The Determinants and Consequences of Regional Migration

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DECLARATION OF RIGHTS

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To Abah (1918-1981)

"Kehadapan anakanda yang jauh di mata tetapi sentiasa dekat di dalam hati. Tidak ada sesuatu pun yang mustahil jika kita berani mencubanya, Insyallah….."

Translation.

"To my dearest daughter, who is far from my sight but always dear to my heart. Nothing is impossible if we only dare to try, ….."

This is part of a letter I received from my dad, whom I fondly called abah (father in the Malay language) when I was doing my first degree in the USA. He died two weeks after I got his letter…

Part I

Part I.

Chapter 1.

1.1. Introduction

The migration process is important for regional economies for many reasons. It is, for example, thought to assist in the correction of any regional imbalances created by regional shocks. Ideally, migration would allocate labour to the region that is in greatest need. This view implies that migration plays an "equilibrating" role, at least ultimately. In its limiting form, this view implies that migration adjusts instantaneously, implying virtually continuous spatial equilibrium of labour markets. However, less extreme versions of this view encompass at least one form of "disequilibrium" perspective on migration. While these models avoid assuming continuous spatial equilibrium, they do assume that such equilibrium is ultimately attained through migration. Models like that of Layard *et al* (1991) may imply that it takes a long time to establish equilibrium, but they do not imply that disequilibria are made worse by migration. This type of disequilibrium model assumes that migration is a function of regional real wage, employment or unemployment rate differentials. (Examples also include , Jackman and Savouri, 1992 and Ermisch 1995).

In these models migration occurs when the expected utility gain exceeds the cost of movement. Here, migration and market adjustments are assumed to be relatively slow, however, so that a new spatial equilibrium may not be achieved for a long period. On the other hand, advocates of "equilibrium" migration models (for example Graves, 1980; Graves and Knapp, 1988) emphasise the role that amenity differentials play in migration and assume that spatial differences in economic opportunities reflect largely compensating differentials associated with corresponding spatial differences in amenities. The equilibrium approach assumes that regional labour and land markets clear continuously and that the migration process is efficient and very rapidly completed. As a result, any significant changes in spatial differences are quickly restored through migration. Thus any household disequilibrium caused by changes in amenity demand and supply is immediately eliminated by migration so restoring spatial compensating differentials in (land and) labour markets.

The disequilibria experienced in the models just dicussed only exist because of the presence of extended adjustment to disturbances. In contrast, there also exist "fundamental disequilibrium" models, typically focussed on some kind of "cumulative causation" perspective. This alternative perspective on the migration process argues that migration flows could actually create, or certainly exacerbate, labour market disequilibria.

In this dissertation we set out to examine both the determinants of migration and its wider effects. Part I of this dissertation deals with the determinants of migration and Part II considers the consequences of migration in a system-wide context.

Overall, in the British context migration is often perceived to have a positive (though small) contribution towards the equalisation of regional unemployment rates. This view is based mainly on studies of aggregate regional migration flows which show that over the past 40 years there has been net aggregate migration out of depressed (high unemployment) regions. A number of studies, such as that conducted by Hart (1970), Molho (1982), Gordon (1985) and Pissarides and McMaster (1990) found that migration gradually reduces unemployment differentials.

In Part I of the dissertation, we begin, in Chapter 2, with a critical review of theories of the determinants of migration. We then, in Chapter 3, provide a summary of past empirical studies of migration, before going on to present our own econometric analysis of net migration flows between Scotland and the UK. In Part II we begin by providing a theoretical analysis of the consequences of migration in a system wide context, in Chapter 4. We then , in Chapter 5, outline the structure of AMOS, A Micro-Macro Model of Scotland, which is of the computable general equilibrium (CGE) type. . In Chapter 6 we present the results of simulating the impact of demand disturbances under alternative formulations of the net migration function. We then consider, in Chapter 7, the importance of the specification of the migration function for the impact of supply disturbances.. Finally, in part III of the thesis (Chapter 8) we provide a summary of our dissertation and present our main conclusions.

1.2. Overview of Part I: The Determinants of Migration

1.2.1. Introduction to theories of the determinants of net migration flows.

Part I of our study concerns the determinants of net migration focussing our own econometric analysis on migration flows between Scotland and the Rest of the UK (RUK). In Chapter 2 we discuss the various approaches to migration studies. The earlier approach is the classical approach that suggests migration between two places is mainly due to the existence of real wage differentials between the two, in a perfectly competitive context where migration is assumed to be costless. This classical approach has been criticised because of several perceived limitations. One of the main weaknesses of the classical approach is that "it fails to allow for regional differences in employment opportunities. This stems from the assumption that wages are perfectly flexible and that labour markets adjust automatically to situations of disequilibrium" (Armstrong and Taylor,1993). Also the fact that the classical approach assumes migration is costless is rather unrealistic. One subsequent development is the human capital approach first introduced by Sjaastad (1962) regards migration as an investment that involves initial costs, but also yields a stream of expected returns, in the form of, for example, higher wages earned in each period in the new location.

The basic human capital approach uses discounted costs and benefits as bases to undertake a decision. After discounting, if benefits are greater than costs,that is if the net present value of migration is greater than zero, then migration will take place. The costs involve include both pecuniary and non-pecuniary costs. Pecuniary costs include transport costs, and the psychological costs of leaving familiar surroundings constitutes the non-pecuniary costs. Hart (1975) developed a human capital model as follows. He considers a risk averse potential migrant who is now living in one particular region and considers relocating to another region. The person calculates his net returns over the time span up to his retirement. In line with the standard human capital approach the decision to migrate into a region depends on a comparison of the expected present value gains from the two regions. If the discounted expected returns are greater in the destination region than the expected costs of moving migration occurs. Otherwise an individual will not migrate. Later Mincer (1978) extends the model to include households as the relevant decision making unit, while Da Vanzo (1983) considers the possibility of multiple moves. Green (1997) highlights the need to compromise in dual career households.

The search process involves the effort of looking for the best alternatives. The relevance of the search process in economics was first highlighted by Stigler (1961,1962). He relates the importance of search in the market, where both sellers and buyers need the best information regarding the highest and lowest price preferred. The search process involves costs and is expensive if it is done individually. The process of moving location is often viewed as the product of a search process. Potential migrants need to know the economic situation in the destination region, hence the search approach provides the missing link by treating uncertainty explicitly. Todaro (1969) was among the first to recognise how a potential mover would discount offers by the probability of finding a job. The reservation wage is the basis for a searcher to accept or reject the opportunities as they arise. Lippman and McCall (1976) begin with the simplest sequential job search model where an unemployed person is seeking a job. Each day the searcher goes out looking for a job, and each day he/she is allowed to generate only one job offer. The job search model is extended to the study of migration. For example, Gordon and Vickerman (1982) attempt to derive the expressions for the probability of migration explicitly. The probability of movement to a chosen destination at a particular time period is said to be dependent upon three basic sets of probabilities namely: the probability of being in search at this period; the probability of receiving an opportunity (provided a search is undertaken), and the probability of accepting the opportunity conditional on receiving an offer. Molho (1986) created a migration decision framework that includes speculative moves.

The gravity model, that is said to derive its name from an analogy to the gravitational interaction between planetary bodies (Haynes 1984), has been widely used in the geographical context. The use of gravity models in migration can be traced back to Ravenstein (1885) who argued that, in studying migration streams, the analyst should consider both the numbers of people in the origin and the destination locations. Lowry later propounded the "economic" gravity model that has greatly influenced econometric work on the migration process (Greenwood 1975). The basic gravity model of migration shows the migration process between any pair of regions depends on the size of the population in each region and the distance attributes between them. The gravity model is used in the study of the determinants of migration in the US (Greenwood and Sweetland, 1972). They found that "distance is the main deterrent to migration and migrants are said to have high tendency to move from low income to high income areas and to areas where there is high per capita government spending." Temperate climate is also found to be a major attraction.

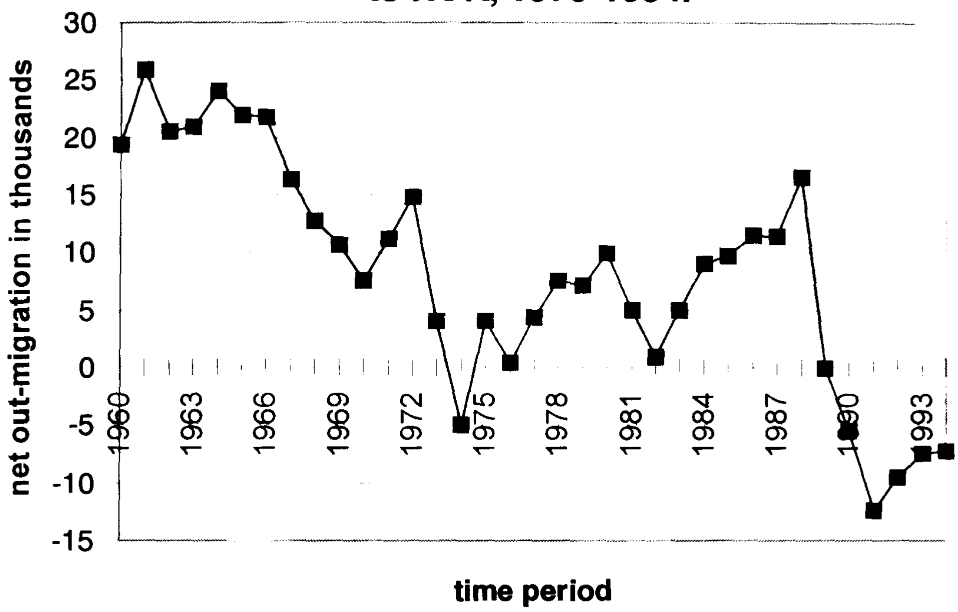
The flow model of migration (for example, Layard *et al* (1991)) implies migration continues as long as differentials in determinants persist. In this case the flow model appears to assume homogeneity of households' "tastes for migration." On the other hand the stock adjustment approach assumes heterogenity of migration preferences across individuals. In the latter case, even if the determinants of migration, such as the real wage differential, change, a limited number of people will migrate between the two regions.

We also seek to address the problems encountered when dealing with the net migration issue. Researchers such as Rogers (1990) have made it clear that models expressed in terms of a net migration rate, measured solely in terms of the origin population, are mis-specified. We thus discuss the need to rectify this problem by incorporating the destination population stock variable into our model of net migration.

1.2.2. Introduction to the estimation of net migration models.

Following the discussion of migration theories, we proceed, in Chapter 3, to conduct our own econometric analysis of the determinants of net Scottish-Rest of UK (RUK) migration data. The theoretical analysis suggests that there are many possible reasons why a potential migrant might move out of a region. For example, the real wage, unemployment rates, educational opportunities, job availability, climatic factors (such as mean temperature) in origin and destination regions, and social factors (such as marriage) may all govern why an individual chooses to migrate. Relative real wage rates, relative unemployment rates, (Layard *et al*, 1991) relative prices and relative vacancy rates (Jackman and Savouri, 1992) between the origin and destination regions are among the economic factors that are emphasised by many as having a strong influence on the decision to migrate or not to migrate. Our concern is with the determinants of the net out-migration rate between Scotland and the rest of the UK (RUK). We define the net out-migration rate as the ratio of the number of net out-migrants from Scotland to the rest of U.K, to the population of Scotland in the previous period. In the period 1970-1994 net out-migration between Scotland and RUK has been positive except for 1974 and the last five years, 1989-1994 as shown in Figure 1.1.

Figure 1.1. Plot of Net Out-Migration from Scotland to RUK, 1970-1994.



We test several migration models such as the Ermisch (1990) and LNJ (1991) models using the Scottish-RUK migration data. We find that none of the basic models, which were initially estimated on other data, can be used to explain the Scottish-RUK migration flows. We then modify these models to allow for 'case specific' dynamics, including lagged exogenous variables, the lagged dependent variable and a time trend variable in the quest of identifying a "best fitted" model for Scottish-RUK net migration flows. However our results show that even these models fail to explain a significant portion of the migration flows between the two regions.

We go on to estimate our own flow adjustment and stock adjustment models, because we hope to obtain the "best fitting" model for the Scottish-RUK migration data. Our flow models give mixed results. For example, the relative real wage between Scotland and RUK sometimes seems to be a significant variable, but has a non-conventional sign. When included in the model, the relative price variable (proxied by the relative house prices) is significant but has the sign opposite to that regarded as conventional. We also include employment related to north-sea oil production to see whether it makes any difference to our results. However it does not seem to be a significant variable. In terms of the test statistics our results with the stock adjustment model look quite promising but the real wage differential does not have the expected sign. The unemployment differential does not seem to be a significant variable, which parallels recent findings by others (Hughes and McCormick, 1994).

As mentioned in our theory, Chapter 2, there are bound to be problems associated with our focussing on the determinants of net migration. Consequently, we explore ways of investigating this possible source of bias, while retaining the focus on net migration rates. We wish to retain this focus because of our ultimate concern with the effects of migration flows on the labour market. Here we begin with transformation to the population ratio model and immediately go to its simplified form, the "share" model. We estimate the models using the adjusted population where migration is the only source of change, and the true population as given by our data. A full account of our results is provided in Chapter 3.

1.3. A system-wide analysis of the consequences of migration.

In Part II we discuss the consequence of migration for the impact of demand and supply disturbances. We also analyse the impact of alternative migration functions. In Chapter 4 we provide a theoretical account of the effect of the migration process on the impact of both demand and supply disturbances. In Chapter 5 we discuss the macro-micro model of Scotland, AMOS, the computable general equilibrium model that we use in our simulations. In Chapters 6 and 7 we provide the simulation results for a demand and a supply disturbance respectively.

We analyse the potential equilibrating role of migration in a regional context in some detail. The system wide role played by migration is explored using a computable general equilibrium model of Scotland. If migrants respond to (relative) real wages and to (relative) unemployment rates, then this implies that, at the regional level, any stimulus that raises the real wage rate and/or reduces unemployment rates, would attract in-migration and so alter the way in which such a stimulus affects the region's economy. We show that migration can have a major impact on the way that regional economies react to various disturbances. Furthermore, we also demonstrate that the precise specification of the net migration function can significantly alter regions' responses to both supply and demand shocks.

1.3.1. Outline of theory.

We develop a theoretical analysis based on the Layard *et al* (1991) imperfectly competitive model of region. We make use of three conceptual time intervals to simplify our analysis. Over the short-run, capital stocks are assumed to be fixed as is population. It takes time for households to respond to any changes in the incentives to migrate. Over the medium run population is fully adjusted and the migration process is complete. In the long-run capital stocks are variable and fully adjust in response to any changes in capital rental rates (profitability) relative to user costs of capital that arise in the short-run. We also assume that Scotland is a small open economy, at least compared to the rest of the UK (RUK), so that all RUK variables, including wage and unemployment rates, can be taken to be exogenous.

We apply a demand shock in the form of an increase in manufacturing exports and consider what difference it makes to the system when migration takes the form of a flow or stock adjustment specification, or when zero labour mobility is assumed. The demand stimulus causes an increase in labour demand which in turn pushes up the real take home wage and employment. Obviously the unemployment rate (defined as unity minus the employment rate) falls. In the short-run, or impact interval, no migration occurs: it takes time for households to begin to respond to any change in the incentive to migrate. Although wage rates in Scotland are higher and unemployment lower than before the shock, no migration occurs. With the flow adjustment migration model, and with wages determined in accordance with regional bargaining (and so responsive to local labour market pressures), the increase in real wage and fall in unemployment rates that occurs in the short-run attract migrants into Scotland in the medium-run. As more migrants are attracted into Scotland, there is downward pressure on wages as the employment to labour force ratio falls. Simultaneously, the unemployment rate increases. With the flow model, because of the assumption that households have homogeneous migration "tastes", and given that Scotland is small in relation to the rest-of-the UK so wage and unemployment rates can be regarded as exogenous, in-migration into Scotland continues until the initial real wage and unemployment rates are re-established. Labour, in this case, is effectively assumed to be in infinitely elastic supply in the longer-run. However, output and employment are permanently expanded. Ultimately, after capital stock adjustment is completed, equi-proportionate expansion in employment, value added and capital occurs in all the three sectors because real wages and prices return to the original equilibrium values.

With the stock adjustment model of migration, the increase in the real wage rate and fall in the unemployment rate that occur in the short-run attracts in-migration into Scotland in the medium-run. The real wage falls as the ratio of employment to labour force falls. However, neither the real wage nor the unemployment rate return to their original levels because in-migration into Scotland is not a continuing process in this model. Labour is, in effect, region-specific, to a degree even in the medium and long-runs. This is because households are assumed to have heterogeneous "tastes" for migration .

With zero mobility, the increase in the real wage and fall in the unemployment rate do not attract in-migration into Scotland. Hence the real wage remains permanently higher than the initial equilibrium, and the unemployment rate is permanently lower than its initial equilibrium value. Employment increases, and the jobs created are absorbed solely by local Scottish workers since no migration occurs. In the long-run, since population expansion does not occur in this case, only capital stocks adjust fully. The increase in output in the long-run will be constrained by the limited local population. Any further increase in demand causes the real wage to increase and, in turn, prices will increase. This will result in Scottish goods becoming less competitive than goods produced elsewhere. Hence exports will fall while imports rise.

We next introduce a supply shock to the system to explore how their impact is affected by the assumed nature of the migration process.. The supply shock takes the form of a labour subsidy. In the short-run, an increase in a labour subsidy to manufacturing reduces the real wage to firms, thus making it cheaper for producers to hire labour. Initially the real wage to the firm falls by the amount of the subsidy while the real take home wage for workers remains unchanged. At this point the demand for labour is greater than supply, hence pushing up the market real wage, when wages are determined through regional bargaining. The fiscal stimulus that arises due to government spending on the labour subsidy increases demand in general, since we take the subsidy to be externally financed. This short-run result is, of course, identical throughout the models because no migration is possible in this impact interval.

With the flow adjustment model, in the medium-run, with fixed capital and labour endogeneity, in-migration continues until a new zero-net-migration is established. In the long-run the inflow of migrants causes the employment rate relative to labour force to fall. This causes the unemployment rate to rise towards the original equilibrium rate. The economy is in a new equilibrium position with the real wage to the firm falling by the amount of the subsidy, and the unemployment rate returning to the original rate.

When the stock adjustment migration specification is used, in the medium-run, under the bargained real wage closure (in which real wages respond to regional labour market pressures), migrants come into Scotland responding to the increase in real take home wage and fall in unemployment rate that occur in the short-run, thus reducing the employment rate. Unlike the response under the flow adjustment model, the influx of migrants does not continue until the initial real wage and unemployment rates are re-established. Here labour remains a scarce factor, even in the long-run. In the long-run, the economy is in a steady state with a new (higher) equilibrium real wage and new (higher) employment rate. The unemployment rate is permanently reduced and the economy is at a new level of output, with employment and population permanently expanded.

With zero labour mobility the impact of the supply shock (in the form of a labour subsidy to manufacturing) will be fully absorbed by the region's own labour market. The wedge between labour cost to producer and the wage received by workers makes it cheaper for the producer to hire more labour. Initially the real wage to workers is unchanged but the limited labour supply due to zero mobility puts upward pressure on wages. Consequently the bargained real wage increases as labour demand increases. In the long-run the labour market is in equilibrium at a new position where the new bargained real wage, intersects the new labour demand curve. The unemployment rate is permanently reduced and employment expanded.

Overall, our theoretical analysis serves to emphasise the critical importance of alternative views of migration for the qualitative behaviour of regional economies.

1.3.2. A Micro-Macro Model of Scotland (AMOS)

We provide a very brief description of the computable general equilibrium model, AMOS, that we employ to explore the consequences of alternative visions of the migration process on the impact of various disturbances on regional economies. We provide a fuller account in Chapter 5. AMOS has four domestic transactor groups, namely households, non-household personal sector, corporations and government sector. The version of AMOS used in this dissertation has three commodities and activities, namely manufacturing, non-manufacturing traded and non-traded (or sheltered sector). Commodity markets are assumed to be competitive and Scotland is assumed to be a price-taker in competitive UK financial markets.

In all our simulations we impose a single Scottish labour market characterised by perfect sectoral mobility. We consider two cases, first we hypothesise that the labour market is characterised by a bargained real wage function (BRW) in which the regional real consumption wage is directly related to workers bargaining power, as indicated by the employment rate. BRW is therefore inversely related to the regional unemployment rate. The BRW function we use is that of Layard *et al* (1991). Secondly, we employ a national wage bargaining closure. In this case, wages are bargained at the national level and the nominal wage is effectively dictated to the region, so that regional labour markets have no direct impact on regional wages.

We investigate three characterisations of labour mobility in the simulations. First, following Layard *et al* (1991, Chapter 6), we take net migration to be positively related to the relative real wage and negatively related to relative unemployment rate between Scotland and RUK. This is a parameterised variant of what we call the ***flow migration*** model. Second, we take net migration to be positively related to the change in real wage differential and negatively related to the change in unemployment rate differential between Scotland and RUK. This is our ***stock adjustment*** model. Third, we assume, alternatively, that labour is immobile, which provides a limiting benchmark case for our studies. We include several alternative net migration functions into AMOS, to allow us to investigate the impact of these alternatives on system-wide behaviour.

1.3.3. Simulation results.

In Chapters 6 and 7 we discuss the simulations that we conduct using various migration models. We conduct simulations with the demand shock (Chapter 6) in the form of export stimulus to see what difference alternative migration models make to system-wide responses.. We then change the migration parameters to test for the sensitivity of the results to such changes. We conduct the simulations initially with the bargained real wage closure, then under the national bargaining closure to show how the results vary under different labour market closures. Next, in Chapter 7 we introduce a supply shock in the form of a labour subsidy. We again compare the system-wide impact of this shock under the flow migration model, stock adjustment hypothesis and zero labour mobility, so that we can assess the importance of the migration response for regional economic behaviour.

We first discuss the results obtained when the regional bargaining closure is employed. With the demand shock, in the short-run with zero labour mobility the 10% increase in export demand stimulates aggregate employment and the real wage. There is a marked increase in employment in the manufacturing sector, but in the other two sectors it actually falls. The expansion in the manufacturing sector indirectly attracts workers from the other two sectors through upward pressure on the wage, and their consequential loss of competitiveness. The short-run results are identical for all three models because there is no migration over this interval: it takes time for migration flows to respond to stimuli. The demand shock also increases the returns to capital sharply in the manufacturing sector, while the other two sectors experience a small increase in the returns to capital, reflected in capital rental rates. However, again in the short-run there is no corresponding adjustment of capital stocks.

