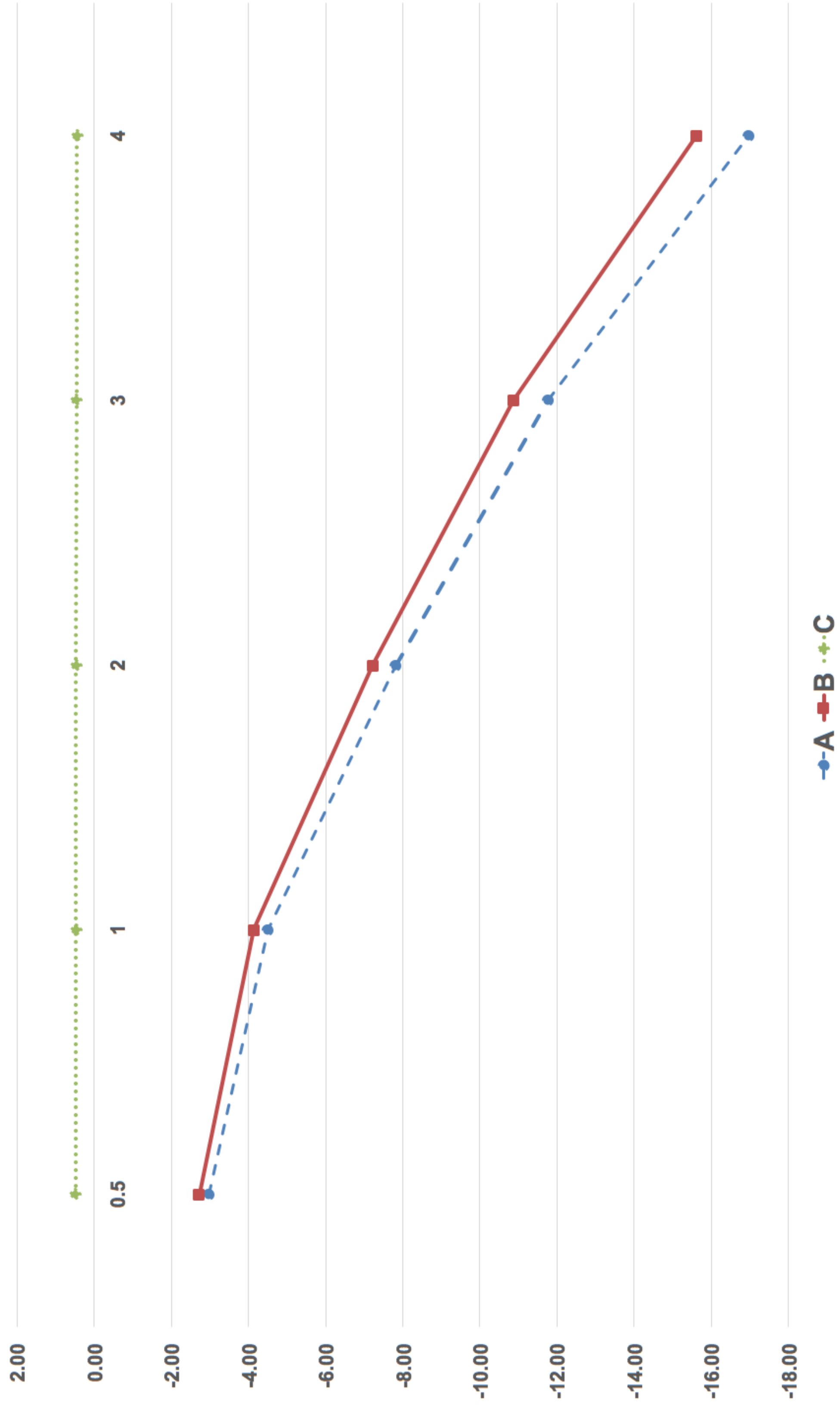


Table 9.9.2: Short Run vs Long Run Results by Sectors - GRP

	Conventional - Macro		Conventional - Micro		Social Wage	
	SR	LR	SR	LR	SR	LR
1. Agriculture, forestry and fishing	-2.54	-9.14	-2.54	-8.57	-0.66	-1.14
2. Mining	-1.79	-6.14	-1.80	-5.71	-0.22	-0.12
3. Food, drink and tobacco	-2.62	-7.97	-2.63	-7.47	-0.66	-0.92
4. Textile, leather, wood and paper	-3.52	-9.71	-3.51	-9.06	-0.56	-0.48
5. Chemicals	-2.30	-8.18	-2.31	-7.62	-0.26	-0.28
6. Rubber, plastic, cement and iron	-4.07	-11.09	-4.05	-10.34	-0.49	-0.41
7. Computer, electrical and transport equipment	-3.84	-10.16	-3.82	-9.45	-0.30	-0.13
8. Electricity, gas and water	-2.39	-8.40	-2.39	-7.85	-0.51	-0.67
9. Construction	-5.90	-11.17	-5.77	-10.42	-0.66	-0.50
10. Wholesale and retail	-4.00	-9.65	-4.00	-9.09	-1.57	-1.84
11. Land transport	-3.52	-10.29	-3.52	-9.62	-0.84	-0.87
12. Water transport	-3.02	-8.15	-3.02	-7.64	-0.84	-0.88
13. Air Transport	-3.26	-9.07	-3.27	-8.53	-1.19	-1.50
14. Post and support transport services	-3.24	-11.21	-3.25	-10.47	-0.57	-0.67
15. Accommodation	-3.21	-7.50	-3.21	-7.05	-1.16	-1.19
16. Food & beverage services	-4.21	-8.88	-4.20	-8.40	-2.03	-2.28
17. Telecommunication	-3.31	-10.11	-3.32	-9.46	-0.90	-1.01
18. Computer and information services	-3.77	-10.37	-3.76	-9.66	-0.59	-0.21
19. Financial services	-2.36	-8.19	-2.37	-7.66	-0.48	-0.66
20. Real estate	-3.01	-8.88	-3.01	-8.40	-1.44	-2.33
21. professional services	-3.27	-10.41	-3.27	-9.68	-0.35	-0.06
22. Research and development	-3.28	-9.72	-3.29	-8.99	0.29	0.75
23. Public administration	1.59	-5.27	1.59	-4.55	4.32	4.96
24. Recreational services	-2.98	-8.71	-2.97	-8.12	-0.50	-0.44
25. Other services	-3.90	-10.18	-3.90	-9.58	-1.46	-1.72

Figure 9.9.4: Long-Run Percentage Change Variations in GRP - Export Demand Elasticities



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