With the flow model, in the medium-run, over which the zero-net migration condition becomes binding and migration responses are therefore complete, the impact of the demand shock on output and employment rises. GDP and total employment rise. However, real wage and unemployment rate return to their original values, since these are tied down by the flow equilibrium conditions (and the exogeneity of RUK wage and unemployment rates)In the long-run, the supplies of labour and capital effectively become infinitely elastic and this ultimately limits all price rises to zero. In these circumstances the system operates as an input-output model in response to demand disturbances, with equal proportionate expansions in employment, capital and value added within each of the three sectors. These results parallel the findings by McGregor *et. al.* (1995). The 10% increase in export demand is fully realised in the manufacturing sector: ultimately exports from this sector increase by the full ten per cent. On the other hand when the stock adjustment migration model is used, our results do not exhibit input output results. The stock adjustment (SA) results are radically different from the flow results in magnitude and in adjustment speed. The increase in GDP is only about half that of the flow adjustment (FA) result. The long-run steady-state results are obtained faster with the stock adjustment model (which, for example, tend to occur around period 35) than with the flow adjustment model (period 90). In the long-run the export sector does not receive the full 10% impact of the demand stimulus unlike with the FA model because in the SA case labour remains a scarce factor.

When we change the elasticities of migration with respect to real wage and unemployment rate the results show that for both FA and SA models the impacts on the net present value of GDP and GDP respectively are more sensitive to variations in the unemployment rate elasticity than to variations in the real wage elasticity.

With zero mobility, in the long-run when capital expands, the increase in capital rental rates is partially offset in all three sectors, but they are still above their base values. Employment increases in all the three sectors, and simultaneously the unemployment rate falls. In the long-run the economy settles at a higher level of output, and at a higher employment rate (and thus lower unemployment rate) than originally. The real wage increases permanently and so the unemployment rate does not exhibit a natural rate of unemployment or a NAIRU of the kind that applies under the flow-adjustment model of migration.

Next, in Chapter 7 we analyse the system-wide impacts of a supply shock. In the short-run the fall in the real wage to producers resulting from the introduction of the labour subsidy to the manufacturing sector stimulates employment. The real take home wage under the regional bargaining closure increases and the unemployment rate falls. The labour subsidy thus provides a stimulus to the manufacturing sector by reducing labour costs and therefore prices. In the other two sectors demand increases due to the fiscal stimulus implied by an externally funded labour subsidy and to the expansion in manufacturing. However, the increase in consumption wages implies an adverse supply shock to these other sectors that dominates the demand effect in the short-run. The real product wage falls in the manufacturing sector, while in the other two sectors it increases. This reflects the fact that the subsidy is only to the manufacturing sector, while the general demand stimulus tends to increase wages across the board. These short-run results are identical throughout the models because no migration can occur over this interval. It is the medium- and long-run results that vary across the models.

With the flow adjustment model, in the medium-run as migrants come into Scotland from RUK, attracted to the higher wages and lower unemployment rate relative to elsewhere, the increase in total employment matches the increase in population. The unemployment rate remains unchanged. By this period the expansion extends to the other two sectors because net in-migration reverses the rise in the real consumption wage. GDP increases further due to the greater impact of the fiscal stimulus as the short-run increase in wages is offset. Finally, in the long-run the real take home wage remains unchanged as in the medium-run. Total employment and population increase by the same percentage, implying no change in unemployment rate. In the long-run there is an expansion in employment in all the three sectors.

With the SA model, in the medium-run in-migration into Scotland occurs as a response to the increase in employment triggered by the labour subsidy. In the long-run the real take home wage increases and unemployment rate decreases further. This suggests the unemployment rate does not return to its original level. There is apparently no NAIRU result, unlike the results under the FA model. (However, notice that in the FA model, while the unemployment rate is ultimately unaffected the levels of output and employment are permanently affected, even for a demand disturbance.) The long-run impacts on value added, employment and capital stocks are not equiproportionate as a result of the substitution of labour for capital, given the fall in the cost of labour to firm.

With zero mobility, in the medium- and long-runs the increase in the demand for labour, as a result of the subsidy, increases the real take home wage. Although the real take home wage is higher in Scotland, there is no in-migration, because labour is immobile. The increased employment will be absorbed by the locals, reducing the unemployment rate permanently.

With the national wage bargaining we find that the results we get differ from those under the bargained real wage closure markedly. For example, GDP in period one increases by more than double the period one increase in GDP under regional bargaining when the supply shock is imposed. This is because wages are not affected by developments in the Scottish labour market under national bargaining, while under regional bargaining, the fall in the unemployment rate increases wages and limits the extent of increase in GDP.

1.4. Conclusions.

Finally in Chapter 8 we conclude by giving a summary of our findings and some suggestions for future research in this area. Our single most important finding is that the specification of the net migration function maybe critically important in governing the response of regional economies to demand and supply disturbances. We also provide appendices for: data description; the specification of our computable general equilibrium model, AMOS, and for the econometric methodology that we adopt in Chapter 3.

Chapter 2. Theories of the Determinants of Migration.

2.1. Introduction.

Interregional movements of capital and labour play a critical role in theories of regional development and growth. The particular factor flow that we are mainly concerned with is the flow of labour. Labour migration is a more complex phenomenon than flows of capital, and this may account for the many theories of migration that have been developed. In section 2.2 of this chapter we begin by describing the classical model of labour migration. The classical model stresses the importance of wage differentials between regions as the main determinant of migration.

Next in section 2.3 we go on to describe the human capital approach which has been of great importance in the study of migration since it was first introduced by Sjaastad (1962). This approach treats the migration decision in a similar manner to the decision to invest in human capital. A potential migrant is taken to act so as to maximise the expected utility derived from the future streams of benefits and costs associated with alternative locations. This provides a decision criterion whereby a utility maximising person will choose that location which accords with this objective.

In section 2.4 we discuss the search theory of migration. Unlike the human capital approach, the search approach divides the search process into two levels. In first level the decision concerns whether migration is going to take place at all. In the second level, the decision on where to migrate is considered.

Section 2.5 presents the gravity approach. This approach emphasises two basic elements, namely the impact of population size geographic distance on migration decisions.

2.2. The Classical Approach.

The classical approach suggests that migration between the origin and the destination region is mainly determined by wage differentials between the two regions. The classical model of migration is constructed under the most extreme assumptions. The classical approach assumes that perfect competition exists in all markets and the production functions exhibit constant returns to scale. Migration is assumed to be costless and there are no barriers to migration. Factor prices are assume to be perfectly flexible and factors of production are homogenous. Owners of labour and capital are assumed to have complete information about factor returns in all regions. The classical model can be described by a simple example. Suppose the economy consistsof two regions, A and B. The economic capacity of the two regions is identical: they produce the same goods and use the same technology. Both the demand and the supply of labour are also assumed identical thus the wage differential will be zero. Labour migration will occur between the two regions as a response to any change in wages. Suppose there is a decrease in the supply of labour in region B due, for example, to a reduction in the retirement age. The real wage increases in region B as the supply of labour shrinks. Given perfect information and no costs of or other barriers to migration, there will be a movement of labour from region A to region B in response to the real wage differential. In-migration will increase the supply of labour in region B, and out-migration reduces the supply of labour in region A. As more labour migrates into region B, the real wage is forced down, while that in A increases. The migration of labour will continue until identical wage rates are re-established in both the regions.

There are many deficiencies of the classical model of migration. First it fails to allow for regional differences in employment opportunities. This neglect stems from the assumption that wages are perfectly flexible and that labour markets adjust automatically to correct disequilibrium. In reality wages may be very sticky in the downward direction. Next, the assumption of homogenous labour may not be realistic as migration covers workers with many different skills as well as including non-workers. Also, the assumption of costless migration and perfect information needs to be examined closely. Migration is not without cost and many costs of migration have been identified. Most of these are money costs such as transport costs, income that is forgone while a migrant searches for a job in the new location, as well as food and lodging costs. Sjaastad (1962) highlights the importance of the non-money costs of migration which include the psychic cost of uprooting of families and the difficulties of settling into unfamiliar surroundings. The apparent complexity of the determinants of migration in practice is a major reason why the classical approach's exclusive focus on the simple wage differential between regions has been widely rejected. A number of later theories relax at least one significant assumption of the classical model.

2.3. The Human Capital Approach.

The human capital approach to migration, first introduced by Sjaastad (1962), considers migration as an investment in human capital. In effect it provides another mechanism through which households may increase the productivity of their human resource. This "investment", like any other, involves a sacrifice in terms of initial costs and a benefit in terms of subsequent returns. Since Sjaastad's (1962) classic contribution there have been many variations on the basic approach.

The basic concept of the human capital approach in migration is the use of discounted costs and benefits as the bases to undertake a decision. When the discounted benefit associated with moving to another region is greater than the discounted costs, implying that the net present value of the investment in a move is greater than zero, migration will take place. In the early version of the human capital model the emphasis was on wage differentials and purely labour market related influences (Molho, 1986). In weighing up the costs and benefits between the origin and destination regions, a migrant has to consider both the money costs and the non-money costs associated with a move. The money costs may include the transportation costs and the income forgone in the process of settling down in the new surroundings, while the non-money cost is the psychic costs of leaving family and friends. Although it is difficult to quantify psychic costs, they are usually proxied by the geographic distance involved in migration. The greater the distance between the origin and the destination the greater will be the non-money costs associated with a move.

The basic human capital model developed by Hart (1975) may be outlined as follows. First he considers a risk averse, potential mover who is at present living in region i, who now considers relocating to another region j. Residing in either region will have some future streams of expected returns attached to it. The time over which the individual calculates net returns is given as t = 0,1,2,...T, where 0 is the current period and T is the time span, say up to retirement, over which a migrant calculates his net returns. As mentioned earlier, any gains from migration will involve two aspects namely monetary and non-monetary costs and benefits. The monetary aspect includes the expected level of earnings. The non-pecuniary advantages and disadvantages include factors such as climate, presence of relatives, less polluted air, friendly neighbourhoods and other environmental factors. In line with the standard human capital approach, the decision to migrate into a region depends on a comparison of the expected present value of gains from each region. Assuming that all gains will occur continuously through the time horizon at a rate of R(t) at time t; the expression for the expected utility gained from residing in the origin can be written as follows,

$$E\{U(R_i(0))\} = \int_0^T e^{-rt}U(R_i(t))dt \qquad (2.3.1)$$

Where r is the subjective discount rate (for both monetary and psychic gains). A similar expression can be written for the expected utility gained from residing in the chosen destination, region j. It can be written as follows,

$$E\{U(R_j(0))\} = \int_0^T e^{-rt}U(R_j(t))dt \qquad (2.3.2)$$

Since costs will be involved in moving from regions i to j, a cost expression then need to be deducted from the expected gains in region j, before comparison of true gains can be made. The expected cost expression can be written as follows

$$E[C_{ij}(0)] = \int_0^T e^{-rt}[C_{ij}(t)]dt \qquad (2.3.3)$$

Where C_{ij} depicts the cost of moving from region i to region j. Within this framework migration will occur if

$$E[U(R_i(0))] < E[U(R_j(0))] - E[C_{ij}(0)] \qquad (2.3.4)$$

Otherwise an individual will not migrate.

The human capital model mentioned above shows that people will move to areas with the greatest net benefits over the relevant time horizon reflecting, for example, expected higher income flows and a better environment. This means that an individual will choose the location which achieves his objective as a utility maximiser. This model is then consistent with multiple migration streams from I to j, for j=1,2,3...k. Where 1,2,.. k reflect the k alternative locations. Multiple streams arise because of the different weights attached to different attributes of location across individuals (Hart, 1975). This feature also admits the likelihood of simultaneous migration in both directions between any two regions, in contrast to the classical model.

This human capital approach can be extended to include a wider framework. For example Mincer (1978) considers the situation where households are the relevant decision making units. Green (1997) suggests the need to compromise in dual career households. Da Vanzo (1983) considers the possibility of multiple moves and Yang (1993) reveals the temporary nature of migration in China.

The risk theoretic framework can be extended by relaxing the assumption of "risk neutral" individuals. For example, to distinguish among different types of potential migrants, they can be classified as employed and unemployed, and they can be grouped according to different age group (Hart, 1975) or they can be classified according to their labour market performance (Vijverberg, 1993).

2.4. The Search Approach.

We begin this section by summarising economic theories of migration and the search process. We acknowledge that the human capital approach has been widely used, but there is something missing in the approach that leads to the foundation of the search theory. Then we then proceed to review search theory, after which we consider optimal job search policies, and the search model as applied to migration.

2.4.1. Economic Theories of Migration and Search.

Human capital theory is one of the most commonly used explanations of how an economically motivated migration agent behaves (Sjaastad, 1962; Borts and Stein, 1964 and Pickles and Rogerson 1984). The process of migration, as we have seen, is viewed as an investment where the returns from migration, partly in the form of higher wages associated with a new job, are greater than the costs involved (both pecuniary and psychic). Hence from a neo-classical perspective, migration should then occur in response to the presence of interregional wage (and amenity) differences. However Miron (1978) stresses the importance of understanding the behaviour of potential migrants as information gatherers and decision makers. Also, it is rather unconvincing to assume that the potential migrant has perfect information about the wages and job availabilities among all the potential locations involved, and is aware of the extent to which these may reflect disequilibria, especially given that such disequilibria must presumably be changing over time.

Thus it has been argued that search theory may therefore be viewed as providing the missing link in the human capital approach by providing an explicit treatment of uncertainty. Todaro (1969) was among the first to recognise how a potential migrant would discount wages by the probability of finding a job. Some other studies also offer alternative ways for estimating the probability of securing a job. For example, Fields (1976) argued that the ratio of the new hire to the unemployment rate provides a more intuitive and better measure of the transition probability from the unemployed state to the employed state. Similarly, Gleave and Cordey-Hayes (1977) and Holt (1978), suggested the use of the ratio of vacancies to unemployment as a measure of labour market tightness, which has the advantage of directly including measures of opportunity and competition. However, some of the assumptions used were rather weak. For example the assumptions regarding how people search and compete for new jobs. In the next section, a brief review of search theory is presented.

2.4.2. Review of Search Theory.

The importance of the search process in economics was first recognised and highlighted by Stigler (1961,1962). He relates the importance of search in the market for sellers and buyers, where both sellers and buyers need information regarding maximum and minimum prices that they preferred. The search process does involve costs and it is especially costly if the search is conducted on an individual basis. The early models on search were non-sequential because the number of (job) offers were taken as a constant known by the individual before starting search. Subsequently, and currently, the literature is dominated by sequential models that pose the "optimal stopping" problem. The optimal stopping rule suggests that under certain assumptions the job searcher will need to choose a wage which is known as the reservation wage. The optimal policy for the job searcher is to reject all offers below the reservation wage, and to accept any offer above it. For example, the economics of search behaviour has been further extended by Lippman and McCall (1976). Much of the literature is concerned with deriving the optimal stopping rules for search that is in the form of reservation wage as mentioned above. The reservation wage is used as a basis for the searcher to accept or reject the opportunities as they come. The simplest form of the search model makes several assumptions. First, the searchers face an independent wage distribution with a known parameter, but an unknown order in which the offer is received. The searcher conducts the search while unemployed and offers are received at a constant rate over time. The optimal reservation wage is calculated to equate the marginal cost of searching for an extra time period with the marginal expected gain of the offer (Lippman and McCall, 1976). Much of the literature on this theory is also concerned with relaxing the assumption that searchers have knowledge of the parameters of the wage distribution[1]. The implication of the reservation wage is also examined. Thus the job seeker continues searching until the wage offered equals, or is greater than, the reservation wage. The reservation wage gets higher as the cost of searching decreases.

When the job search framework is adapted to the analysis of migration a distinction arises between contracted and speculative migration (Molho, 1986; Silvers, 1977). Contracted migration can be seen as the outcome of the search process while speculative migration is an essential component of the search process. Most of the search literature concerns these two types of migration processes. For example David (1974) analyses the case of speculative migration. His main concern is with the expected variance of the offer distribution that confronts job seekers relative to an average offer. Assuming that the risk-neutral migrants have a limited

[1] There are two alternatives regarding information on wage offers. If the searcher is assumed to search "with information" then he knows the offer distribution. On the other hand if he/she is searching "without information" then the offer distribution is not known (Hey, 1993).

budget allocated for searching purposes, once exhausted the migrant will select the most valued offer over the search period. David's (1974) study confirms that the potential returns to job search are highest in the labour market where the dispersion of wages is widest relative to the average offer.

In the following part of this chapter we discuss optimal job search policies, and then we consider search theory as applied to migration.

2.4.3. Optimal Job Search Policies

In this section we address how a job seeker would react in a given situation, where he/she is allowed to enter the search process and then to decide whether to continue searching or to quit searching when an offer is received, or abandon the search process altogether.

Lippman and McCall (1976) begin with the simplest sequential model of job search, where an unemployed individual, referred to as the searcher, is seeking for a job. Every day the individual ventures out to look for a job, and each day he will generate only one job offer. He/she is not allow to intensify his/her search effort. The cost of producing each offer includes all money costs, such as the cost of transportation and advertising that are incurred each time a job offer is obtained, and is assumed to be a constant, c. There is no limit to the number of offers the searcher can obtain. Lippman and McCall (1976) consider both the cases where offers which are not accepted immediately are lost and the cases in which offers are retained. These two cases are referred to as sampling without recall and sampling with recall, respectively. When an offer is accepted, the searcher transits to the permanent state of employment, so that quits and layoffs[2] are not allowed in this model.

The searcher skills are considered homogeneous in all respects, while the prospective employers do not necessarily value them equally hence different employers tender different offers to the searcher. The dispersion of offers is included in the model by assuming that there is a probability distribution F of wages that

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[2] In a recent study by Usategui (1992) when unemployment insurance is brought into the model, affecting reservation wage, layoffs is allowed but quits for higher paying job are not.

governs the offers tendered. In addition, the distribution is consider to be invariant over time and the business cycle effect is ignored. So, on any day the probability that the searcher will receive an offer of w or less is F(W), which is independent of all past offers and of the time the offer is made. It is assumed that the searcher knows the parameters of the wage distribution from which his offers are generally generated, that is he knows F. In this simple model the offer can be interpreted as the discounted present value of the life time earnings from a job.

Every individual participating in a job search is assumed to be risk neutral and possesses a linear utility function and will always seek to maximise his/her expected net benefits. The key decision that he/she has to make is when to stop searching and accept a job offer. The length of the search will depend upon the opportunity cost and the distribution of wages that he knows his services can command in the job market. If the searcher is aware of his skill as being valuable he/she will reject any offer that falls short of his expectations and thus remains unemployed. On the contrary if the search costs are high the search activities will be limited. Under the given assumptions the optimal policy for the job searcher will be to reject all offers under a single number known as the reservation wage and to accept any offer above it. The reservation wage is assumed to be a constant over time and the lower the search cost the higher the reservation wage and the longer is the expected period of search, thus the longer is the unemployment period for the individual concerned. The reservation wage is chosen such that the expected marginal return from additional search is equal to the marginal cost of search, c. The cost of search can be given as;

$$c = \int_{\xi}^{\infty} (x - \xi) f(x) dx \qquad (2.4.1)$$

where ξ is the reservation wage and f(x) is the distribution of the wage offers. Suppose the job offers presented in period i is denoted by x_i, where each x_i is a nonnegative random variable with cumulative distribution function F(.), $E(x_i)<\infty$, and that x_i's are mutually independent. Together with the assumptions made earlier the optimal strategy for an individual job seeker will be either (after each offer is received) to accept any job offer received thus far or to search at least one more time.

This decision is made by comparing the expected marginal return from soliciting one more offer with the marginal cost of receiving that offer (Hall, et.al.1979). Algebraically if w is the best offer received to date, then the expected gain from searching one more time, H(w), is given by

$$H(w) = \int_{w}^{\infty} (x - w) f(x) dx \qquad (2.4.2)$$

The optimal rule is to stop searching and accept an offer whenever w satisfies $H(w) \geq c$. Also any offer is accepted when $w \geq \xi$ where $H(\xi) = c$.

The basic search model outlined above has been modified and extended to in various directions by a range of studies. For example Mortensen (1977), Burdett (1979) and Lindeboom and Theeuwes (1993) concentrate on search models with variable search intensities. In their model, time is represented as a sequence of discrete time periods of given length. Utility is generated by income and leisure. Search is to take place in an environment with imperfect information regarding job location, job availability and offered wage. Likewise the basic model has also been extended to focus on migration processes.

2.4.4. The Search Model as Applied to Migration

Many researchers have extended the basic search model in order to increase its general validity and applicability in a variety of circumstances. An example of special importance here is the search model's application to the study of migration processes. As pointed out by Gordon and Vickerman (1982) the lack of attention given to the constraints on the choices faced by an individual in making the migration decision is an important source of dissatisfaction with the human capital approach. Furthermore, before a migration decision is made, an individual needs to know about the available opportunities. Relying on the human capital model alone is insufficient to explain the process involved in migration. The human capital model also assumes that information is free, thus placing everyone in the population at risk of migration. In contrast, Gordon and Vickerman (1982) claim that an explicit treatment of the search process provides a new definition of the population at risk, which is a subset of the whole population in a region.

As a consequence of the above arguments, Gordon and Vickerman (1982) propose the following model. They suggest that the decision to migrate can be broken down into at least two distinct stages. First, the need to decide whether to become a potential migrant (thus accepting the costs involved while searching for opportunities) or to become a stayer (that is to quit from the searching mode). Secondly, there is a need to decide whether to accept or reject a given opportunity.

In general, the basic decision whether to be a potential migrant or stayer will depend on the associated net present values. That is a comparison is made between the current net present value (NPV) and the expected (reservation) NPV, based upon knowledge of the existing distribution of specific opportunities. For the risk-neutral individual search is worthwhile as long as the reservation NPV exceeds the current NPV. During the search process, a searcher is expected to accept the first offer with an NPV higher than his/her reservation NPV.

The above simplified account of the migration search process has assumed that an individual has only one type of search available to him/her and there is a single level of search costs. However, in reality the intensity of search does vary. In the case of migration an individual may choose between considering local search for opportunities that are cheaper in terms of money and psychic costs, or a wider area that incurs higher search costs. Hence, there are very many possibilities from which an individual can select in deciding whether to move and where to move to. This is especially so when international migration is considered.

In general Gordon and Vickerman (1982) assume that individuals' search for opportunities can be clustered together into two or three relatively distinct levels of search. Within each level the cost of searching for each opportunity is considered to be a constant. Of course the costs between levels would be different as information on available opportunities is usually biased towards areas that are closer geographically, and with which there are typically stronger information linkages. An individual is also allowed to move between these levels of search as their expectations change.

Applications of disaggregated choice models to the analysis of intra-metropolitan movement addressed the treatment of opportunities and population at risk quite directly (McFadden, 1978; Lerman, 1979; Gordon and Vickerman, 1982). Their models basically attempt to derive expressions for the probability of movement explicitly from the specification of random utility functions for certain groups of people. The probabilities may relate to a set of alternatives that include choice of type of dwelling, workplace, mode of commuting and even area of residence. The utility of these alternatives varies according to their attributes and with the characteristics of the individuals involved in this process of migration.

Within this simple framework the probability of movement to a specific destination region at a particular time as given by Gordon and Vickerman (1982) is as follows:

$$P_t(mj|\, i,p) = P_t\,(s|\, i,p).P_t(oj|\, s).P_t(aj|\, oj).P_t(1\text{-}R|\, aj) \qquad (2.4.3)$$

The above model shows that the probability of movement to a specific destination at a particular time period t, is dependent upon four basic sets of probabilities namely: the probability of being in search during this period $P_t(s)$; the probability conditional on search, of receiving an opportunity of a specific type, P(oj); and the probability, conditional on receiving such an opportunity, of accepting it P(aj). It is also necessary to discount the probability of more than one acceptable opportunity being received by the same potential migrant, since he/she is supposed to accept only the first acceptable offer. $P_t(R)$ is the probability of having already received an acceptable opportunity during period t. P(s) and P(aj) are strictly choice probabilities which, based on the standard random utility assumptions, could be represented by logit functions of the expected utilities of the alternatives. P(oj) and P(R) are exogenous and relate directly to the supply of opportunities that faces a potential migrant who has chosen to be involved in a particular form of search (Gordon and Vickerman, 1982).

Molho (1986) argues that the Gordon and Vickerman (1982) framework only specifically relates to the determination of contracted migration and thus does not include the issue of speculative migration, which takes place as part of the search process rather than as the outcome. The migration decision framework as shown in Figure 2.1 tries to include the possibility of a speculative move. A potential migrant chooses to enter the search process, either locally or externally. In the process of searching for opportunities he/she will either receive an acceptable offer, an unacceptable offer or no offer at all. If the offer received is acceptable then he may quit searching and thus migrate to the area that provided that opportunity. If the offer received is unacceptable then he will either continue searching for an acceptable opportunity or he can quit searching and thus be a stayer. When recall is allowed the potential migrant can keep records of offers received and make comparisons after which he can then choose the best offer. In the case of speculative migration the potential migrant can exit any search field and enter a new one when the former does not seem to provide promising opportunities.

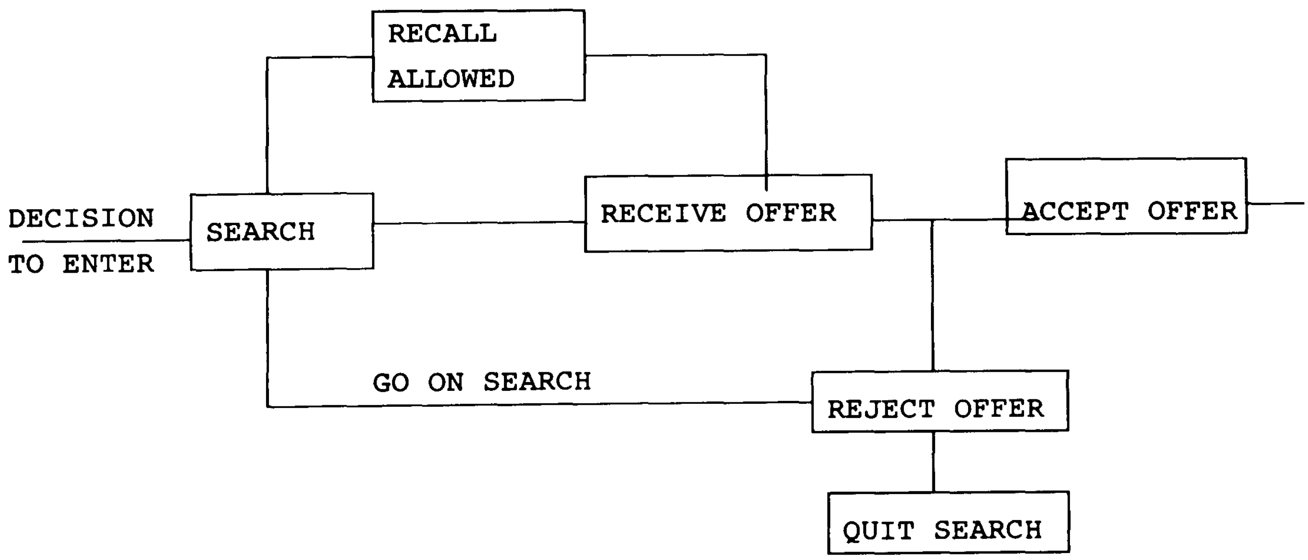

Figure 2.1. The Migration Decision Making Framework (Adapted from Molho, 1986, p. 404).

Migration thus can again be considered as the outcome of receiving and evaluating specific opportunities as they come. It is a continuous process because there is no reason why a person who has already moved to assist in the search process may not do so again, in response to a change in his/her expectations. Next we consider the gravity approach.

2.5. The Gravity Approach

Spatial interaction is a broad term which includes any movement over space that results from a human process. It includes journeys to work, information and commodity flows, student enrolments, the utilisation of public and private utilities, migration and even the transfer of knowledge. Gravity models are the most widely used types of interaction models. They are mathematical formulations that are used to analyse and forecast spatial interactions.

The gravity model has been widely used in the geographical context. It makes explicit and useful the idea of relative as opposed to absolute location. All things on the surface of the earth can be located in absolute terms by longitude and latitude coordinates, and the absolute position of things can be related to each other by reference to such coordinates. Distances can be specified in these absolute terms. It is then possible to talk about one location as being "five miles from London" and another being "five miles from Glasgow." In absolute terms, these two locations are equal in that they are both five miles away from an urban centre. In relative terms, however, these locations are very different in many ways, for example in terms of access to job opportunities, access to entertainment centres or access to rural life-styles. Each of these significantly differentiates absolute location from relative location. The gravity model allows explicit measurement of such relative location concepts by integrating measures of relative distance with measures of relative scale or size.

The gravity model, which derives its name from an analogy to the gravitational interaction between planetary bodies, appears to capture and relate two basic elements namely: scale impacts, for example cities with large populations tend to generate and attract more activities than cities with small populations; and distance impacts, for example, the further people, places or activities are apart, the less they interact.

These concepts are used by analysts to explain why some public services or shopping outlets attract more users or customers than do others. They are used to explain why land values are high in the central areas of cities and at other easily accessible points, and why land values are higher in larger cities than in smaller cities. On a larger scale, they are used to explain the movement of population in the form of migrants, visitors, business and commercial travellers, and the movement of information in the form of mail, telecommunications, and data transfers.

2.5.1. The Basic Model.

The basic gravity model shows the interaction between any pair of regions depends on the (mass) size of the population P, in each region and the distance d_{ij}, between the two regions (Wilson 1971). T_{ij} gives a representation of such interaction as;

$$T_{ij} = P_i P_j / d_{ij} \qquad (2.5.1)$$

The basic.model is then modified to;

$$T_{ij} = kP_i^{\lambda} P_j^{\alpha} d_{ij}^{\beta} \qquad (2.5.2)$$

Where the exponent β is used to indicate whether the impact of distance on the model is proportional or not[3], while α and λ allow for situations where other variables, aside from population size, affect the generation and attraction of interactions.[4] The constant k, is the equilibrating variable used to adjust for any differences in magnitude of the flows under study.

The basic concepts of the gravity model can be expanded to a more generalised and widely applicable model. Instead of the population variables (P_i, P_j) the variables V_i and W_j are used to describe the vector of origin-generating flow attributes and the

[3] For example, the cost per mile of travelling may decrease with distance, as in air travel. Obviously the operational effect of distance would therefore not be directly proportional to airline miles and the negative aspect of distance would need to be reduced so that the model properly reflects its effect. Even though distance always has a negative influence on interaction, in some cases it may be more negative than in others. An exponent on the distance variable $d_{ij}\beta$, allows this variability to be captured.

[4] For example, when examining the flow of shopping expenditures between two centres we would expect the flow of expenditures to be related not only to population at both centres but also the average income level at each centre. We would expect higher income centres to have greater expenditure flows than do lower income centres of comparable size. An exponent on the population variable would allow for this.

vector of destination-attracting flow attributes respectively. Thus several surrogate variables for origin propulsiveness and destination attractiveness are included in the model. For example, the destination attractiveness can be measured by population, climate, economic variables and social variables (Wilson 1971).

Another expansion of the gravity concept deals with the separation of origins from destinations and the effect of intervening distance or space. Not only does distance inversely affect the flow of interactions between an origin and a destination, so does the presence of alternative destinations. So instead of relying on just distance d_{ij}, alone as the spatial separation, the model now includes the vector S_{ij} whose attributes represent the negative effect of spatial separation of origins and destinations (including distance and other intervening opportunities). The general expanded model now becomes:

$$T_{ij} = f(V_i, W_j, S_{ij}) \qquad (2.5.3)$$

where V_i represents a vector of origin attributes; W_i represents a vector of destination attributes and S_{ij} represents a vector of separation attributes.

From the basic gravity model described above, various types of gravity models can be obtained to suit any particular situation, depending on the information available on the interaction system. The various models which form the family of gravity models are addressed in the next section.

2.5.2. The Family of Gravity Models

This section briefly discusses the different gravity models that can be generated from the general formulation given by equation (2.5.3) above to form the "family" of gravity models. Assume that each of the vectors V_j, W_j, and S_{ij} contains only one variable. The lower case letters are used to represent this single measure situation (v_i,w_j,d_{ij}). For convenience also assume that spatial separation can be measured by distance and that origin propulsiveness and destination attractiveness can be measured accurately by some size variable such as population. In some instances there may be good estimates or even exact values for outflow totals from the origins or inflow totals into the destinations. Since the origin propulsiveness and destination attractiveness are defined in terms of such totals, they are included in the gravity model instead of the less accurate size variable. The various ways in which the size variables are replaced by outflow and/or inflow totals produces a "family" of gravity models (Wilson 1971). Wilson considers four situations in forming the family of gravity models.

First Wilson (1971) considers the situation in which information is available only on the total number of interactions in the system, while there is a need to forecast the interaction pattern in the system The gravity model containing this simple constraint is known as a total flow constrained gravity model.

Second, Wilson (1971) considers circumstances in which information is available on the outflow totals for each origin in the system, this implies that the total number of interactions in the system is known or can be predicted. In this case the total number of people leaving a particular region is known but their destination is not known. This model is useful in forecasting destination inflow totals that are unknown.

Third, Wilson (1971) also considers the case where the inflow totals into each destination are known the outflow totals for each origin are unknown. This is simply the reverse of the above case. This model can be used to forecast total outflows from origins. For example, in forecasting the effects of locating a new industrial park within a city the number of workers to be employed in the new development is known, and the attraction-constrained gravity model can be used to forecast the demand for housing in particular parts of the city that will result from the new employment.

Finally, Wilson (1971) considers the doubly constrained gravity model, in which information on both outflow totals and inflow totals are available. A complete description of the family models mentioned above can be found in Wilson (1971).

2.5.4. Origin- and Destination-Specific Gravity Models

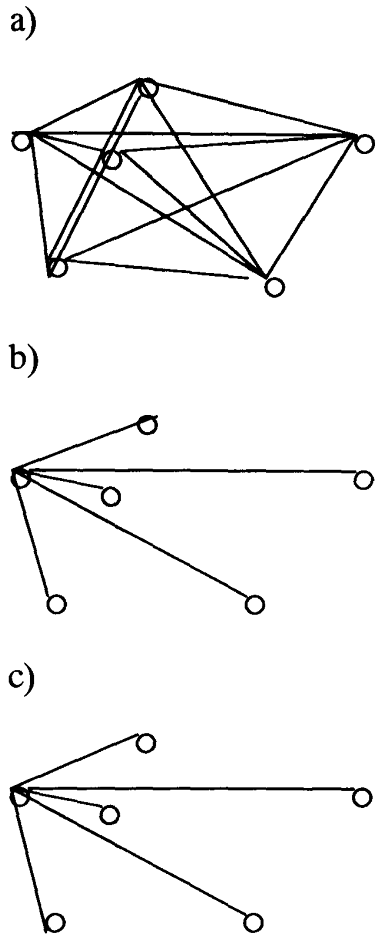

Figure 2.2 Interaction Systems (Source: Haynes, 1984, p. 42.)

Part (a) of Figure 2.2. represents a system of interactions between many origins and many destinations. Gravity models can be applied to flow systems such as those of Figure 2.2. Part (b) of Figure 2.2 shows a system in which there are flows from only one origin while part (c) shows the flows into only one destination. In the former situation the gravity models are described as origin-specific because the results are specific to one origin, while in the latter situation, the models are described as destination-specific, because the results are specific to one destination. Both origin- and destination-specific gravity models have been used in migration studies.

The origin-specific gravity models have probably been more widely employed than the destination-specific models. Information regarding origins is perhaps more intuitively appealing and more useful than information regarding destinations, because the former is based on a more homogeneous set of interactions (Haynes, 1984). For example, migrants starting out from the same origin are more likely to have more characteristics in common with one another than are migrants choosing the same destination.

2.5.5. Gravity Models and Migration.

The gravity models mentioned above have been widely applied in migration research. Their application to migration is generally traced back to Ravenstein, whose first "law" of migration formulated more than a century ago states that "the great body of migrants only proceed a short distance" and that in forming an estimate of the size of migration stream the researcher "must take into account the number of natives of each county which furnishes the migrants, as also the population of the towns or districts which absorb them" (Ravenstein, 1885). Later on Lowry (1966) propounded an "economic" gravity model, which has profoundly influenced the econometric work on the migration process (Greenwood 1975).

Greenwood and Sweetland (1972) review the determinants of migration and, using the gravity approach, they analyse the determinants of migration in terms of metropolitan flows. In their studies distance was found to be a serious deterrent to migration, which is consistent with the findings of previous migration studies. They also suggested that migration tends to be from low- to high-income localities, to localities that provide relatively high local per capita government expenditures, and to localities in temperate climates.

Smith and Clayton (1978) on the other hand examine the U. S migration stream in terms of the transitivity characteristic of the gravity model. If the gravity model is given as

$$m_{ij} = A_i B_j f(D_{ij}) \qquad (2.5.4)$$

where A_i, B_j are the origin and destination specific factors, pushing or pulling migrants to or from the corresponding regions, D is the distance between the two regions which affects migration according to some function. Then according to Smith and Clayton (1978), as long as a symmetrical distance function is chosen:

$f(D_{ij}) = F(D_{ji})$ then the gravity model observes the transitivity property. As such if $m_{ij} > m_{ji}$ and $m_{jk} > m_{kj}$ then the model predicts $m_{ik} > m_{ki}$. Smith and Clayton (1978) found that U.S. migration streams for the period 1935 to 1970 exhibited relatively large numbers of intransitivities in both probabilities and numbers. In particular the degree of intransitivity was larger for numbers than for probabilities.

Several researchers have argued that the poor performance of the gravity model in explaining migration flows may be due to its omission of several factors that are important in influencing migration flows. One such omission relates to information flow processes. Also, the interaction term which traditionally depends only on the distance between the two regions, seems quite inadequate for capturing such effects (Smith and Slater, 1981). Another omission arises in connection with the constrained choice sets that most decision makers face. Very seldom do all destinations fall within the actual choice set of any given migrants, and the actual choice sets themselves are likely to vary, perhaps significantly, among individuals. Smith and Slater (1981) suggest an alternative model. They try to incorporate the concepts of information flows into gravity models of U.S migration patterns.

The concept of information flow in migration modelling was also adapted by Plane (1981). He uses the minimum information principle (MIP) form of the gravity model to assess migration flows in the U.S. The full MIP model is in the form;

$$\hat{m}_{ij} = m_{ij}^{\ 0} \gamma (\alpha_i / \alpha_j) e^{-\beta d_{ij}} \qquad (2.5.5)$$

where $\hat{m}_{ij}$ is the predicted flows between the two regions; $m_{ij}^{\ 0}$ are the current (known) flows; γ is the scaling factor and d_{ij} is the distance relating factor. The parameters to be estimated are α, β and γ. In this model, β can either have positive or negative values. A positive value indicates that the deterrent effect of distance has increased over time, while a negative value indicates that it has decreased. However in recent years, distance has become a less important impediment to migration (Plane 1981). Plane calibrated his model using the U. S 1965-70 migration data.

Gravity models also assume spatial parameter stability; for movement out of any one origin, the parameter has been assumed to be stable across the range of destinations towards which flows are directed. It suggests that the effect of distance out of a particular origin is unmodified in spite of the diversity of places within the spatial system. This, according to Eldridge and Jones (1991) is an heroic assumption; in cases where the assumption is not made, the possible existence of place-to-place differences in the relationship between distance and interaction can be examined. Specifically, distance in one area may have one kind of effect on interaction, while the same distance in another area may have a different kind of effect. The gravity model ignores these potential biases and results in the same predicted interaction for all observations with the same distance, *ceteris paribus* (Eldridge and Jones, 1991). To overcome these potential biases and misinterpretation of the estimated parameters, Fotheringham (1978) suggests the use of a new set of interaction models; the "competing destinations" models.

The theories of competing destinations consider many types of interaction to be a result of a two-stage decision making process. The first stage is that individuals choose a broad region with which to interact. The second stage is that individuals then choose a specific destination from the set of destinations contained within the broad region. As an example consider the decision to migrate in search of employment. An individual from a region of high unemployment (say, North East England) will be aware that there are other regions which have better prospects for employment (other parts of United Kingdom such as the Midlands, South East and the South West). Once the individual has decided to move, his first locational decision is to choose one of these broad regions, in which to concentrate his search for work, and then choose a specific location within that region.

2.6. The Todaro (1969) and Harris-Todaro (1970) migration model.

The basic Todaro (1969) model implies migration proceeds in response to urban-rural differences in expected income rather than actual earnings. Migrants compare the various labour market opportunities that are available in the rural and urban sectors and choose the one that maximises their expected gains, should they choose to migrate. These expected gains are measure by the difference in real incomes between rural and urban work and the probability of a new migrant getting an urban job. This is how unemployment rates are introduced into the model. The Todaro

(1969) model assumes that each worker has an identical planning horizon and has fixed costs of migration that are identical to all workers.

Later the Todaro (1969) model is extended to include a third sector, namely the informal urban sector (Harris-Todaro 1970). The 3 sectors model assumed the following characteristics. The rural sector is branded by low, flexible wages with full employment and job stability. Also there are no fringe benefits available to workers. While the urban informal sector is where the new migrants "reside" while waiting to be "permanently" employed in the formal urban sector. It is characterised by low, flexible wages, with underemployment and job instability. There is also no fringe benefit for workers in this informal sector. The urban formal sector is characterised by high, downwardly rigid wages and by a limit in the number of jobs. These jobs are "stable" and there is opportunity for advancement, with fringe benefits to workers. With the above assumptions, the extended migration model demonstrates that job creation in the urban formal sector could result in an increase in the urban informal sector through rural-urban migration. According to Todaro (1969), the objective of a typical rural-urban migrant is to get a job in the urban formal sector. Since the number of jobs available in the urban formal sector is limited, in-migrants from the rural sector are thus typically employed, upon arrival, in the urban informal sector. Being involved in petty-trading is an example of an urban informal sector job. Earnings in this informal sector may be below earnings in the rural sector, but the migrants are willing to remain in that sector because of the possibility of accessing a formal sector job.

The Todaro (1969) and Harris-Todaro (1970) models have been criticised for several short comings (Eaton, 1992; Willis and Fields, 1980). First, there are no clear details regarding the relationship between the urban formal and informal sectors. Second, the causes of the downwardly rigid wages in the urban formal sector are ignored, and there is no proof that such rigidity exists. Third, the mathematical formulation of the model completely ignores labour earnings in the urban informal sector. Fourth, there is an implicit assumption that the labour of rural-urban migrants is homogeneous, which is unlikely to be the case. Finally, the Todaro (1969) model lacks empirical support for its theoretical bases, and empirical testing of its implications.

2.7. The Jackman and Savouri Model.

Jackman and Savouri (1992) model migration as a special case of job-matching, in which a job-finder in region A is matched to a job in region B. Although people can live in one area and work in another (Jackman and Savouri 1992), more often than not, such job match usually involves migration of the household. Thus migration is viewed as the result of successful job search, but not a pre-condition for it; as available information technology makes it easy for a job-finder to look for a job without having to "physically relocate" himself. Their finding suggest there will be a higher rate of out-migration from regions of high unemployment. The unemployed are more likely to move.

Their model suggests that the flow of migrants from the origin to destination region is the product of total engagements in the economy, the share of unemployment in the origin region and the share of vacancies in destination region. Their simple model assumes distance is immaterial in job search. However, in practice this is not true, as people prefer to take jobs near to home, and thereby avoid all the costs associated with moving. Later they allow for discouraging effect of a distance on job search and also allow for some effects of differences between regions. People obviously prefer to apply for high paying jobs and hence potential migrants tend to look for work in high wage rather than low wage regions. Hence, a larger number of job-seekers applying for vacancies in high wage regions will be resident outside the region and we might expect that a higher proportion of jobs in high wage regions will be filled by in-migrants rather than by local residents (Jackman and Savouri, 1992).

2.8. The Layard, Nickell and Jackman (LNJ, 1991) Model.

The Layard *et al* (1991) model includes real wage, unemployment rate and price differentials between regions as determinants of in-migration. The emphasis is on the importance of the real wage and unemployment rate differentials in influencing migration decisions. Thus their findings suggest that the higher the real wage in

Scotland relative to RUK, the fewer people migrate from Scotland to the rest of the UK. Likewise the lower the unemployment rate in Scotland relative to RUK, the less people will out-migrate from Scotland to RUK.

The Layard *et al* (1991) in-migration function is as follows

$$\frac{M_i}{L_i} = b_1 \log\left(\frac{\frac{N_i}{L_i}}{\frac{N}{L}}\right) + b_2 \log\left(\frac{W_i}{W}\right) + b_3 \log\left(\frac{P}{P_i}\right) + b_{4i}$$

and for estimation purposes is given as,

$$\frac{M_i}{L_i} = b_1(u - u_i) + b_2(w_i - w) + b_3(p - p_i) + b_{4i}$$

where p refers to house prices; u and u_i are the unemployment rates in the two regions; w and w_i are the real wages, and lower case indicates natural logarithm of the corresponding variable. Our regression model follows the Layard *et al* (1991) model closely as they claim their model explains much of UK regional migration.

2.9. The Ermisch (1995) Model.

The Ermisch (1995) migration model focuses on the relative real wage and relative employment rate, lagged one period, as the main determinants of net migration between Ireland and Great Britain. He tried to explain the degree of responsiveness of migration to real wage differentials by examining the size and pattern of European migration and whether there has been convergence in real wages. He found low responsiveness to real wage differentials, which "could be interpreted as large compensating differentials." (Ermisch, 1995). Similar to many other studies he found that migration is more sensitive to unemployment differentials between regions (and countries) than real wage differentials. The coefficient on the relative employment rate (which is unity minus unemployment rate) is ten times that on relative wages suggesting strong risk aversion. His findings suggest that the unemployment rate in Ireland relative to that in the UK was the most important explanation for the large changes in Irish net migration. The high unemployment rate in Ireland relative to the UK appears to have been mainly responsible for the large out-migration from Ireland during the 1951-1971 period (Ermisch, 1995).

2.10. The Stock Adjustment Model.

In the stock adjustment model we make several assumptions. The key point here is that we assume that migrants are heterogeneous and may respond quite differently in response to any given change in the variables relevant to the migration decision. People have different psychic transaction costs or may value amenities differently and so the expected net present value from migration varies, possibly significantly, among individuals.

Suppose individuals expected net present values of migration are distributed in accordance with the solid line:

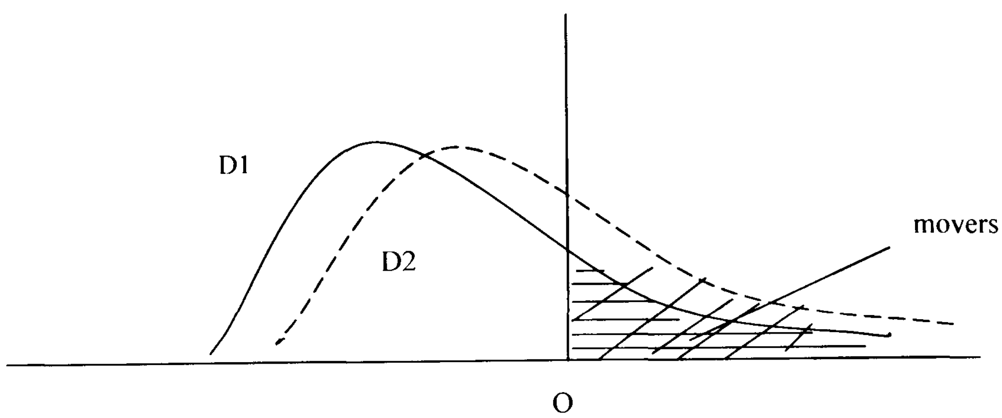

Figure 2.3

The origin, O, coincides with a zero expected net present value (NPV) associated with migration. Hence only those who are in the upper tail of the distribution of expected NPVs - above that value of expected NPV - become movers. Those whose expected NPV is below zero are stayers. When the real wage increases in the destination region relative to the region of origin, there will be a shift in the distribution from D1 to D2, with more people being movers than before, but in general there will be more stayers than movers as illustrated by the distribution.

Since people are different, as wages increase in Scotland their expected net present value associated with migrating to Scotland increases. But due to the nature of the distribution across individuals not many households still wish to stay and there is a limited number of new movers as a consequence of the shift in of the distribution of expected NPVs. This raises the possibility that the numbers induced to migrate may well be insufficient to restore wage and unemployment differentials, for example. This contrasts with the implications of Harris-Todaro (1970) and Layard *et al* (1991). Notice that we have not actually identified the variables that enter the computation of the expected value of NPV here. The argument is therefore valid with respect to any set of determining variables. For example, if it is wage and unemployment differentials that "matter", the argument implies that net migration flows occur here in response to the *first differences* of wage and unemployment rates, and not their *levels*. As we shall see, this apparently minor alternative specification of the net migration function may have significant consequences for the behaviour of regional economies.

2.11. The "net-migration" Issue

The net-migration model discussed above is not without problems. The focus of many migration studies has been on net migration flows, perhaps because of their concern for the overall impact of migration flows on labour markets. However, there is the issue of the appropriate specification of such model. In particular the argument that there is "no such thing as a net migrant" in fact can be interpreted as raising an issue of the appropriate specification of net migration functions, rather than necessarily objecting to their "netness" *per se*. For this reason in the later part of chapter 3 we try to "correct" for the mis-specification by introducing the population ratio model.

IV. Conclusions

There are many approaches to the study of why people move. The classical approach suggests wage differentials as the main determinant of migration between regions. Migration is taken to be "costless" and without risk in this approach. The human capital approach introduced by Sjaastad (1961) treats migration as an investment in human capital that involves costs and returns. The costs and benefits include both monetary and non-monetary costs.

There are many facets of search theories that have emerged from the basic search strategies initiated by Stigler (1961, 1962). Search theory has also been useful in the study of migration; it shows how migration decisions may involve different stages. The stages include: the decision whether to be involved in the search process; the decision when to stop searching upon receiving an acceptable offer. When the optimal stopping rule is observed, search will stop and an offer accepted when the net present value of the offer received is greater or equal to the reservation NPV.

Gordon and Vickerman (1982) focus, in effect, on contracted migration. They construct a general decision making framework in which the probability of migration taking place is expressed as the product of the probabilities discussed above. The probability of receiving an offer is simplified in the basic search model by assuming a fixed rate at which offers are generated, for example once a day.

As for speculative migration, since it is considered as part of the search process it is quite difficult to differentiate it from the search process *per se*. Once an individual has decided to enter the search process he/she is effectively involved in a speculative form of migration because in the process of searching for opportunities he/she may need to move from one region to another.

Gravity models have been widely used in the study of migration processes. Their early use was highlighted by Ravenstein who argue that in studying migration stream the analyst should consider both the numbers of people in the origin and the destination locations. The basic gravity model of migration emphasises that the migration process between any pair of regions depends on the size of the population in each region and the distance attributes between the two regions.

Some researchers focused on the characteristics of gravity model in their study of migration processes (Smith and Clayton, 1978; Goodchild and Smith, 1980) while others included information flows in the gravity model (Smith and Slater,1981; Plane, 1981). Fotheringham (1978) and Eldridge and Jones (1991) add the accessibility (of a destination to other destinations) variable to the gravity models to form the competing destinations' models. The latter models allow for the existence of competitions among the destinations attracting the potential migrants. The more accessible a destination is, the less likely it will be the last stopping place for the potential migrants.

While the flow model suggests that migration involves the response of homogenous individuals reacting to changes in the determinants of migration in much the same way, the stock adjustment model has rather different implications. In the stock adjustment model individuals are assumed to be heterogeneous, as reflected in a distribution of expected net present values of migration decisions across individuals. This has fairly radical implications for the appropriate specification of the net migration function.

Chapter 3: Econometric Analysis of net migration flows between Scotland and the Rest-of-the UK.

3.1a. An Introduction to the Estimation of Net Migration Models.

As we have seen in chapter 2, there are many theories of why people migrate from one region to another. Here, we test several net-migration models using annual data on net migration between Scotland and the rest-of-the UK (henceforth, RUK). Thus this chapter concerns the specification, estimation and testing of the net migration models that we have chosen to focus on, in view of their prominence in the literature. In section 3.2 we estimate conventional "net migration rate" models related to the contributions of Ermisch (1995), Layard *et. al.* (1991) and Jackman and Savouri (1992). In section 3.3 we investigate the bias arising from the use of net migration rate equations. The motivations are described in the appropriate sections.

3.1b. Description of the variables employed in our analysis.

The data we used are described briefly in this section. A fuller account is given in the data appendix. We use data that are published in official sources. We use secondary data because it is readily available and we did not have the resources to generate primary data. We obtain the net migration data from RG's Annual review publish by the General Register Office for Scotland. Migration in this case is derived from the following sources of data. The National Health Service Central Register (NHSR) is used to calculate moves between health board areas within the UK, with migration at council area level within Scotland estimated using data from the Community Health Index (CHI)

The average gross weekly earning of full time employee in Scotland and Great Britain are considered as wages in Scotland and RUK. While the Nation Wide building Society index on secondhand modern house in Scotland and RUK provide the house prices data. The unemployment rates and vacancies data are obtained from the Economic Trends and Economic Trends Annual Supplement. The main problem that may arise from using secondary data, is that, we are not in control of how the data collection is done.

3.2. The Estimation of Conventional "Net Migration Rate" Models.

We begin by estimating a range of net migration rate equations that have been proposed by other researchers on our Scottish-RUK dataset. A number of authors have claimed to find specifications that fit U.K regional data well, for example Layard et al (1991) and Jackman and Savouri (1992) while Ermisch (1995) claims his model provides a good explanation of net migration from Ireland to the UK. In this section, using microfit and employing OLS[5] regression we examine the performance of these models on a different data set from that used by each of the authors. Accordingly, we investigate a number of variations of each basic model. These include: allowing for more complex dynamics, since these may well vary across regions, both in term of perception and reaction lags and possible partial adjustment behaviour; allowing for the possible effects of time trends. The original specifications of the models are first tested on the Scottish-RUK data. Next the models are augmented to include other lagged terms, a time trend and the lagged dependent variable. This allows an element of "data-fitting" of the relevant models without modifying their basic theoretical content.

Subsequently the *stock adjustment* versions of each of the Ermisch (1995), Layard *et. al.* (1991) and Jackman and Savouri (1992) models are estimated. In stock adjustment form we consider the effect of the *change* in the key variables as our regressors, in accordance with our discussion in Chapter 2. So for example, instead of the level of the relative real wage that we employ in the flow adjustment specifications, we now use the *change* in the real wage differential as one of the regressors. Next we introduce our models in level form and follow the specific to general method of modeling. We start off by incorporating the explanatory variables separately to see how net out migration is affected by each individual regressor. Later we explore how the different combinations of variables affect net out migration behaviour between Scotland and RUK by adding in groups of variables.

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[5] We explain the limitations of using OLS in our discussion of econometric methodology in Appendix 3.

Next we consider the possibility that the discovery and development of North Sea Oil may have had an impact on the pattern of Scottish-RUK net migration. We use the employment related to the oil production in the North sea as our proxy for the Northsea oil activity and conduct a number of hypothesis tests. Here we use the general to specific method of modeling to see what difference it makes to our results. We start off with the most general form of the model (combining the North sea oil activity proxy with the other variables mentioned above) and using the variable deletion test we omit the variables that least affect the net out migration behaviour. Finally, we examine the performance of our stock adjustment model on Scottish-RUK migration data. The "best" of the models is then identified, drawing on a range of econometric criteria.

3.2.1. The Ermisch model

The model Ermisch (1995) estimated over the period 1955-77 is reported as;

$$NM_t = 0.0313 + 0.093 \ln(RW)_{t-1} + 0.963 \ln[(1-u_I)/(1-u_{UK})]_{t-1} \quad (3.1)$$

(2.60) (5.60) (2.69)

$R^2 = 0.78$ SE = 0.0108 DW = 1.87; t-statistics in parentheses.

Where: NM is net migration as a proportion of the labour force with mean = -0.0125; RW is the real wage in Ireland relative to that in U.K and the u_i are the relevant country unemployment rates. The size of the coefficients of the explanatory variables show that the unemployment differentials have a profound positive effect on net migration. The coefficient on the relative employment rate is ten times that of relative wages, suggesting strong risk aversion (Ermisch, 1995). Hence migrants are very careful in making their migration decisions especially in relation to the availability of jobs. The Ermisch (1995) study shows that the high unemployment rate in Ireland relative to that of U.K has been the major cause for the massive emigration from Ireland to U.K during that period (1951-1971). Thus Ermisch (1995) offers strong support for the notion that labour market conditions have a major influence on migration decisions.

The result of regressing the Ermisch model (1995) on Scottish-RUK data is shown as equation 1 of Table 3.1.1. Equation 1 shows that the unmodified Ermisch (1995) model does not provide a very good explanation of Scottish-RUK migration behaviour. The relative real wage variable is significant at the 5 per cent level, as shown by the t-value that is higher than the critical t-value, but has the opposite sign to that expected. Here the dependent variable is defined as net out-migration is so that the sign on the wage differential is opposite to that expected. The implication is that the higher the real wage in Scotland the greater the number of people who leave Scotland for the RUK, whereas theory predicts the reverse. The employment differential between Scotland and the RUK does not have the expected positive sign and it is not significant at the 5 per cent level. The R^2 value of only 0.27 implies the model explains very little of the migration behaviour between Scotland and RUK over the period. The DW-statistic of 0.78 indicates the likely presence of serial correlation, and this is confirmed by the Lagrange multiplier test of residual serial correlation, which rejects the null hypothesis of no serial correlation. The diagnostic test results also indicate that normality and heteroscedasticity problems are present. Given these results we conclude that the basic Ermisch model is not a suitable model for explaining Scottish-RUK migration data.

Next, in equation 2 of Table 3.1.1, we regress the original Ermisch model but this time the lagged dependent variable is included. The results do not improve much as a consequence. Only the lagged dependent variable is significant at the 5 per cent level. The positive sign on the parameter indicates that previous migration magnitude does encourage more migration in the current period. The larger the magnitude of previous migration the more people will migrate from Scotland to RUK. This result is compatible with a "partial adjustment" interpretation of aggregate migration flows, according to which it is "as if" aggregate migration flows adjust only gradually each period (perhaps because of the presence of transactions costs). The $\bar{R}^2$ value has improved so that the Scottish-RUK migration data are better explained by equation 2 than equation 1 but the signs on the key variables remain unexpected. The diagnostic test results do not show evidence of serial correlation or of functional form problems in the model. However, there are indications of the likely presence of heteroscedasticity.

In equation 3 of Table 3.1.1 we regress the Ermisch model with the time trend included. None of the variables are significant at the 5 per cent level. The standard error of regression increases from the previous migration equation and the R^2 value declines to 0.31. Equation 3 explains the Scottish-RUK migration data less well than equation 2. The diagnostic test results also provide evidence of serial correlation and functional form problems. Given these results we conclude that equation 3 provides an inadequate explanation of Scottish-RUK migration behaviour.

We now estimate further augmented versions of the Ermisch model. We start by regressing up to the second lag of the variables used in the Ermisch model and also include the lagged dependent variable. We report only three of the models that we think are worth discussing in Table 3.1.2. We also include the time trend in our regression but we find that when the lagged dependent variable and the time trend are regressed in the same equation both the variables fail to be significant at the 5 per cent level. We then drop the time trend from our regression since the results suggest that it is better to include the lagged dependent variable separately from the time trend. When the time trend is regressed with other variables without the lagged dependent variable the results obtained are not convincing thus we do not report them here.

In equation 1, we regress the net migration rate on relative real wage and employment differentials up to their second lags and the lagged dependent variable. None of the variables, apart from the intercept, is significant at the 5 per cent level. Then we conduct the variable deletion test to exclude the lagged values of the relative real wage variable. The test results imply that the variable can legitimately be omitted from the regression. The result of the regression is given by equation 2 of Table 3.1.2. The relative real wage is significant at the 5 per cent level as reflected by the t-value that is higher than the critical t-value, but it does not have the expected sign. Thus the result does not support the hypothesis that people move from low wage origins to high wage destinations. The employment differentials are not significant at the 5 per cent level. The lagged dependent variable is significant at the 5 per cent level. The positive sign indicates that the previous migration behaviour will encourage current migration behaviour. This suggests the presence of partial adjustment in the migration process.[6] Next we omit the current employment differential and its first lag from our model, which are statistically acceptable, and the result is as shown by equation 3 of Table 3.1.2. The relative real wage variable remains significant at the 5 per cent level and maintains the sign opposite to what theory predicts. The employment differential remains insignificant at the 5 per cent level, implying that the Scottish-RUK migration behaviour is not affected by the relative employment rates between the two regions. The lagged dependent variable shows a stronger positive influence on the net out migration behaviour between Scotland and RUK. The R^2 value of 0.64 implies that the model explains 64% of the variation in the Scottish-RUK migration data. The diagnostic test result shows there is no evidence of serial correlation or functional form problems. The tests of skewness and kurtosis of residuals do not reject the the null hypothesis that the residuals are normally distributed. The high chi-square value given by the test on heteroscedasticity indicates its likely presence.

From the above findings we conclude that the augmented versions of the Ermisch (1995) model do not provide very good explanations of the Scottish-RUK migration data.

We next regress the 'stock adjustment' form of the Ermisch model. The stock adjustment forms of the Ermisch model are estimated and the results are shown in Table 3.1.3. Equation 1 of Table 3.1.3 show the result of regressing the net out-migration rate on the change in relative real wage and the change in unemployment differentials between Scotland and RUK. The change in real wage is not significant at the 5 per cent level but has the expected sign. The change in employment differential variable is also not significant at the 5 per cent level. The R^2 value is only 0.15 which indicates that the model accounts for only 15% of the Scottish net out migration behaviour. The DW statistics and the diagnostic test results on serial correlation suggest that this is a problem. We try to eliminate the serial correlation

[6] The partial adjustment can be described in terms of different perception lags as follows.

$nm_t - nm_{t-1} = \lambda(nm_t^* - nm_{t-1})$

problem (as suggested by Johnston, 1984) by including the lagged dependent variable as a regressor. The result is given by equation 2 of Table 3.1.3. In equation 2 only the lagged dependent variable is significant at the 5 per cent level. The net out migration behaviour of the Scottish is dependent upon the previous migration magnitude. The R^2 improves to 0.52, and the serial correlation problem is rectified. We next estimate the model which includes the time trend. The result is as given by equation 3 of Table 3.1.3. The change in relative real wage variable now becomes significant at the 5 per cent level and has the expected negative sign. This implies that as real wage in Scotland increases less people will migrate from Scotland to RUK. The change in employment differential remains insignificant at the 5 per cent level. The time trend variable is significant at the 5 per cent level and its negative sign indicates that net out migration tends to declines over time. The R^2 value of 0.45 indicates that the model explains only 45% of Scottish RUK migration behaviour. The DW statistic and the diagnostic test on serial correlation do not suggest the presence of serial correlation. The result also shows that the null hypothesis that the functional form is correct is not rejected. There is also no evidence to suggest that the residuals are not normally distributed and there is no evidence of heteroscedasticity.

The results of estimating the Ermisch model, and the augmented forms of this model, suggest that it does not provide a very good explanation of net migration flows from Scotland to RUK. We next examine other models of migration from Scotland to RUK.

3.2.2. The Layard *et. al.* (1991) Model

In this section we estimate the Layard *et. al.* (1991) model in its original and augmented form on Scottish-RUK migration data. We also regress the model in the stock adjustment form in an attempt to obtain the model which best describes Scottish-RUK migration behaviour. We first spell out the model and then discuss the results of the regressions.

The Layard *et al* (1991) model is very much similar to the Ermisch (1995) model except that the former uses the unemployment differential variable instead of the employment differential, and the Layard *et al* (1991) model also includes the price differential in their model, but Ermisch (1995) does not.

The Layard *et al* (1991) estimated model is given as follows

$$M_i/L_i = 0.081(u-u_i) + 0.058(w_i-w) + 0.010(p-p_i) + b_{4i} \quad (3.2)$$

$$(2.7) \qquad (3.9) \qquad (1.6)$$

(Standard error =0.0031)

Where: u represents unemployment rates, w real wages and p refers to house prices. All independent variables are in natural logarithms. The above model is quite consistent with the idea that real wages and the unemployment rates have the same proportional effect on migration. Higher wages and better job opportunities both encourage migration into and area with almost the same intensity while lower housing prices encourage migration to a lesser extent.

The result of regressing the Layard *et. al.* (1991) model in its original form is given by equation 1 of Table 3.1.4. The real wage differential between Scotland and RUK is significant at the 5 per cent level but the result does not support the hypothesis that people migrate from low real wage to high real wage regions. The unemployment differential between Scotland and RUK is also significant at the 5 per cent level and has the expected sign. It supports the hypothesis that people move from high unemployment to low unemployment regions. The price differential variable is not significant at the 5 per cent level and does not have the expected sign. The R^2 value of 0.40 means the model only explains 40% of Scottish-RUK migration behaviour. The DW statistic and the diagnostic test on serial correlation indicate that serial correlation might be present. The diagnostic test on functional form however does not provide evidence of a functional form problem being present. Neither the hypothesis that the residuals are normally distributed nor the hypothesis that there is homoscedasticity is rejected.

Next we regress equation 1 with the time trend variable included as a regressor. The time trend variable is not significant at the 5 per cent level. The real wage differential remains significant at the 5 per cent level and maintains the perverse sign. With the inclusion of the time trend variable in the regression, the unemployment differential is no longer a significant regressor although it maintains the expected sign. The relative price differential is not significant at the 5 per cent level and has the opposite sign to that predicted by theory. Indeed, the R^2 value has not changed, which implies that equation 2 is no better than equation 1 at explaining why people migrate from Scotland to RUK. Indeed the value of $\bar{R}^2$ indicates lower explanatory power. The diagnostic results are similar to those of equation 1.

Next we include the lagged dependent variable as a regressor while maintaining the previous regressors except for the time trend. The result is given by equation 3 of Table 3.1.4. In general the explanatory power of the variables has declined. None of the variables used in the regression is significant at the 5 per cent level. Although the R^2 has improve a little and the diagnostic test results implies that the model may be a better model than equation 1 and equation 2, the fact that none of the variables used in the regression are significant at the 5 per cent level leads us to conclude that equation 3 is not capable in explaining Scottish-RUK net migration data. Hence we also conclude that Layard *et. al.* (1991) model, augmented by the inclusion of the time trend variable and the lagged dependent variable, is incapable of explaining Scottish-RUK net migration.

Next we augment the Layard *et. al.* (1991)model to see whether the inclusion of other lags of the variables used in the regression can help to improve its explanatory power. We start with the general form of the model which includes the current, first lags and second lags of the real wage differential, unemployment differential and the price differential between Scotland and RUK. We also include the lagged dependent variable as a regressor to see how previous migration affects current migration behaviour. The results show that all the variables except the price differential are insignificantly different from zero at the 5 per cent level. We then undertake the variable deletion tests to arrive at more parsimonious models. The results are reported in Table 3.1.5. In equation 1 of Table 3.1.5 the real wage differential between Scotland and RUK is shown to be significant at the 5 per cent level but has the opposite sign to that predicted by theory. The current unemployment differential is not significant at the 5 per cent level but the unemployment differential lagged two periods is very close to being significant but again does not have the expected sign. The current price differential is also significant at the 5 per cent level but does not support the hypothesis that people move from high price regions to low price regions. The lagged dependent variable is not significant at the 5 per cent level. The R^2 value of 0.81 implies that the equation tracks Scottish-RUK net migration flows data[7] reasonably well. The diagnostic test results do not provide evidence of either serial correlation or functional form problems. Tests also indicate that the null hypothesis that the residuals are normally distributed is not rejected, and that there is no evidence of heteroscedasticity.

Next in equation 2 of Table 3.1.5 we find that omitting the current unemployment differential does not yield much improvement. Only the price differential variables are significant at the 5 per cent level but the parameters are almost equal in magnitude and have signs opposite to one another[8]. The lagged dependent variable remains insignificant at the 5 per cent level. Next we regress the net migration rate on the current real wage differential, the current unemployment differential and the second lagged of the price differential together with the lagged dependent variable. Only the second lag of the price differential and the lagged dependent variables are significant at the 5 per cent. The price differential in period (t-2) has the expected positive sign. This suggests that the higher are house prices in Scotland relative to RUK two years ago the more people leave Scotland for RUK. The positive sign on the parameter of the lagged dependent variable indicates that the higher the number of people migrating from Scotland to RUK in the previous period will encourage more people to leave Scotland in the current period. The R^2 value of 0.69 indicates that equation 3 explains 69% of the Scottish-RUK migration data. The diagnostic test

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[7] The high R^2 value might be due to more variables being used in the regressions than before, as increase in the number of variable used always increase R^2 but not R-bar-squared.

[8] We thus think that the stock adjustment form of the model may be more relevant in describing the data. Hence we estimate the stock adjustment form of Layard *et. al.* (1991) model and the results are as shown in Table 3.1.6.

results provide no evidence of serial correlation, functional form problems, non-normally distributed residuals or heteroscedasticity.

Finally, we estimate the stock adjustment form of Layard *et. al.* (1991) model and present the results in Table 3.1.6. In equation 1 of Table 3.1.6, the change in real wage between Scotland and RUK is not significant at the 5 per cent level but has the expected sign. The change in unemployment differential is close to being significant at the 5 per cent level and has the expected sign. The change in price differential is significant at the 5 per cent level but has a negative sign, which does not support the theory. The R^2 indicates that equation 1 explains 62% of the Scottish-RUK migration data. The DW statistic and the diagnostic test on serial correlation imply that the null hypothesis of no serial correlation cannot be rejected. The other diagnostic test result indicates that the null hypotheses concerning the tests are not rejected. We then test for parameter stability by conducting the CUSUM and CUSUM-SQ test. The results show that the residuals are within the accepted critical bands which implies parameter stability. Next we add the lagged dependent variable to our model and the result is as given by equation 2 of Table 3.1.6. The change in real wage and the change in unemployment remain insignificant at the 5 per cent level. The change in the price differential remains significant at the 5 per cent level and maintains the perverse sign. The lagged dependent variable is significant at the 5 per cent level and again takes a positive sign. The R^2 value improves and the standard error of regression decreases. These imply that equation 2 provides a better data fit than equation 1. The diagnostic test results provide no evidence of serial correlation or functional form problems. The null hypotheses that the residuals are normally distributed and the model is homoscedastic are not rejected.

Next we replace the lagged dependent variable by the time trend variable. The result is as given by equation 3 of Table 3.1.6. The change in the real wage variable is very near to significance at the 5 per cent level, and has the expected sign. The change in unemployment differential remains insignificant at the 5 per cent level. The change in the price differential remains significant at the 5 per cent level (indeed its significance improves relative to equation 2) but maintains the perverse sign. The time trend variable is significant at the 5 per cent level. The negative sign indicates that over time the dependent variable tends to decline *ceteris paribus*. The R^2 value of 0.73 indicates that equation 3 is the best model among the 3 models reported in Table 3.1.6. The standard error of regression also decreases. While the DW statistic improves from that of equation 1 of Table 3.1.6, the diagnostic test result provides no evidence of serial correlation or of a functional form problem. There is no evidence that the residuals are other than normally distributed or of the presence of heteroscedasticity. We next conduct the parameter stability test using the CUSUM and CUSUM-SQ procedures. We find that the residuals are within the given critical bands. Hence the parameters can be said to be stable. From the above findings we conclude that equation 3 of Table 3.1.6 is the best model among the stock adjustment versions of the Layard *et. al.* (1991) models that describe the Scottish-RUK migration behaviour presented in Table 3.1.6.

3.2.3. The Jackman and Savouri Model

The Jackman and Savouri (1992), preferred equation for net migration is given as

$$m_i^{net} = F_i - 3.2(u_i - u) + 16.5(v_i - v) - 0.56\ln(PH_i/PH)$$

$$(3.4) \qquad (2.2) \qquad (5.3)$$

where F are regional fixed effects; u and v are natural logarithm of unemployment and vacancy rates respectively and PH are house prices. Notice that wage effects are not defined in Jackman and Savouri (1992) model unlike the Ermisch (1995) and the Layard *et al* (1991) migration models.

Initially we estimate the Jackman and Savouri (1992) model in its original form (see equation 1 of Table 3.1.7), later we include the lagged dependent variable (as in equation 2 of Table 3.1.7) and the time trend (as in equation 3 of Table 3.1.7) as regressors. The results of equation 1 show that the unemployment differential is significant at the 5 per cent level but the sign is contrary to expectations. The vacancy differential is also significant at the 5 per cent level which supports the hypothesis that the higher the vacancy rate in Scotland the less the number of people leaving Scotland for RUK. The price differential does not seem to have any effect on the net out migration rate. The R^2 value of 0.69 implies the model explains 69% of the data. The DW statistics and the diagnostic test on serial correlation do not provide evidence of a serial correlation problem. There is also no evidence of functional form or heteroscedasticity problems. The diagnostic test result indicates that the null hypothesis that the residuals are normally distributed is not rejected.

In equation 2 the unemployment rate differential is significant at the 5 per cent level and maintains the perverse sign. A high unemployment rate in Scotland relative to RUK does not seem to encourage net out migration from Scotland to RUK. The price differential remains insignificant in the regression. The vacancy differential remains significant at the 5 per cent level (but has a higher standard error than before) and maintains the expected sign. The lagged dependent variable is not significant at the 5 per cent level. The R^2 implies that 73% of the variation in Scottish-RUK data is explained by the equation. The standard error has decreased which means equation 2 fits the data slightly better than equation 1. There is no evidence of serial correlation or of functional form problems. The diagnostic test results for normality and homoscedasticity indicate that the residuals are normally distributed and homoscedastic.

The results for equation 3 show that the unemployment differential remains significant at the 5 per cent level and maintains the perverse sign. The price differential variable remains an insignificant regressor. The vacancy rate differential remains significant at the 5 per cent level and has the expected sign. The inclusion of the time trend variable as a regressor seems to increase the explanatory power of the vacancy differential variable, although the time trend itself is not a significant regressor. The model explains some 70% of the Scottish-RUK data. The standard error of regression increases a little which implies that equation 3 may not be quite as good a fit as equation 2 or equation 1. There is no evidence of serial correlation or functional form problems. The diagnostic test result fail to reject the null hypotheses that the residuals are normally distributed and homoscedastic. Next we check for parameter stability using the CUSUM and CUSUM-SQ test for all the 3 equations discussed in above. The results suggest the stability of the parameters as all the residuals are within the given critical bands.

We further augment the Jackman and Savouri (1992) model to include other lags, a lagged dependent variable and the time trend as regressors. Many different combinations of the variables are regressed but only those that we think are among the best are recorded in Table 3.1.8. In equation 1 the unemployment differential at (t-1) is significant at the 5 per cent level but still maintains the sign opposite to that predicted by theory. The current price differential is not significant at the 5 per cent level but the price differential at (t-2) period is significant and has the expected sign. This implies that the higher the prices in Scotland two years ago the greater migration from Scotland to RUK in the current period. The vacancy differential is significant at the 5 per cent level and has the expected sign. The result thus supports the hypothesis that, as the vacancy rate in Scotland increases relative to RUK, fewer people will migrate from Scotland to RUK. The higher vacancy rate implies that more jobs are available hence there is no need for people to migrate out of Scotland to look for a job (assuming that job hunting is one of the main reason why people move). The lagged dependent variable is not significant at the 5 per cent level. The R^2 value implies the model explains 81% of the variation in the dependent variable. There is no evidence of serial correlation or functional form problems. The diagnostic test results do not reject the null hypotheses of normality and homoscedasticity in the residuals.

We conduct the variable deletion test and eliminate the current price differential from the regression. The result of the test indicates that the chosen variable can be omitted from the regression. We then regress the new model and the result is as shown by equation 2 of Table 3.1.8. In equation 2 the unemployment differential at period (t-1) remains significant at the 5 per cent level and maintains the perverse sign. The price differential in period (t-2) remains significant at the 5 per cent level and maintains the expected sign. The vacancy differential at period (t-1) also remains significant at the 5 per cent level and also has the expected sign. The t-value for the vacancy differential at period (t-1) is also higher than before. The lagged dependent variable, however, remains insignificant. The standard error falls a little and there is no evidence of serial correlation or functional form problems. The diagnostic tests do not reject the null hypotheses of normality and homoscedasticity in the residuals. Equation 2 therefore explains the Scottish-RUK migration processes reasonably well.

Next in equation 3 we replace the unemployment differential variable lagged one period by the current unemployment differential variable as a regressor to see whether the latter has an influence (or greater influence) on net out migration behaviour. The result shows that the current unemployment differential is not significant at the 5 per cent level but still maintains the perverse sign. The price differential at period (t-1) is significant at the 5 per cent level and has the expected sign. The vacancy differential at period (t-1) also remains significant at the 5 per cent level and has the expected sign. The lagged dependent variable is now significant at the 5 per cent level. The positive sign indicates that as the magnitude of migration in the previous year increases, the current migration magnitude will also increase, as would be implied by a partial adjustment mechanism. The R^2 value decreases a little which indicates that equation 3 is not a better fit than equation 2. The standard error of regression also increases which also indicates that equation 3 is no better than equation 2 at explaining the data. There is no evidence of serial correlation or functional form problems. The diagnostic tests results do not reject the null hypotheses of normality and homoscedasticity in the residuals.

Next we vary our model to include the time trend as a regressor. In equation 4 the unemployment differential lagged one period remains significant at the 5 per cent level and continues to take "wrong" sign. The price differential lagged one period is also significant at the 5 per cent level and has the expected sign (but has a lower t-value than in equation 3). The significance of the vacancy differential lagged one period has greatly increased and also maintains the expected sign. Thus in this model migration from Scotland to RUK is largely explained by the vacancy rate and house prices differentials between Scotland and RUK. The higher the vacancy rate in Scotland relative to RUK the fewer people will migrate from Scotland to RUK. The time trend variable is not significant at the 5 per cent level. The model explains 81% of the variation in the dependent variable. The DW statistics and the diagnostic test result suggest that serial correlation is not present. There is no evidence that the functional form is incorrect. The diagnostic test result does not reject the null hypotheses of normality and homoscedasticity in the residuals. We then conduct the test for parameter stability for all the equations mention for Table 3.1.8 thus far. The

CUSUM and CUSUM-SQ results indicate that parameter's stability prevails in equation 1 through equation 4. We tried to augment the Jackman and Savouri (1992) model further, but the results did not improve. For example, as shown by equation 5 of Table 3.1.8, the explanatory power of the model declines and the serial correlation problem appears. Accordingly we did not report the results of further augmenting the Jackman and Savouri (1992) model in level forms.

Next we estimate the stock adjustment form of the Jackman and Savouri (1992) model. The results are as given by Table 3.1.9. In Equation 1 the change in unemployment differential between Scotland and RUK is significant at the 5 per cent level and has the expected sign. The result supports the hypothesis that people move from high unemployment to low unemployment regions. The change in price between Scotland and RUK is significant at the 5 per cent but still maintains the perverse sign. The change in vacancy rates between Scotland and RUK is not significant at the 5 per cent level. There is no evidence of serial correlation nor of a problem of functional form. There is also no evidence of a heteroscedasticity or non-normality, as shown by the relevant low Chi-SQ values. Next we hope to improve the model by including the lagged dependent variable. The result is as reported by equation 2 of Table 3.1.9. The addition of the lagged dependent variable reduces the explanatory power of the change in unemployment variable. The change in price variable remains significant at the 5 per cent level and maintains the sign opposite to that predicted by theory. The change in vacancy rates between Scotland and RUK remains insignificant at the 5 per cent level. The lagged dependent variable is significant at the 5 per cent level. It has the largest coefficient, thus suggesting that net out migration from Scotland is largely influenced by previous migration experience. The R^2 indicates that equation 2 has a better fit than equation 1. There is no evidence of serial correlation or functional form problems. The diagnostic test result indicates that the null hypotheses that the residuals are normally distributed; and that there is no heteroscedasticity cannot be rejected.

Next we include the time trend variable as a regressor while at the same time omit the lagged dependent variable as a regressor. The result is reported as equation 3 in

Table 3.1.9. The change in unemployment differential between Scotland and RUK now becomes significant (again) at the 5 per cent level and has the expected sign. The higher the unemployment rate in Scotland relative to RUK the higher will be the net out migration rate from Scotland to RUK. The change in the price differential between Scotland and RUK remains significant at the 5 per cent level and maintains the sign opposite to that predicted by theory. The change in the vacancy differential between Scotland and RUK remains an insignificant regressor. The time trend variable is significant at the 5 per cent level. The negative sign indicates that over time, there is a trend decline in the net migration rate. Equation 3 explains 68% of the variation in the dependent variable (an improvement from equation 1 and equation 2 above). The standard error of regression has decreased which indicates that the fit of the model has improved. The DW statistic of less than 2 indicates the likely presence of positive autocorrelation in the residuals (e.g. Johnston, 1984), but this is not confirmed by the Chi-squared test. The diagnostic test result provides no evidence of functional form problems and the hypothesis of normally distributed residuals cannot be rejected (as shown by the low Chi-SQ value). There is also no heteroscedasticity. Next we conduct tests of parameter stability for all the equations in Table 3.1.9. The results provide evidence that the parameters used in the models are stable.

3.2.4. Our Models in Level Forms.

3.2.4a. Regressing the levels of the chosen variables individually.

In view of the comparatively poor performance of models in the above section, we explore the behaviour of a set of simple sub-models, in which there is only one key economic determinant (for example, the unemployment differential or the real wage differential). In this section we regress the variables individually to explore basic relationships more carefully. In Table 3.1.10, equation 1 shows that real wage in the own region relative to the destination region does not exert an impact on the dependent variable that is statistically significantly different from zero. . Next, in equation 2, when the lagged dependent variable is included in the regression the relative real wage variable becomes significant at the 5 per cent level, but it has the sign opposite to that which theory predicts. The lagged dependent variable is also significant at the 5 per cent level. The R^2 value of 0.59 implies the model explains 59% of the Scottish-RUK migration data. The diagnostic test result on serial correlation suggests that it is not a problem. There is no evidence that the functional form is incorrect. The diagnostic test results do not reject the null hypotheses of normality and homoscedasticity in the residuals. Next in equation 3 the result show that the time trend variable is not significant at the 5 per cent level. Only the lagged dependent variable remains significant at the 5 per cent level.

In Table 3.1.11 we estimate models in which the unemployment rate differential is the main explanatory variable. Equation 1 shows that the unemployment rate in Scotland relative to RUK has a positive significant effect on the migration behaviour. The higher the unemployment rate in Scotland relative to that of RUK the greater the out migration rate from Scotland to RUK. This result parallels that of theory, where people migrate from high unemployment to low unemployment regions. The R^2 value is very small, however. In equation 2, when the lagged dependent variable is included in the regression, the unemployment variable ceases to be a significant regressor. Next, in equation 3 the time trend variable is insignificant at the 5 per cent level. Only the lagged dependent variable remains significant. The unemployment variable, apart from being insignificant, has the opposite sign to that expected on theoretical grounds..

In Table 3.1.12 equation 1 shows that vacancy rate in Scotland relative to RUK has a significant negative impact on net out migration between the two regions. As the vacancy rate in Scotland increases fewer people will migrate from Scotland to RUK. This result parallels that of theory, that people migrate from low vacancy to high vacancy regions. The R^2 implies the model explains 60% of the Scottish-RUK migration data. The diagnostic test results on serial correlation suggests that it is not a problem. There is no evidence that the functional form is incorrect. The diagnostic test results do not reject the null hypotheses of normality and homoscedasticity in the residuals. Equation 2 shows that previous migration does not appear to affect the current migration behaviour when the vacancy rate differential is included. The vacancy rate in Scotland relative to that of RUK remains significant at the 5 per cent level. Next in equation 3 the result shows that the time trend variable is not significant at the 5 per cent level. Only the relative vacancy rate between Scotland and RUK remains a significant regressor and maintains the expected sign.

In Table 3.1.13 the result given by equation 1 suggests that house prices in Scotland relative to RUK are not important in determining the net migration decisions between Scotland and RUK. In equation 2 only the lagged dependent variable is significant at the 5 per cent level. The R^2 value of 0.50 implies the model only explains 50 per cent of the variation in the Scottish-RUK migration data. The diagnostic test results provide no evidence of serial correlation or of a functional form problem. There is no evidence that the residuals are not normally distributed. Finally, there is no evidence of a heteroscedasticity problem. In equation 3 only the time trend variable is significant at the 5 per cent level. The R^2 value declines from that of equation 2 which implies that equation 3 is not a better explanation for the data than equation 2. The diagnostic test results provide evidence that serial correlation and functional form problems are present in the model. However there is no evidence of normality or heteroscedasticity problems.

From the above findings we conclude that only the unemployment rate and vacancy rate variables have significant effects on net out migration behaviour between Scotland and RUK when regressed individually. However, the results show that other variables are to be included in the regression so as to improve the results. In the next sub-section we regress different combinations of the variables mentioned above to see which model can best describes the Scottish-RUK migration data.

3.2.4b. Regressing different combinations of the Scotland- rest-of the UK (RUK) variables.

In this subsection we try to specify the models by regressing the relative variables that we think might affect net out migration behaviour between the two regions. It is worthwhile conducting a general to specific approach in an attempt to identify the "best" specifications given our data set. We have tried many different combinations of the variables in our regressions including the lagged variables. The following are results are the subset that we consider worthy of discussion. In equation 1 of Table

3.1.14 the result shows that relative real wage and relative unemployment rates between Scotland and RUK are significant at the 5 per cent level but only the unemployment variable has the expected sign. The R^2 value is very small which suggests missing variables. The DW statistics and the diagnostic test results on serial correlation provide evidence that serial correlation is present. There is no evidence of functional form or non-normality problems. The diagnostic test results also provide no evidence that there is a heteroscedasticity problem.

Next in equation 2 the result shows that the relative real wage is significant at the 5 per cent level but maintains the unexpected sign. The relative vacancy rate is significant at the 5 per cent level and has the expected sign. The inclusion of the vacancy rate variable seems to have a negative impact on the unemployment variable. The result shows that the unemployment rate variable now become insignificant at the 5 per cent level. The R^2 value of 0.76 implies the model explains 76% of the Scottish-RUK migration data. The DW statistics and the diagnostic test result on serial correlation provide no evidence of serial correlation. Nor is there any evidence to suggest that the functional form is incorrect. The diagnostic test results do not reject the null hypotheses of normality and homoscedasticity in the residuals. Hence none of the assumptions of white noise residuals ($E(\mu_t,\mu_s)=0$ for every $t\neq s$ and the constant variance (homoscedasticity) $E(\mu^2)=\sigma^2$) are violated. If both the conditions are satisfied at the same time a strong white noise is said to prevail. Next we test for parameter stability using the CUSUM and CUSUM-SQUARED tests. The results indicate that the parameters are stable. The residuals are within the two bands of the 5 per cent significant level.

In equation 3 the result shows that the relative real wage between Scotland and RUK remains significant at the 5 per cent level but maintains the sign opposite to that predicted by theory. The relative vacancy rate remains significant at the 5 per cent level and maintains the expected sign. The higher the vacancy rates in Scotland fewer people will migrate from Scotland to RUK. The relative house price variable is not significant at the 5 per cent level. Next in equation 4 the result shows that only the relative vacancy rate between Scotland and RUK remains significant at the 5 per cent level and maintains the expected sign. The R^2 value implies that the model explains

75% of the variation in dependent variable. The DW statistics and the diagnostic test on serial correlation do not provide evidence of a problem. There is also no evidence of functional form or heteroscedasticity problems. The diagnostic test result indicates that the null hypothesis that the residuals are normally distributed is not rejected.

Finally in equation 5 the result shows that the relative real wage variable and the relative vacancy variable are significant at the 5 per cent level and maintain the signs discussed earlier. Thus the higher the real wage in Scotland relative to RUK the more people migrate out from Scotland to RUK. This finding does not support the theory that people migrate from low wage to high wage regions. The result however supports the theory that people migrate from low vacancy to high vacancy regions. Higher vacancies mean more jobs are available and hence people are attracted to move into such regions (as one of the motivations of migration is to improve job prospects). The lagged dependent variable is not significant at the 5 per cent level. This implies previous migration does not affect current migration behaviour.

We also experimented with inclusion of a time trend and lagged values of the explanatory variables, but our results are not convincing and so we do not record them here.

3.2.4c. The effect of North sea oil development on net migration.

We think that the discovery of oil in Scotland in the earlier part of 1970's helped with job creation, and hence might have influenced the net out migration decision. As mentioned earlier, employment wholly related to the oil production in the North sea is used as the proxy for the direct effects of the overall level of development of the North Sea. The log of the North Sea oil variable (nso), is expected to have a negative effect on net out migration from Scotland to RUK. As more jobs are available in the North sea oil production, fewer people will migrate out of Scotland to RUK.

The result of regressing the North sea oil variable with the other variables mentioned earlier are as shown in Table 3.1.15. Equation 1 shows that real wage is significant at the 5 per cent level but has the sign opposite to that predicted by theory. The relative vacancy between Scotland and RUK has the expected sign and is significant at the 5 per cent level. The house price differential and the North sea oil variable are not significant at the 5 per cent level. Previous migration is also not influential on current migration decision. The model explains 78% of the variation in dependent variable. The DW statistics and the diagnostic test on serial correlation do not provide evidence of a serial correlation problem. There is also no evidence of functional form or heteroscedasticity problems. The diagnostic test result indicates that the null hypothesis that the residuals are normally distributed is not rejected. In equation 2 the result shows that the real wage maintains the positive sign and remains significant at the 5 per cent level. The house price differential and the North sea oil variable remain insignificant at the 5 per cent level, but now the North sea oil variable has the expected sign. The lagged dependent variable is significant at the 5 per cent level and has a positive sign. The R^2 value declines which means that equation 2 is no better than equation 1 in explaining the Scottish-RUK migration data. The diagnostic test on serial correlation do not provide evidence of a serial correlation problem. There is also no evidence of a functional form problem. The diagnostic test result indicates that the null hypothesis that the residuals are normally distributed is not rejected. However the high value of the CHI-SQ with one degree of freedom indicates that there is a heteroscedasticity problem. In equation 3, the inclusion of the time trend as one of the regressors does not help to improve the model. In equation 4 the result shows that the real wage variable and the vacancy rate variable remain significant at the 5 per cent level and maintain the signs as before. The coefficient on the Northsea oil variable remains insignificantly different from zero at the 5 per cent level. The DW statistics and the other diagnostic test of serial correlation provide no evidence of a the presence of serial correlation. There is also no evidence of functional form or heteroscedasticity problems. The diagnostic test result indicates that the null hypothesis that the residuals are normally distributed is rejected. This implies that the residuals are not normally distributed. Hence equation 4 is not capable of explaining the Scottish-RUK migration data.

Finally in equation 5 the results show that the real wage remains significant at the 5 per cent level and has the sign which is opposite to what theory predicts. The North sea oil variable is significant at the 5 per cent level and has the expected sign. Thus the higher the employment level in the North sea oil production, fewer people will migrate from Scotland to RUK. The R^2 value however is very small which means that the model explains very little of the variation in the Scottish-RUK migration data. This suggests that there are other variables that need to be included in the model. There is evidence that the residuals are serially correlated. The diagnostic test result suggests that the residuals are normally distributed. There is also no evidence of functional form or heteroscedasticity problems. Our results above suggest that the North sea oil variable does not work well with the vacancy and house price variables. Thus there may be other variables that need to be surveyed and be included into the model.

This completes our exploration of the level forms of the variables. In the next section we report the results of estimating our stock adjustment models.

3.2.5. Stock Adjustment Models

The above models are all of the flow adjustment variety, which as our analysis in the preceding chapter argues, appear to be based on an implicit assumption of homogeneity among migrants. Allowing for heterogeneity, for example in the form of a distribution of expected psychic migration transactions costs, suggests that a stock-adjustment formulation may be more appropriate. The stock adjustment equation we estimate follow the given form

$$NMGRATE^{SA} = \beta_0 - \beta_1 \Delta(rw_S - rw_{RUK}) + \beta_2 \Delta(u_S - u_{RUK})$$

Where Δ is the first difference operator, capturing the stock adjustment specification, and the other variables are as defined previously and in the data appendix. We estimate the stock adjustment models that we think can be used to explain Scottish-RUK migration data. We start by regressing the most general form of the stock adjustment model as given by equation 1 of table 3.1.16. Only the change in the price variable between Scotland and RUK is significant at the 5 per cent level but has the opposite sign to that predicted by theory. The time trend and the lagged dependent variable are both insignificant at the 5 per cent level. The R^2 value implies the model explains 74% of variation in the dependent variable. There is no evidence of serial correlation or functional form problems. The diagnostic test result does not reject the null hypotheses of normality and homoscedasticity in the residuals. Next we drop the lagged dependent variable from our regression. In equation 2 the result shows that the change in price variable remains significant at the 5 per cent level with a larger t-value than before. However it maintains the sign opposite to that predicted by theory. The time trend now becomes significant at the 5 per cent level. The negative sign indicates that the dependent variable tends to decrease over time. The DW statistic is very close to 2, which implies that there is no evidence of serial correlation in the residuals. This result is confirmed by the other diagnostic test of serial correlation. There is also no evidence of serial correlation or functional form problems. The diagnostic test result does not reject the null hypotheses of normality and homoscedasticity in the residuals. Next, based on the t-values we omit the change in vacancy variable from our regression. The result is given in equation 3. The change in real wage is not significant at the 5 per cent level but has the expected sign. The change in the unemployment rate between Scotland and RUK also remains insignificant at the 5 per cent level and maintains the expected sign. The change in price between Scotland and RUK maintains to be a significant variable but still has the sign opposite to that predicted by theory. The time trend remains significant at the 5 per cent level. The R^2 decreases slightly which implies the model is a worse fit. The DW statistics is greater than 2 which indicates negative autocorrelation of the residuals (e.g. Johnston 1984). This is not corroborated by the other diagnostic test for serial correlation, however. There is also no evidence of a functional form problem in the model. The diagnostic test result does not reject the null hypotheses of normality and homoscedasticity in the residuals.

Next we omit the change in unemployment variable from our regression. We also reintroduce the change in vacancy variable into our model to see whether the change in vacancy will have significant effect on net out migration variable when the change in unemployment is excluded from the regression. The result given in equation 4 indicates that the real wage now becomes significant at the 5 per cent level and has the expected sign. This result supports the theory that people move from low wage to high wage regions. Thus the higher the real wage in Scotland relative to RUK fewer people will migrate from Scotland to RUK. The change in vacancy variable remains insignificant at the 5 per cent level. The price variable remains significant at the 5 per cent level and maintains the negative sign as before. The time trend variable remains significant at the 5 per cent level with a lower standard error. The negative sign implies that the net out migration from Scotland to RUK decreases over time. The R^2 value implies that the model explains 70% of the net out migration flow from Scotland to RUK. The DW statistic of 2 implies there is no autocorrelation in the residuals. The diagnostic test result also implies that there is no evidence of serial correlation and functional form problems. The diagnostic test result does not reject the null hypotheses of normality and homoscedasticity in the residuals.

Finally we omit the change in the vacancy variable from our regression. The result is shown in equation 5. The change in real wage remains significant at the 5 per cent level and maintains the expected sign. The standard error has also reduced. The change in price variable also remains significant at the 5 per cent level and maintains the previous sign. Its standard error has also decreased. The time trend variable also remains significant at the 5 per cent level and the standard error has also decreased. The R^2 value remains unchanged and the corrected R^2 does not change very much, indicating the change imposed on the model is acceptable. The DW statistic of 2 means that there is no evidence that the residuals are not autocorrelated (Johnston 1984). The standard error of the regression has decreased which means equation 5 can be a better model than equation 4. There is no evidence of serial correlation and functional form problems. The diagnostic test result also indicates that the test for normality and homoscedasticity gives affirmative result. We also conduct the parameter stability test for all our models discussed above using the CUSUM and CUSUM-SQ methods. The results provide evidence of parameter stability in all our stock adjustment models. Given the above findings we conclude that equation 4 and equation 5 are among the best statistical models that could be used to describe the net out migration flows between Scotland and RUK, although the unexpected sign on house price variables limits the genuine explanatory power of the model.

3.2.6. The Non-Nested Tests

Initially in this section we conduct some non-nested tests of the better models that we identify as providing a reasonable explanation of the data. The non-nested tests are conducted on a sample of the best models that describe the Scottish RUK migration behaviour that we have discussed above. Non-nested tests involve the comparison of two selected models, say M1 and M2. The null hypothesis Ho: M1 is better than M2 is tested against the alternative hypothesis Ha: M1 is no better than M2. The Akaike's Information Criterion and the Schwarz's Bayesian Information Criterion of M1 versus M2 will provide the chosen result of which model is favoured. We conduct the non-nested tests on several of our flow models against our stock adjustment models. The results indicate that the stock adjustment models are preferred to the flow models.

Our results suggest that the variables used in the regression generally give better explanations when regressed in the stock adjustment forms rather than in level forms. Hence we suggest that the stock adjustment models might be more appropriate in describing the Scottish-RUK migration data. However, since none of the models thus far provide clear-cut superior results we think there might be a better way to specify the migration model. In the next sub-chapter we try to correct for the misspecification in the normally assumed net migration function. This is because our models are based on the LNJ model that is expressed in terms of a net migration rate. Rogers (1990) makes it clear that such models are misspecified because the ratio of home and other regions' populations are treated as a constant whereas in reality they cannot be. We try to "correct" for this misspecification by first understanding the nature of the net migration function. Then we specify the net migration function relative to the home population. We call this the population ratio migration function. Later we specify this function as the "share" specification. We then regress these two specifications of net migration function, using the true population and then the adjusted population in which migration is the only source of population change.

3.3. Investigating of Bias Arising from the Use of Net Migration Rate Equations.

We noted in Chapter 2 that models of net migration rates have been subject to criticism, despite which they remain very popular and influential. In this section we explore ways of investigating this possible source of bias, while retaining the focus on net migration rates. We wish to retain this focus because of our ultimate concern with the effects of migration flows on the labour market, where it is the net flows that are critical in governing changes in regional labour forces.

3.3.1. The population ratio model.

First we accept the superiority of a gross migration function as a starting point. We assume a simple formulation of the probability of out-migration as:

$$O/POP_S = -\alpha_0 - \alpha_1(rw_S - rw_{RUK}) + \alpha_2(u_S - u_{RUK}) \qquad (3.3.1)$$

Where O is out-migration from Scotland; and the other variables are as defined previously. As in the other regressions we have so far conducted, we assume that the right-hand-side variables are linear in logarithms for simplicity. Similarly the probability of in-migration can be modeled in an analogous way as

$$I/POP_{RUK} = \beta_0 + \beta_1(rw_S - rw_{RUK}) - \beta_2(u_S - u_{RUK}) \qquad (3.3.2)$$

The probability of net-out-migration can then be converted to an in-migration rate relative to the home population by multiplying the left-hand-side of equation (3.3.2) by POPS/POPS (=1):

$$I/POP_{RUK} \bullet POP_S/POP_S = \beta_0 + \beta_1(rw_S - rw_{RUK}) - \beta_2(u_S - u_{RUK})$$

Hence we obtain

$$I/POP_S = (POP_{RUK}/POP_S)[\ \beta_0 + \beta_2(rw_S - rw_{RUK}) - \beta_2(u_S - u_{RUK})]$$

We can then derive an equation in the form of a net migration rate as follows:

$$(I\text{-}O)/POP_S = k\beta_0 + k\beta_1(rw_S - rw_{RUK}) - k\beta_2(u_S - u_{RUK}) + \alpha_0 + \alpha_1(rw_S - rw_{RUK}) - \alpha_2(u_S - u_{RUK}) \qquad (3.3.3)$$

where $k = POP_{RUK}/POP_S$

3.3.2. The "share" models of migration.

In this section we assume that the variables in equation (3.3.3) have the same coefficients. That is, $\alpha_1=\beta_1$, $\alpha_2=\beta_2$ and $\alpha_0=\beta_0$. We can then simplify equation 3.3.3 further as

$$(I-O)/POP_S = (1+k)\beta_0 + (1+k)\beta_1(rw_S - rw_{RUK}) - (1+k)\beta_2(u_S - u_{RUK}) \quad (3.3.4)$$

which can be converted to a "share "equation: $(1+k) = (P_S+P_{RUK})/P_S = s^{-1}$

Where s is the Scottish share of UK population. Hence equation (3.3.4) now becomes

$$(I-O)/POP_S = s^{-1}\beta_0 + s^{-1}\beta_1(rw_S - rw_{RUK}) - s^{-1}\beta_2(u_S - u_{RUK})$$

In the next section we then regress the "share" equation to see what different it makes to the results. Later we relax the assumption of equal coefficients and regress the population ratio equation mentioned above.

3.3.3. Estimating the "Share" Models of Migration.

3.3.3a. The flow models.

In Table 3.3.1 we show the results of regressing equation (3.3.4), the "share" migration model using the LNJ specification, with t and later with the lagged dependent variable. In general the models fail the test statistics and there is evidence of serial correlation and of heteroscedasticity, except in equation 3 and equation 6 when the lagged dependent variable is included. In these models, the lagged dependent variable explains the migration flows between Scotland and RUK. The positive sign on the lagged dependent variable indicates that previous period migration encourages current period out-migration flows.

Next we include other lagged variables in our regression. In Table 3.3.2 we provide the results when the adjusted population is used while in Table 3.3.3 we give the result with the true population. In general the results with true population are more promising than those with the adjusted population. For example compare equation 2 and equation 6 of Table 3.3.2 with equation 2 and equation 6 of Table 3.3.3. In equation 2 and equation 6 of Table 3.3.2 none of the variables are significant at the 5 per cent significance level but in equation 2 and equation 6 of Table 3.3.3 $(1+k2)(rw_S-rw_{RUK})_t$ and $(1+k2)(u_S+u_{RUK})_t$ are significant but the former does not have the expected sign. The DW statistics (note the equations do not include the lagged dependent variable) imply that the there is no indication of the presence of first order serial correlation. The diagnostic test results imply the hypotheses of no serial correlation and no heteroscedasticity cannot be rejected. Hence we conclude the two equations are quite capable of explaining the Scottish-RUK migration flows (but notice the variable related to the relative real wage has the opposite sign to that conventionally expected).

Later we include the lagged dependent variable in our models to see how previous out-migration flows affect current migration flows. We show the results in equations 9 through 12 of Table 3.3.2 for the adjusted population and in equations 9 through 12 of Table 3.3.3 for the true population. The results show that in equation 10 and equation 11 of Table 3.3.2 only the lagged dependent variable is significant. Similarly, in Table 3.3.3, only the lagged dependent variable is significant in equation 10, whereas the other equations show that even the lagged dependent variable is not significant at the 5 per cent significance level. In Table 3.3.3, the diagnostic tests results indicate evidence of heteroscedasticity problems in equation 9 through equation 12. Hence with the true population, previous out-migration does not seem to be important in determining out-migration flows between Scotland and RUK when other lagged variables are included. But with the adjusted population, where migration is the only source of population change, previous period out-migration flows do affect current migration flows positively.

Next we estimate the stock adjustment form of the migration model to explore what difference this make to our results.

3.3.3b. The stock adjustment models.

In the stock adjustment specification equation 3.3.4, now becomes

$$(I-O)/POP_S = (1+k)\beta_0 + (1+k)\beta_1\Delta(rw_S-rw_{RUK}) - (1+k)\beta_2\Delta(u_S-u_{RUK}) \quad (3.3.5)$$

Where the presence of the first difference operator, Δ, implies the stock adjustment specification. We estimate equation (3.3.5) as before employing the same sample period of 1970-1994. In Table 3.3.4 we provide the results with the LNJ kind of specification using the adjusted population and the true population value. In equation 1 the "share" variable, (1+k1) and $(1+k1)\Delta(rw_S-rw_{RUK})_t$ are significant at the 5 per cent significance level. The R^2 value of 0.54 indicates that the model explains only 54% of Scottish-RUK migration flows. The DW statistics imply the absence of first order serial correlation. The diagnostic tests results imply that the hypotheses of no serial correlation and no heteroscedasticity cannot be rejected. When a time trend is included in the regression, see equation 2, none of the variables are significant at the 5 per cent level of significance. Next we replace the time trend by the lagged dependent variable. Equation 3 shows that only the lagged dependent variable is significant. Hence the model is explained by previous migration flows when the lagged dependent variable is included as a regressor. In equation 4, with true population, only the "share" variable, (1+k2) is significant at the 5 per cent significance level. But when the time trend is included, as with adjusted population, none of the variables are significant. Similarly, when included in the regression, only the lagged dependent variable is significant.

Next we include other lagged variables in our regression to see how they affect our results. We also include the time trend and later the lagged dependent variable as our explanatory variables. We present the results with adjusted population in Table 3.3.5. The time trend is not significant in any of the regressions in which it is included (see equations 1 through equation 3). We then drop it from our regression. In equation 5 only the (1+k1) variable is significant. In equation 6 we regress all the variables as in equation 5 but leave out $(1+k1)\Delta(rw_S-rw_{RUK})_t$ from our model. The result improves, with $(1+k1)\Delta(u_S+u_{RUK})_t$ variable being significant apart from the (1+k1) variable. The DW statistics imply the residuals do not indicate the presence of first order serial correlation. There is no apparent evidence of serial correlation or heteroscedasticity as shown by the diagnostic test results. In equation 7 we include the $(1+k1)\Delta(rw_S-rw_{RUK})_t$ variable in our regression but leave out its lagged value. None of the variables except for (1+k1) is significant at the 5 per cent level. Next we include all the variables in equation 5 except $(1+k1)\Delta(u_S+u_{RUK})_t$. The result in equation 8 shows that the $(1+k1)$ and the $(1+k1)\Delta(rw_S-rw_{RUK})_t$ variables are significant. The R^2 statistic implies the model describes 59% of Scottish-RUK migration flows. The DW statistics imply the absence of first order serial correlation. The diagnostic tests results show no evidence of serial correlation or heteroscedasticity. Next we replace the time trend variable with the lagged dependent variable and regress our models as before. We present the results in equation 9 through equation 12 of Table 3.3.5. As expected, the R^2 values improve, but the lagged dependent variable is not significant in any of the equations. The $(1+k1)$ variable seem to be the only variable that is significant in equations 9, 10 and 12. Hence we conclude that none of these equations are better than the previously discussed equations in this sub-section. We attribute the improvement of the R^2 value to the addition of the lagged dependent variable.

Next we conduct similar regressions to the above with true population value and present the results in Table 3.3.6. In equation 1 none of the variables is significant at the 5 per cent significance level. We drop the $(1+k2)\Delta(rw_S-rw_{RUK})_t$ and regress all the other variables as in equation 1. Only the $(1+k2)\Delta(u_S+u_{RUK})_t$ variable is significant. Next in equation 3 we replace the $(1+k2)\Delta(rw_S-rw_{RUK})_t$ with its first lag and include all the other variables as in equation 1, none of the variables are significant at the 5 per cent level (see equation3). We then conduct the variable deletion test to see whether both $(1+k2)\Delta(rw_S-rw_{RUK})_t$ and $(1+k2)\Delta(rw_S-rw_{RUK})_{t-1}$ can be omitted from our model. The Wald variable deletion test indicates that these variables may not be omitted from our model. We further conduct variable deletion test and our results indicate the $(1+k2)\Delta(u_S+u_{RUK})_t$ and its first lagged variable can be omitted from our model. We regress the $(1+k2)\Delta(rw_S-rw_{RUK})_t$ and $(1+k2)\Delta(rw_S-rw_{RUK})_{t-1}$ with the $(k+1)$ and the time trend variable, and present the result in equation 4. The $(1+k2)\Delta(rw_S-rw_{RUK})_t$ and $(1+k2)\Delta(rw_S-rw_{RUK})_{t-1}$ are significant at the 5 per cent significance level. The DW statistics imply the residuals does not indicate the presence of first order serial correlation. The diagnostic test results show no evidence of serial correlation or heteroscedasticity. Notice that the time variable is not significant in any of the equation hence we drop it from our regression that follows. In equation 5 only the $(1+k2)$ variable is significant, while in equation 6, the

(1+k2) and the $(1+k2)\Delta(u_S+u_{RUK})_t$, variables are significant at the 5 per cent significance level, but the latter does not have the conventional expected sign. This parallels recent studies that suggest that either unemployment rates have a perverse sign or are statistically insignificant (Hughes and McCormick, 1994). Next we conduct Wald's variable deletion test that suggests the $(1+k2)\Delta(u_S+u_{RUK})_t$ and $(1+k2)\Delta(u_S+u_{RUK})_{t-1}$ may be omitted from the regression. In equation 8, the result suggests all the variables are significant at the 5 per cent significance level.

Next we proceed by regressing the lagged flow variant of the "share" model

3.3.3c. Estimating the flow specification of the "share" model with lagged regressors.

In this sub-section we estimate the "share" flow models of migration with lagged regressors. From equation (3.3.4) above, our "share" equation now becomes

$$(I-O)/POP_S = s^{-1}\beta_0 + s^{-1}\beta_1(rw_S-rw_{RUK})_{t-1} - s^{-1}\beta_2(u_S-u_{RUK})_{t-1} \qquad (3.3.6)$$

We regress equation (3.3.6) to see what difference it makes to the results. In Table 3.3.7 we show the results when the adjusted population is used, with t and later with the lagged dependent variable. In Table 3.3.8 we conduct similar regressions but with the true population. Equations 1 through 6 of Table 3.3.7 and Table 3.3.8 indicate that the models exhibit evidence of serial correlation and heteroscedasticity. The results improve when the lagged dependent variable is included in the model. In equation 7 of Table 3.2.7, with the adjusted population, only the lagged dependent variable is significant at the 5 per cent significance level. The positive sign indicates the positive influence of previous migration on current migration flows. Next we conduct Wald's variable deletion test that indicates the possibility of omitting $(1+k1)(rw_S - rw_{RUK})_{t-1}$ from our model. The result improves, all the variables are significant and have the expected sign. The R^2 value of 0.66 implies that the model is quite capable of explaining the Scottish-RUK migration flows. The diagnostic test results provide no apparent evidence of serial correlation or heteroscedasticity. The standard error is reduced from that of equation 7 implying the model is better than equation 7 in explaining the Scottish-RUK migration data. Similarly, in equation 7 of Table 3.3.8, only the lagged dependent variable is a significant variable. While in equation 8, all the variables are significant except $(1+k2)(rw_S - rw_{RUK})_{t-1}$ which is only close to being significant. Comparing equation 8 of Table 3.3.8 with equation 8 of Table 3.3.7 implies that the latter is a better model, because the former model exhibits evidence of heteroscedasticity. Hence in this case our "share" model works better with the adjusted population where migration is the only source of population change.

3.3.4. Estimating the Population Ratio Model.

We estimate equation (3.3.3) by first computing $k1 = POP_{RUK1}/POP_{S1}$, ratio of the adjusted population, where migration is the only source of change. We then calculate

$k1. (rw_S - rw_{RUK}) = POP_{RUK1}/POP_{S1}.(rw_S - rw_{RUK})$ and

$k1.(u_S - u_{RUK}) = POP_{RUK1}/POP_{S1}. (u_S - u_{RUK})$. Later we employ the true population values. We compute k2 in the similar way as we compute k1 but using the true population instead of the adjusted population ratio.

In the section that follows we first conduct the regressions using the Layard et al (1991) specification of the net migration model (with time trend and later with lagged dependent variable). Then we include lagged explanatory and also lagged dependent variables to explore how the results vary.

3.3.4a. The flow models.

Using microfit we then proceed to estimate equation (3.3.3). We begin by describing the results when we employ the LNJ kind of specifications in Table 3.3.9. Later in Table 3.3.10 we include lags of the chosen variables, with the adjusted population and in Table 3.3.11 we present the results with the true population. In equation 1 and equation 3 we regress the model following the LNJ specification, plus the population ratio variables. In equation 1 with the adjusted population the relative real wage between Scotland and RUK is significant and has the anticipated sign. $k1(rw_S - rw_{RUK})_t$ is significant but has the opposite sign from that expected. Similarly in equation 3, with the true population, only the relative real wage between Scotland and RUK is significant and has the expected sign. The R^2 values are very small and the DW statistics indicate that serial correlation is present in equation 1 and equation 3, a result supported by the results of the other diagnostic tests. In equations 2 and 4 we include the time trend but the results do not improve. In equation 5 through equation 8 we omit the k1 and k2 variables because they are not significant at the 5 percent significance level as our results show, but it does not improve the model much except in equation 6, where the time trend is now significant. The diagnostic test result shows that the residuals are serially correlated in all the models (equation 5 through equation 8). We then include the lagged dependent variable, and as expected the R^2 increases and the diagnostic test results improve. However only the lagged dependent variable is significant at the 5 percent significance level. Hence in equation 9 and equation 10 the net out-migration rate in the previous period is the only statistically significant influence on net migration flows between Scotland and RUK. Next we include lagged values of the chosen variables as our regressors. The results are, in general, more promising than those of Table 3.3.9.

In Table 3.3.10 we present the results with the adjusted population in which migration is the only source of population change. While in Table 3.3.11 we regress our FA models using the true population values.[9] Our FA models basically follows that of the LNJ(1991) specification with lagged variables included. The results in Table 3.3.11 give R^2 values ranging from 0.79 to 0.90, while that of Table 3.3.10 ranges from 0.68 to 0.86. The results on the variables are mixed; equation 1 of Table 3.3.10 shows that only the time trend variable is significant at the 5 percent level of significance. While similar variables that we regress in equation 1 of Table 3.3.11 using the true population indicates that k2 (the true population ratio), the relative real wage between Scotland and RUK lagged one period, and $k2(rw_S\text{-}rw_{RUK})_{t-1}$ are significant at the 5 percent significance level. The higher the real wage in Scotland relative to RUK in the previous period fewer people out-migrate from Scotland to RUK. The positive sign on k2 indicates that as the ratio increases more people have migrated from Scotland to RUK, *ceteris paribus*. Next we drop the relative real wage from our model. The result improves, as shown by equation 2 of Table 3.3.10 and Table 3.3.11. The population ratio remains significant in Table 3.3.11 and insignificant in Table 3.3.10. The relative real wage lagged one period is significant and has the expected negative sign in both Table 3.3.10 and Table 3.3.11. The higher the real wage in Scotland relative to that of RUK fewer people out-migrate from Scotland to RUK. The relative unemployment rate between Scotland and RUK, lagged one period, is significant only with the true population value. The coefficients of $k1(u_S-u_{RUK})$ and $k2(u_S-u_{RUK})$ are statistically significantly different from zero in Table 3.3.10 and Table 3.3.11 respectively, so that they are important in explaining net migration flows between the two regions. The coefficients of $k1(rw_S-rw_{RUK})_{t-1}$ and $k2(rw_S-rw_{RUK})_{t-1}$ are significant but do not have the expected sign. The time trend variable remains significant in Table 3.2.2 and maintains the positive sign as before. This implies that the autonomous net out-migration from Scotland to RUK is increasing with time. The R^2 value implies that the models are quite good at explaining the Scottish-RUK migration data, but the signs on the variables are opposite to that expected. There is no evidence of serial correlation or heteroscedasticy..

In equation 3 we include all the variables as in equation 1 but omit $k1(rw_S-rw_{RUK})_{t-1}$ as our regressors. All the variables in equation 3 of Table 3.3.10, except k1 and the lagged relative real wage between Scotland and RUK are significant at the 5 percent significance level. While in equation 3 of Table 3.3.11, k2, $k2(u_S-u_{RUK})_t$ and the relative real wage between Scotland and RUK lagged one period, and time trend are significant. The R^2 values of 0.83 and 0.86 indicate the models are quite capable of explaining the migration flows between Scotland and RUK. The residuals do not indicate the presence of first order serial correlation. The diagnostic test results indicate there is no evidence of the presence of heteroscedasticity in either model. Next in equation 4 we include all the variables as in equation 3 except the relative real wage lagged one period as our explanatory variables. The relative real wage and $k1(u_S-u_{RUK})$ are significant and have the expected signs in both models (equation 4 of Table 3.3.10 and Table 3.3.11). The time trend is significant only in equation 4 of Table 3.3.11 but not in equation 4 of Table 3.3.10.

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[9] Once we include the lagged variables, we are close to the "stock adjustment" models, hence later in this chapter we regress the Flow model with t-1, variables only.

Next in equations 5 and 6 of Table 3.3.10 we omit the current and lag values of the relative unemployment rates, $k1(u_S-u_{RUK})$ and $k1(u_S-u_{RUK})_{t-1}$. The relative real wage lagged one period, $k1(rw_S-rw_{RUK})$ lagged one period, and the time trend variables are significant at the 5 percent significance level. While, in equation 6, all the variables except time trend are significant. The relative unemployment rate lagged one period and $k1(u_S-u_{RUK})$ have the expected signs. The higher the unemployment rate in Scotland relative to that of RUK in the previous period more people out-migrate from Scotland to RUK. k1, the population ratio variable is significant and has a negative sign. The higher the population in RUK (where migration is the only source of change), the less people will out-migrate from Scotland to RUK. The R^2 value of 0.69 implies the model explains the dependent variable quite well. There is no evidence of serial correlation (given the small sample size of 24 and the number of explanatory variables used).

In equation 5 of Table 3.3.11 we omit the relative unemployment rate and $k2(u_S-u_{RUK})_{t-1}$ from our model. The result shows that the relative real wage lagged one period, and $k2(rw_S-rw_{RUK})_t$ are significant and have the expected negative sign. $k2(u_S-u_{RUK})_t$ is also significant at the 5 percent significance level and has the expected positive sign. The higher the unemployment rate in Scotland relative to that of RUK more people out-migrate from Scotland to RUK. Next we omit the unemployment rate variables from our model as that of equation 5 of Table 3.3.10, but none of the variables are significant hence we do not report the result. Instead we regress the net migration rate on k2, the current and lagged values of the relative real wage, $k2(rw_S-rw_{RUK})_{t-1}$, $k2(u_S-u_{RUK})_t$ and the time trend. The result in equation 6 of Table 3.3.11 suggests only the relative real wage variable lagged one period is significant and has the expected sign.

Next we omit the time trend from our model to study the importance of the other regressors in determining the net out-migration rate from Scotland to RUK. First we regress the model as in equation 1 but omit the time trend. With the adjusted population none of the variables are significant hence we do not report the result in Table 3.3.10. But a similar regression with the true population yields the result shown in equation 7 of Table 3.3.11. The population ratio k2 and the relative real wage between Scotland and RUK are significant at the 5 percent level of significance and have the expected sign. In equation 7 of Table 3.3.10 we omit the relative real wage lagged one period, and $k1(rw_S-rw_{RUK})_{t-1}$ from our model. The result shows that all the variables except k1, are significant at the 5 percent significance level. The relative real wage, the relative unemployment rate lagged one period, and $k1(u_S-u_{RUK})_t$ have the expected signs. The R^2 value of 0.76 indicates the model explains 76% of the net migration flows between Scotland and RUK. We then omit the variables that have the 'incorrect' sign from the model using the Wald's variable deletion tests, but the results show that we may not omit those variables. Next we omit the population ratio, k1 from our model and regress the other variables as in equation 7 of Table 3.3.10. The result in equation 8 shows that all the variables are significant and the relative real wage, the relative unemployment rate lagged one period, and $k1(u_S-u_{RUK})_t$ have the expected signs. The R^2 value of 0.72 implies the model explains the Scottish-RUK migration data quite well but the current relative unemployment rate does not have the expected sign. The diagnostic tests imply that the hypothesis of white noise residuals cannot be rejected. In equation 8 of Table 3.3.11 we include all the variables as in equation 7 of the same table, except the relative unemployment rate and $k2(u_S-u_{RUK})_{t-1}$, as our regressors. The result indicates that the relative real wage lagged one period, $k2(rw_S-rw_{RUK})_t$ and $k2(u_S-u_{RUK})_t$ are significant and have the expected signs.

Next we include the lagged dependent variable in our models and report the results in equation 9 through equation 11 of Table 3.3.10 and Table 3.3.11. Initially we include all the current and lagged values of the chosen variables as in equation 1 but replace the time trend with the lagged dependent variable. With the adjusted population in which migration is the only source of change none of the variables are significant (see equation 9 of Table 2). But with the true population, the population ratio, k2 and the relative real wage between Scotland and RUK lagged one period, are significant at the 5 percent significance level, and have the expected signs (see equation 9 of

Table 3.3.11). Next we omit the current value of relative real wage and regress the model as before. The result with the adjusted population improves; relative real wage between Scotland and RUK lagged one period, is significant and has the expected sign (see equation 10 of Table 3.3.10). With true population, the result is even better (see equation 10 of Table 3.3.11): the population ratio, k2, relative real wage lagged one period, relative unemployment rate lagged one period and $k2(u_S-u_{RUK})_t$ are significant at the 5 percent significance level and have the expected signs how ever the current relative unemployment rate between Scotland and RUK has the opposite sign from that conventionally expected. The low real wage and high unemployment rate in Scotland relative to RUK in the previous period, encourage people to migrate from Scotland to RUK. (We later regress only the first lags of the chosen variables and report the findings in a subsequent sub-section).

Next we regress all the variables as in equation 10 but we omit the $k1(rw_S-rw_{RUK})_t$ and $k2(rw_S-rw_{RUK})_t$ respectively. In equation 11 of Table 3.3.10, only the relative real wage differential between Scotland and RUK lagged one period, is significant and has the expected sign. Hence equation 11 is no better than equation 10 in explaining the Scottish-RUK migration data. However with the true population value, the results are better than that of equation 11 of Table 3.3.10: the population ratio, the real wage differential lagged one period, and $k2(u_S-u_{RUK})_t$ are significant and have the expected signs (see equation 11 of Table 3.3.11). The R^2 values of 0.87 indicates the model is quite good at explaining Scottish-RUK net migration flows. The diagnostic tests results exhibit no evidence of serial correlation or heteroscedasticity.

In the next sub-section we conduct similar regressions to those estimated above, but using the stock adjustment form of the models.

3.3.4b. Estimating the "Stock Adjustment" Models of Migration.

In our theory section we assume that in the stock adjustment migration model, migrants respond to ***changes*** in real wage and unemployment differential between Scotland and RUK. With the stock adjustment specification, equation (3.2.3) now becomes

$$(I-O)/POP_S = k\beta_0 + k\beta_1\Delta(rw_S-rw_{RUK}) - k\beta_2\Delta(u_S-u_{RUK}) +$$

$\alpha_0 + \alpha_1 \Delta(rw_S - rw_{RUK}) - \alpha_2 \Delta(u_S - u_{RUK})$ (3.2.7)

In this section we estimate equation (3.2.7), the stock adjustment model to see what difference it makes to our results. In regressing the stock adjustment form of our migration model, when using the Layard *et al* (1991) specification involving only the current variables our results in Table 3.3.12 show that none of the variables are significant when the adjusted population is used except for k1 in equation 1 (see equations 1 through 6).

Next we include the first lags of our explanatory variables in our models. We present the results when the adjusted population is used in Table 3.3.13. In Table 3.3.14 we present the result when the true population is used. In general our results do not parallel the Layard *et al* (1991) results. Comparing Table 3.3.13 and Table 3.3.14, when we regress the current and first lagged of the real wage differential and the unemployment rate differential together with the time trend, none of the variables have coefficients that are statistically significantly different from zero (see equation 1 of both the tables). Next we conduct various variable deletion tests and the results show that it is possible to omit the real wage differential lagged one period but none of the variables are significant hence we do not report the results in the Tables. In equation 2 of Table 3.3.13 and Table 3.3.14 we omit the real wage differential lagged one period, and the lagged unemployment differential, $k\Delta(rw_S - rw_{RUK})_{t-1}$ and $k\Delta(u_S - u_{RUK})_{t-1}$. In equation 2 of Table 3.3.13 only the k1 variable is significant at the 5 per cent significance level. But in equation 2 of Table 3.3.14 all the variables remained insignificant. Next we conduct the variable deletion test to see whether the real wage differential can be omitted from our model as the t-values involving it is always smaller than the t-values of the unemployment differential. Wald's variable deletion test result indicates the real wage differential variable can be omitted. In equation 3 of Table 3.3.13 the unemployment differential between Scotland and RUK and $k1\Delta(u_S - u_{RUK})_t$ are significant. Notice the perverse sign of the unemployment differential that parallels recent findings. In equation 3.3.14, with the true population, however, the unemployment differential is only close to being significant, but $k1\Delta(u_S - u_{RUK})_t$ and the time trend variable is significant. Since none of our regression involving both the real wage differential and the unemployment rate differential produce very good results we decide to include the second lagged of these variables. We chose to report only the best among the results we obtained. In equation 4 of Table 3.3.13, with the adjusted population the result seems promising. The real wage differential lagged two periods is significant and has the conventional sign. The higher the real wage in Scotland relative to the RUK in the last two periods discourage out-migration from Scotland to RUK. The coefficient on the unemployment differential is statistically significantly different from zero, but has a perverse sign. People seem to migrate into high unemployment regions. In fact this has been true in the last 5 years of the observation period, as more people come into Scotland than leave despite the higher unemployment rate in Scotland relative to RUK (though of course other things have not been constant over the period). However, throughout the sample period there are generally more people migrating from Scotland (high unemployment region) to RUK (low unemployment region relative to Scotland). The k1 and $k1\Delta(u_S-u_{RUK})_t$ variable are also significant at the 5 per cent significance level. The time trend variable is not significant and so we drop it from our regression, and report the result in equation 8. Only the k1 and the unemployment differential remain significant. The result is not as good with the true population; in equation 4 none of the variables are significant, while in equation 8 only the k2 variable is significant at the 5 per cent significance level.

Next we include the lagged dependent variable in our regressions, and report the results in equations 9 through 12 of Table 3.3.13, with the adjusted population, and of Table 3.3.14 with the true population. In both the tables only the lagged dependent variable is significant (see equation 11 for both tables). Notice that in the other equations where the lagged dependent variable is included, none of the variables are significant at the 5 per cent significance level.

3.3.4c. Estimating the lagged FA model.

I. Introduction.

Our regression results for the population ratio models thus far have failed to generate any clear-cut result. Hence we decided to explore the lagged version of the flow model. In this sub-section we estimate the population ratio flow models of migration with lagged regressors. From equation (3.3.3) above, our population ratio model now becomes

$$(I\text{-}O)/POP_S = k\beta_0 + k\beta_1(rw_S\text{-}rw_{RUK})_{t-1} - k\beta_2(u_S\text{-}u_{RUK})_{t-1}$$

$$+\alpha_0 + \alpha_1(rw_S\text{-}rw_{RUK})_{t-1} - \alpha_2(u_S\text{-}u_{RUK})_{t-1} \qquad (3.3.8)$$

We regress equation (3.3.8) to see what difference it makes to the results. We regress the models as before, using a similar sample period to that employed in our previous regressions, 1970-1994. We provide the results of the regressions with the adjusted population in Table 3.3.15. In Table 3.3.16 we provide the results with the true population. Comparing the two tables, the results look more promising when the adjusted population is used. This may be so because with the adjusted population we are only dealing with changes caused by migration flows between the two regions.

II. The results.

In equation 1 of Table 3.3.15, the k1 variable, the lagged relative real wage and the $k1(rw_S\text{-}rw_{RUK})_{t-1}$ variables are significant at the 5 percent significance level. The R^2 value of 0.70 implies that the model explains 70 percent of the net out-migration flows between Scotland and RUK. The DW statistics imply the absence of first order serial correlation. The diagnostic test results show no evidence of serial correlation or heteroscedasticity problems. Next we conduct Wald's variable deletion test; it indicates the possibility of omitting the relative unemployment rate lagged one period from our model. The result of the regression shows all variables except the $k1(u_S\text{-}u_{RUK})_{t-1}$ are significant. Next in equation 3 we omit the $k1(u_S\text{-}u_{RUK})_{t-1}$ variable from our model and conduct the regression as before. The result shows all the variables are significant at the 5 percent significance level. The relative real wage between Scotland and RUK has the expected sign implying, as the real wage in Scotland relative to that of the RUK in period t-1, increases fewer people out-migrate from Scotland to RUK. The R^2 value of 0.67 implies the model explains the Scottish-RUK migration flows quite well. The DW statistics imply that the residuals does not indicate the presence of first order serial correlation. The diagnostic test results suggest that there is no apparent evidence of serial correlation and heteroscedasticity. On the other hand, regressing similar models, with true population measures included generates less promising results. There appears to be a problem of serial correlation in equation 1 through equation 4 of Table 3.3.16.

Next we add the time trend variable to our model to see what difference it makes to our results. We report the results in equations 4 through 6 of Table 3.3.15, with adjusted population and of Table 3.3.16 with true population value. With adjusted population, adding the time trend variable does not improve the result. It results in a serial correlation problem in equations 5 and 6 of Table 3.3.15. Similarly, adding the time trend to our models does not improve the results with the true population. The serial correlation problem that occurs in equation 1 through equation 3 of Table 3.3.16, persists in equation 4 through equation 6 of the same table. We then replace the time trend with the lagged dependent variable. In equation 7 of Table 3.3.15 the lagged dependent variable is not significant, but in equation 8 and equation 9 it is significant at the 5 percent significance level. In equation 9 the result shows that out-migration rate between Scotland and RUK is explained by the relative real wage lagged one period and by the lagged dependent variable, plus the population ratio variable. The positive sign on the lagged dependent variable indicates out-migration rate in the previous period encourages people to out-migrate in the current period. This could be explained by the fact that, successful out-migration in the previous period encourages others to migrate in the current year, ceteris paribus. The model explains 73 percent of the out-migration flows between Scotland and RUK. The diagnostic test results do not show suggest the presence of serial correlation or heteroscedasticity. Similarly, adding the lagged dependent variable to our model improves the results with the true population. As expected the R^2 values improve. In equation 7 through equation 9 of Table 3.3.16, the serial correlation problem that occurs before (as shown in equation 1 through equation 6 of Table 3.3.16) is apparently eliminated. In equation 7, the k2 variable, the relative real wage lagged one period, the $k2(rw_S-rw_{RUK})_{t-1}$ and the lagged dependent variable are significant at the 5 percent significance level. We next omit the relative unemployment rate variable, and the result shows all the variables are significant (see equation 9). This result parallels the result show by equation 9 of Table 3.3.15, discussed above. The R^2 value suggests the model explains 79 percent of the net out-migration flows between Scotland and RUK. There is no evidence of serial correlation or heteroscedasticity problems. Thus the above findings indicate that the lagged flow adjustment (population ratio) model may be a better model for explaining Scottish-RUK migration flows, especially when the adjusted population is used.

Since our estimation results thus far yield such variable coefficients in terms of scale and sometimes signs of the relative real wage and relative unemployment rates, we proceed by testing for temporal stability.

3.3.5. Testing for Structural "breaks"

Our regression results thus far show a mixture of effects of explanatory variables on the our net out-migration variable. The perverse sign of the variables, such as the relative real wage and relative unemployment rate call for the need to test for structural break, whether the break in the series causes the change of sign and the significance status of these explanatory variables. We conduct "block" regression of the Layard *et al* (1991) model and its lagged variant, with and without time and the lagged dependent variable as regressors. We start with sample period 1970-1980 and progress by adding the samples on a yearly basis up to the end of our sample period, 1994. Later we start with sample period 1984-1994 and go down to 1970 period. We report our findings in Appendix 4.

3.4. Conclusions.

The above findings suggest our estimation results do not really ultimately offer any compelling evidence in favour of any one theoretical model. Even the performance of "vacancies" is open to interpretation. It could be that vacancies are simply a better proxy of labour market conditions over this observed period, because, unlike measured unemployment rates, vacancies are not directly affected by changes in the criteria for claiming benefit.

While some of our results suggest that the stock adjustment model is better than the flow adjustment models, this is not true of those models that include vacancies, so this issue is not straightforward.

Finally, consider the issue of bias arising from the net migration rate specification. While there are suggestions that this may be a problem, again there is no compelling evidence. The results of our econometric analysis on the determinants of the net out-migration rate from Scotland to RUK are disappointing, in that they do not allow any very firm conclusions. We appreciate that further analysis could be undertaken.

First, we could adopt a more systematic analysis of time series and search for cointegrating vectors. In fact we have done some work on this, which we report in Appendix 2, but again limited observations constrain what is likely to be achievable. Secondly, we could investigate pooled time-series, cross-section data for all UK regions as a means (providing some pooling restrictions are feasible) of increasing the degrees of freedom we have available in estimation. However, the focus of this study is on Scotland, and in any case, such analyses would carry no guarantee of improvement.

Finally we could investigate the determinants of gross migration flows. There are two main reasons for not pursuing this, one practical, the other theoretical. First, gross flows are not published by Scottish Office, who are apparently much more sceptical of the data on gross flows than that on net flows. Secondly, our concern is with migration-labour market linkages and, in this context at least, it is net flows that are potentially critical in governing changes in regional labour supplies.

While each of these possibilities would be worth exploring in future work, we focus, instead, in the rest of this dissertation, on the consequences of net migration flows. In the circumstances, we feel it sensible to proceed to examine effects of migration by allowing for a number of alternative specifications of the net migration function. First we employ the Layard *et al* (1991) flow specification in view of the widespread influence this model specification. However, here we treat it as representative of the whole class of flow models.

Secondly, we adopt the stock adjustment version of the Layard *et al* (1991) model, again as representative of stock adjustment models in general. Finally, we investigate the impact of there being effectively no labour mobility at all. This is not, of course, to deny that net migration flows occur, but rather to reflect one possible interpretation of our results: that we cannot be certain that net migration flows are, after all, systematically related to economic variables. This case provides us with a useful benchmark for investigating the possible effects of migration flows.

We do not explore further the alternative specifications intended to overcome the problems with the net migration rate specification because the importance of this misspecification varies with circumstances. First, it is likely to be small when the home region's population is small relative to the other region, for here net migration flows make minimal difference to population ratios. Secondly, it is also likely to be minimised where the focus is on comparative statics, rather than growth. In a growth context it could be a major problem, for example neglect of population ratios could, in the limit, result in predicting continued out-migration from a region when there is zero population there. In the growth context neglect of the population ratio could result in nonsensical simulation properties. However, in the context of our own comparative static analysis this neglect is much less of a problem. Thirdly, our emphasis is on the impact of migration on the economic system, not accurate projections of regional populations. The potential specification error resulting from omission of the population ratio is much less serious given our purposes.

Following this chapter, in Part II, Chapter 4 provides the theoretical analysis of the demand and supply stimulus with; zero mobility, the flow model of migration and the stock adjustment migration specification. In Chapter 5 we give an account of AMOS, the computable general equilibrium model that we employ in our simulations. In our migration equations we employ the parameters of the LNJ (1991) migration model instead of our econometric results because none of our the latter seem to be compelling. Chapters 6 and 7 discuss the outcomes of the demand shock and supply shock to the system wide, respectively.

Tables for Chapter 3.

Table 3.1.1

Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	.0019 (2.59)	.0011 (1.85)	.0053 (1.63)
$(rw_S-rw_{RUK})_{t-1}$	.0398 (2.67)	.0223 (1.81)	0233 (1.08)
$[(1-u_S)-(1-u_{RUK})_{t-1}$	.0014 (1.55)	.1267E-3 (0.16)	-.4089E-3 (0.21)
$NMGRATE_{(t-1)}$	-	.6601 (3.91)	-
T	-	-	-.9978E-4 (1.06)
R-Squared	0.27	0.59	0.31
R-Bar-Squared	0.20	0.52	0.21
DW Statistic	0.78	-	0.78
Durbin's h-stats	-	0.69	-
S.E	.0014580	.6811E-3	.0014537
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	7.9814[.005]	.36670[.545]	9.7388[.002]
Functional Form CHI-SQ(1)	12.5401[.000]	.075472[.784]	12.3388[.002]
Normality CHI-SQ(2)	1.0031[.606]	.061116[.970]	1.7154[.424]
Heteroscedasticity CHI-SQ(1)	4.9784[.026]	5.9460[.015]	3.3173[.069]

Table 3.1.2: Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	.0018	.0018	.0016
	(2.44)	(2.64)	(2.51)
$(rw_S\text{-}rw_{RUK})_t$	.0290	.0293	.0256
	(0.05)	(2.48)	(2.42)
$(rw_S\text{-}rw_{RUK})_{t-1}$	.0030	-	-
	(0.05)		
$(rw_S\text{-}rw_{RUK})_{t-2}$	-.0032	-	-
	(0.07)		
$[(1\text{-}u_S)\text{- }(1\text{-}u_{RUK})]_t$	-.6113E-3	-.5346E-3	-
	(0.23)	(0.23)	
$[(1\text{-}u_S)\text{- }(1\text{-}u_{RUK})_{t-1}$	.0021	.0020	-
	(0.80)	(0.88)	
$[(1\text{-}u_S)\text{- }(1\text{-}u_{RUK})_{t-2}$	-.0024	-.0023	-.9245E-3
	(1.11)	(1.58)	(1.34)
$NMGRATE_{(t-1)}$	.66011	.64847	.70447
	(1.94)	(2.86)	(4.98)
R-Squared	0.66	0.66	0.64
R-Bar-Squared	0.51	0.57	0.58
DW Statistic	-	-	-
Durbin's h-stats	0.73	0.73	0.62
S.E	.0011484	.0010790	.0010556
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	.99365[.319]	.83898[.360]	.004043[.949]
Functional Form CHI-SQ(1)	.36123[.548]	.32232[.570]	.020211[.887]
Normality CHI-SQ(2)	.96749[.616]	1.0736[.585]	.59068[.744]
Heteroscedasticity CHI-SQ(1)	3.278[.070]	3.2985[.069]	4.4677[.035]

Table 3.1.3

Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	.7703E-3 (2.35)	.1433E-3 (0.48)	.0059 (3.79)
$\Delta(rw_S - rw_{RUK})_t$	-.0090 (0.23)	.0108 (0.36)	-.0807 (2.11)
$\Delta[(1-u_S)-(1-u_{RUK})]_t$	.0031 (1.62)	.9643E-3 (0.61)	.0014 (0.85)
$NMGRATE_{(t-1)}$	-	.7107 (3.96)	-
T	-	-	-.1543E-3 (3.34)
R-Squared	0.15	0.52	0.45
R-Bar-Squared	0.06	0.45	0.37
DW Statistic	0.90	-	1.64
Durbin's h-stats	-	1.86	-
S.E	.0015766	.0012101	.0012943
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	7.5091[.006]	1.6681[.197]	.90517[.341]
Functional Form CHI-SQ(1)	1.5273[.217]	1.3086[.253]	1.7687[.184]
Normality CHI-SQ(2)	1.0501[.592]	3.9591[.138]	.071424[.965]
Heteroscedasticity CHI-SQ(1)	1.4150[.234]	.03547[.851]	.37902[.538]

Table 3.1.4 Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	.0016 (2.12)	.0027 (0.77)	.0014 (1.71)
$(rw_S - rw_{RUK})_t$	.0457 (2.76)	.0431 (2.31)	.0352 (1.67)
$(u_S - u_{RUK})_t$	.0035 (2.87)	.0272 (0.97)	.0011 (0.72)
$(p_S - p_{RUK})_t$	-.0059 (1.81)	-.0067 (1.61)	-.0030 (0.70)
$NMGRATE_{(t-1)}$	-	-	.5358 (1.95)
T	-	-.3116E-3 (0.33)	-
R-Squared	0.40	0.40	0.57
R-Bar-Squared	0.31	0.28	0.48
DW Statistic	0.92	0.89	-
Durbin's h-stats	-	-	none
S.E	.0013103	.0013406	.0011617
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	8.4054[.004]	11.9609[.001]	2.8660[.090]
Functional Form CHI-SQ(1)	.782229[.376]	1.0872[.297]	.009649[.922]
Normality CHI-SQ(2)	1.2449[.537]	1.5851[.453]	1.1637[.559]
Heteroscedasticity CHI-SQ(1)	.011167[.916]	.11208[.738]	.95139[.329]

Table 3.1.5 Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	.0029 (3.25)	.0022 (2.89)	.7604E-3 (1.29)
$(rw_S\text{-}rw_{RUK})_t$	.0484 (2.29)	.0304 (1.79)	.0045 (0.34)
$(u_S\text{-}u_{RUK})_t$	.0030 (1.38)	-	-.8620E-3 (0.60)
$(u_S\text{-}u_{RUK})_{t-2}$	-.0031 (2.06)	-.0014 (1.58)	-
$(p_S\text{-}p_{RUK})_t$	-.0106 (2.99)	-.0089 (2.60)	-
$(p_S\text{-}p_{RUK})_{t-2}$	.0061 (1.99)	.0080 (2.90)	.0061 (2.19)
$NMGRATE_{(t-1)}$	-.0035 (0.01)	.2569 (1.46)	.6662 (3.51)
R-Squared	0.81	0.79	0.69
R-Bar-Squared	0.73	0.72	0.62
DW Statistic	-	-	-
Durbin's h-stats	none	1.09	0.48
S.E	.8256E-3	.8484E-3	.0010052
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	.094203[.759]	.027059[.869]	.017319[.895]
Functional Form CHI-SQ(1)	1.3021[.254]	3.1810[.074]	.20585[.650]
Normality CHI-SQ(2)	.29127[.864]	1.1578[.561]	1.2770[.528]
Heteroscedasticity CHI-SQ(1)	2.0591[.151]	1.8440[.174]	.76821[.381]

Table 3.1.6

Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	.8570E-3 (3.77)	.4841E-3 (1.77)	.0040138 (3.42)
$\Delta(rw_S - rw_{RUK})_t$	-.0103 (0.38)	.0070 (0.27)	-.0517 (1.86)
$\Delta(u_S - u_{RUK})_t$	.0037 (1.96)	.0026 (1.41)	.0024 (1.43)
$\Delta(p_S - p_{RUK})_t$	-.0145 (3.94)	-.0011 (3.06)	-.0124 (3.81)
$NMGRATE_{(t-1)}$	-	.3800 (2.11)	-
T	-	-	-.9602E-4
R-Squared	0.62	0.69	0.73
R-Bar-Squared	0.56	0.63	0.67
DW Statistic	1.58	-	2.11
Durbin's h-stats	-	0.10	-
S.E	.0010683	.9831E-3	.9235E-3
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	.78322[.376]	.0015261[.969]	.15808[.691]
Functional Form CHI-SQ(1)	.0071348[.933]	.56215[.453]	.35074[.554]
Normality CHI-SQ(2)	.55280[.759]	5.0327[.081]	.76732[.681]
Heteroscedasticity CHI-SQ(1)	1.5868[.208]	.70560[.401]	.92204[.337]

Table 3.1.7

Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	-.0154 (5.80)	-.0123 (3.78)	-.1233 (3.22)
$(u_S-u_{RUK})_t$	-.0031 (2.61)	-.0037 (2.64)	-.0045 (2.34)
$(p_S-p_{RUK})_t$	.0022 (1.11)	.0031 (1.55)	.5928E-3 (0.19)
$(v_S-v_{RUK})_t$	-.0076 (5.82)	-.0062 (3.87)	-.0074 (5.41)
$NMGRATE_{(t-1)}$	-	.3412 (1.61)	-
T	-	-	-.4191E-4 (0.66)
R-Squared	0.69	0.73	0.70
R-Bar-Squared	0.65	0.67	0.64
DW Statistic	1.88	-	1.84
Durbin's h-stats	-	none	-
S.E	.9388E-3	.9229E-3	.9523E-3
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	.078286[.780]	.84674[.357]	.13324[.715]
Functional Form CHI-SQ(1)	2.06664[.151]	.44311[.506]	2.6069[.106]
Normality CHI-SQ(2)	.54540[.761]	.10325[.950]	2.0049[.367]
Heteroscedasticity CHI-SQ(1)	1.7824[.182]	2.2479[.134]	.95062[.330]

Table 3.1.8

Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3	equation4	equation5
Intercept	-.0097 (2.13)	-.0108 (3.01)	-.0080 (2.18)	-.0141 (4.09)	-.0174 (3.58)
$(u_S-u_{RUK})_t$	-	-	-.0028 (1.79)	-	-.0017 (0.81)
$(u_S-u_{RUK})_{t-1}$	-.0042 (2.62)	-.0028 (3.02)	-	-.0072 (4.49)	-
$(p_S-p_{RUK})_t$	-.9775E-3 (0.31)	-	-	-	-
$(p_S-p_{RUK})_{t-1}$	-	-	.0079 (3.67)	.0057 (2.21)	.0110 (3.43)
$(p_S-p_{RUK})_{t-2}$	.0083 (3.23)	.0075 (4.27)	-	-	-
$(v_S-v_{RUK})_{t-1}$	-.0052 (2.33)	-.0056 (3.18)	-.0041 (2.27)	-.0085 (7.53)	-.0073 (4.05)
$NMGRATE_{(t-1)}$	.0940 (0.46)	.1291 (0.65)	.5650 (2.88)	-	-
T				-.6666E-4 (1.27)	.6622E-4 (1.03)
R-Squared	0.81	0.80	0.72	0.81	0.62
R-Bar-Squared	0.75	0.76	0.66	0.77	0.54

Variable	equation1	equation2	equation3	equation4	equation5
DW Statistic	-	-	-	2.06	1.19
Durbin's h-stats	0.26	0.39	0.93	-	-
S.E	.8160E-3	.8088E-3	.9528E-3	.7870E-3	.001111
Diagnostic Tests					
Serial Correlation CHI-SQ(1)	.26945[.604]	.15051[.698]	.95487[.328]	.06116[.805]	4.4479[.035]
Functional Form CHI-SQ(1)	3.8553[.050]	1.3736[.241]	.13203[.716]	.51726[.472]	2.1582[.142]
Normality CHI-SQ(2)	.72596[.696]	.24895[.883]	.72011[.698]	2.1684[.338]	.007002[.997]
Heteroscedasticity CHI-SQ(1)	.13399[.714]	.14460[.704]	1.8232[.177]	.0674[.302]	2.0626[.151]

Table 3.1.9 Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
Intercept	.8805E-3 (4.05)	.4768E-3 (1.75)	.0028 (2.92)
$\Delta(u_S\text{-}u_{RUK})_t$	.0046 (2.10)	.0018 (0.75)	.0043 (2.14)
$\Delta(p_S\text{-}p_{RUK})_t$	-.0147 (3.99)	-.0105 (2.57)	-.0143 (4.18)
$\Delta(v_S\text{-}v_{RUK})_t$	.6622E-3 (0.33)	-.9072E-3 (0.44)	.9890E-3 (0.54)
$NMGRATE_{(t-1)}$	-	.3981 (2.13)	-
T	-	-	-.6032E-4 (2.05)
R-Squared	0.62	0.69	0.68
R-Bar-Squared	0.56	0.63	0.62
DW Statistic	1.62	-	1.86
Durbin's h-stats	-	0.29	-
S.E	.0010500	.9797E-3	.9745E-3
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	.62490[.429]	.050317[.823]	.1190[.738]
Functional Form CHI-SQ(1)	.34018[.560]	.060463[.806]	3.3610[.067]
Normality CHI-SQ(2)	1.6808[.432]	2.5408[.281]	.36717[.832]
Heteroscedasticity CHI-SQ(1)	1.8436[.175]	.70740[.400]	.36993[.543]

Table 3.1.10 Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	.0018 (2.46)	.0011 (2.00)	.0015 (1.25)
$(rw_S - rw_{RUK})_t$	.0222 (1.61)	.0208 (2.06)	.0186 (1.60)
$NMGRATE_{(t-1)}$	-	.7108 (4.89)	.6827 (4.20)
T	-	-	-.1634E-4 (0.43)
R-Squared	0.10	0.59	0.60
R-Bar-Squared	0.06	0.55	0.54
DW Statistic	0.58	-	-
Durbin's h-stats	-	0.47	0.62
S.E	.0014792	.0010364	.0010572
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	12.0651[.001]	.028302[.866]	.10582[.745]
Functional Form CHI-SQ(1)	1.7980[.180]	1.0672[.302]	.84317[.358]
Normality CHI-SQ(2)	.57165[.751]	.60603[.739]	.56834[.753]
Heteroscedasticity CHI-SQ(1)	9.3207[.002]	.10185[.750]	.56834[.753]

Table 3.1.11

Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	-.1948E-3 (0.44)	.6432E-4 (0.17)	.0033 (1.65)
$(u_S-u_{RUK})_t$	.0031 (2.58)	.1107E-3 (.08)	-.0018 (1.07)
$NMGRATE_{(t-1)}$	-	.7313 (3.55)	.7730 (3.87)
T	-	-	-.7995E-4 (1.65)
R-Squared	0.22	0.51	
R-Bar-Squared	0.19	0.46	0.57
DW Statistic	0.73	-	-
Durbin's h-stats	-	NONE	0.81
S.E	.0013742	.0011363	.0010924
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	10.6231[.001]	.61427[.433]	.0078066[.930]
Functional Form CHI-SQ(1)	3.0366[.081]	2.6181[.106]	1.8568[.173]
Normality CHI-SQ(2)	.87335[.646]	1.9923[.369]	.96489[.617]
Heteroscedasticity CHI-SQ(1)	.49177[.483]	5.9505[.015]	.64241[.423]

Table 3.1.12

Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	-.0099 (5.43)	-.0072 (2.47)	-.0095 (3.09)
$(v_S - v_{RUK})_t$	-.0047 (5.85)	-.0034 (2.50)	-.0046 (4.58)
$NMGRATE_{(t-1)}$	-	.2888 (1.26)	-
T	-	-	-.6088E-5 (0.18)
R-Squared	0.60	0.62	0.60
R-Bar-Squared	0.58	0.59	0.56
DW Statistic	1.29	-	1.29
Durbin's h-stats	-	NONE	-
S.E	.9891E-3	.9974E-3	.0010106
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	2.9252[.087]	1.5242[.217]	3.2612[.071]
Functional Form CHI-SQ(1)	2.0320[.154]	1.3931[.238]	3.2612[.071]
Normality CHI-SQ(2)	1.4269[.490]	2.1425[.343]	1.5318[.465]
Heteroscedasticity CHI-SQ(1)	.018555[.892]	.039169[.843]	.1885E-4[.997]

Table 3.1.13 Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3
intercept	.7511E-3 (2.30)	.1557E-3 (0.55)	.0043 (3.05)
$(hp_S - hp_{RUK})_t$	-.0014 (0.48)	.0026 (1.04)	-.0044 (1.50)
$NMGRATE_{(t-1)}$	-	.7944 (4.39)	-
T	-	-	-.1117E-3 (2.57)
R-Squared	0.01	0.50	0.25
R-Bar-Squared	0.03	0.45	0.18
DW Statistic	0.58	-	0.69
Durbin's h-stats	-	0.16	-
S.E	.0015193	.0011303	.0013564
Diagnostic Tests			
Serial Correlation CHI-SQ(1)	12.7708[.000]	.041200[.839]	11.7591[.001]
Functional FormCHI-SQ(1)	2.6450[.104]	2.0180[.155]	11.7591[.001]
Normality CHI-SQ(2)	2.2116[.331]	.53016[.767]	1.1343[.567]
Hetero-dasticityCHI-Q(1)	1.9313[.165]	1.4070[.236]	.14307[.705]

Table 3.1.14 Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3	equation4	equation5
intercept	.0010 (1.59)	-.0118 (5.16)	-.0084 (4.81)	-.0116 (4.26)	-.0010 (3.46)
$(rw_S-rw_{RUK})_t$	.0287 (2.43)	.0230 (3.00)	.0302 (2.89)	.0225 (1.99)	.0228 (2.79)
$(u_S-u_{RUK})_t$	.0036 (3.23)	-.0019 (1.59)	-	-.0021 (1.52)	-.0020 (1.63)
$(v_S-v_{RUK})_t$	-	-.0062 (5.70)	-.0046 (6.31)	-.0062 (4.92)	-.0053 (3.84)
$(hp_S-hp_{RUK})_t$	-	-	-.0020 (0.92)	-.7889E-3 (0.35)	-
$NMGRATE_{(t-1)}$	-	-	-	-	.1894 (1.00)
T	-	-	-	-	-
R-Squared	0.39	0.76	0.72	0.75	0.78
R-Bar-Squared	0.33	0.73	0.68	0.70	0.73
DW Statistic	0.84	1.90	1.56	1.89	-
Durbin's h-stats	-	-	-	-	1.06
S.E	.0012473	.8002E-3	.8471E-3	.8207E-3	.8088E-3
Diagnostic Tests					
Serial Correlation CHI-SQ(1)	9.5648[.002]	.015202[.902]	.94513[.331]	.036533[.848]	.61276[.434]
Functional Form CHI-SQ(1)	3.1543[.076]	.18482[.667]	.18682[.666]	.48099[.488]	.021167[.884
Normality CHI-SQ(2)	.96239[.618]	4.1962[.123]	7.1839[.028]	4.6701[.097]	1.2870[.525]
Heteroscedasticity CHI-SQ(1)	1.8118[.178]	.52980[.467]	.11440[.735]	.42383[.515]	.77035[.380]

The inclusion of the time trend does not improve the result thus it is not recorded here.

Table 3.1.15 Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3	equation4	equation5
Intercept	-.0096 (2.31)	.0029 (2.18)	.0045 (2.89)	-.0109 (4.48)	.0035 (3.56)
$(rw_S-rw_{RUK})_t$	.0320 (2.08)	.0404 (2.19)	.0617 (2.60)	.0234 (2.93)	.0293 (2.27)
$(v_S-v_{RUK})_t$	-.0049 (3.11)	-	-	-.0054 (6.13)	-
$(hp_S-hp_{RUK})_t$	-.0022 (0.66)	-.0044 (1.14)	-.0088 (2.78)	-	-
nso_t	.1523E-3 (0.73)	-.2676E-3 (1.38)	-.7213E-3 (1.49)	.1500E-3 (1.01)	-.4405E-3 (2.37)
$NMGRATE_{(t-1)}$	.0256 (0.11)	.5033 (2.30)	-	-	-
T	-	-	.3432E-4 (0.33)	-	-
R-Squared	0.78	0.61	0.50	0.74	0.28
R-Bar-Squared	0.67	0.52	0.35	0.71	0.22
DW Statistic	-	-	0.78	1.87	0.65
Durbin's h-stats	NONE	NONE	-	-	-
S.E	.8666E-3	.0010550	.0012076	.8272E-3	.0013495
Diagnostic Tests					
Serial Correlation CHI-SQ(1)	.042225[.837]	1.9226[.166]	10.5907[.001]	.033205[.855]	11.9451[.001
Functional Form CHI-SQ(1)	.25601[.613]	.96202[.327]	12.9310[.000]	.13484[.713]	3.2223[.073]
Normality CHI-SQ(2)	4.7939[.091]	1.1027[.576]	1.4151[.493]	6.7157[.035]	1.8115[.404]
Heteroscedasticity CHI-SQ(1)	.0065656[.935]	4.3698[.037]	9.6532[.002]	.018491[.892]	3.7638[.052]

Table 3.1.16 Dependent variable is NMGRATE. Sample period 1970-1994.

Variable	equation1	equation2	equation3	equation4	equation5
intercept	.0036 (1.88)	.0041 (3.47)	.0040 (3.42)	.0044 (3.60)	.0044 (3.78)
$\Delta(rw_S - rw_{RUK})$	-.0454 (1.05)	-.0561 (1.97)	-.0517 (1.86)	-.0681 (2.37)	-.0676 (2.59)
$\Delta(u_S - u_{RUK})$	.0029 (1.19)	.0033 (1.67)	.0024 (1.43)	-	-
$\Delta(v_S - v_{RUK})$	.0010 (0.42)	.0016 (0.88)	-	.8738E-4 (0.05)	-
$\Delta(p_S - p_{RUK})$	-.0123 (2.92)	-.0132 (3.89)	-.0124 (3.81)	-.0134 (3.79)	-.0134 (4.08)
$NMGRATE_{(t-1)}$	.0944 (0.34)	-	-	-	-
T	-.8740E-4 (1.67)	-.9998E-4 (2.79)	.9602E-4 (2.72)	-.1104E-3 (2.99)	-.1099E-3 (3.16)
R-Squared	0.74	0.74	0.73	0.70	0.70
R-Bar-Squared	0.65	0.67	0.67	0.63	0.65
DW Statistic	-	2.03	2.11	2.00	2.00
Durbin's h-stats	None	-	-	-	-
S.E	.9544E-3	.9291E-3	.9235E-3	.9742E-3	.9483E-3
Diagnostic Tests					
Serial Correlation CHI-SQ(1)	.11395[.736]	.023031[.879]	.15808[.691]	.024225[.876]	.029769[.863]
Functional Form CHI-SQ(1)	.86264[.353]	.98070[.322]	.35074[.554]	1.4319[.231]	1.3230[.250]
Normality CHI-SQ(2)	.13247[.936]	.0092844[.995]	.76732[.681]	.15115[.927]	.15871[.924]
Heteroscedasticity CHI-SQ(1)	.65750[.417]	.79222[.373]	.92204[.337]	1.1224[.289]	1.1278[.288]

Table 3.3.1 Dependent variable is NMGRATE. Sample period 1970-94. ($k1=POP_{RUK1}/POP_{S1}$) and ($k2=POP_{RUK}/POP_{S}$): The "SHARE" models.

Variable	equation 1	equation 2	equation 3	equation 4	equation 5	equation6
Intercept	-.0177 (0.59)	.1857 (1.22)	.0277 (0.53)	-.0233 (0.81)	-.0013 (.009)	-.0175 (0.39)
(1+k1)	.0017 (0.62)	-.0188 (1.23)	-.0025 (0.51)	-	-	-
(1+k2)	-	-	-	.0022 (0.85)	.1429E-4 (0.0009)	.0017 (0.41)
(1+k1) $(rw_S-rw_{RUK})_t$	.0036 (1.75)	-.8613E-3 (0.22)	.1194E-3 (0.03)	-	-	-
(1+k2) $(rw_S-rw_{RUK})_t$	-	-	-	.0040 (1.95)	.0035 (0.91)	.0032 (0.98)
(1+k1) $(u_S-u_{RUK})_t$	.4369E-3 (2.08)	.4851E-3 (2.32)	-.1516E-3 (0.38)	-	-	-
(1+k2) $(u_S-u_{RUK})_t$	-	-	-	.4825E-3 (2.25)	.4814E-3 (2.19)	.1803E-3 (0.50)
T	-	.5815E-3 (1.37)	-	-	.6580E-4 (0.15)	-
NMGRATE(-1)	-	-	.7679 (2.66)	-	-	.5966 (2.30)
Test Statistics						
R^2	0.37	0.42	0.60	0.38	0.38	0.59
R-BAR-SQUARED	0.28	0.31	0.51	0.29	0.26	0.52
DW	0.93	1.00	-	0.93	0.96	-
Durbin's h-statistics	-	-	none	-	-	None
S.E	.0013612	.0013341	.0011389	.0013498	.0013824	.0022536

Diagnostic Tests						
Serial Correlation CHI-SQ(1)	11.1877[.001]	8.7862[.003]	1.4011[.237]	9.7581[.002]	11.1495[.001]	2.9849[.259]
Functional Form CHI-SQ(1)	2.0308[.154]	.24533[.620]	.041795[.838]	1.4944[.222]	1.6954[.193]	.049651[.842]
Normality CHI-SQ(2)	.022108[.989]	.073763[.964]	.46534[.792]	.027363[.986]	.0084771[.996]	.76758[.681]
Heteroscedasticity CHI-SQ(1)	2.2329[.135]	5.5867[.018]	.2224[.075]	2.1942[.139]	2.4656[.116]	2.3555[.125]

Table3.3.2

Dependent variable is NMGRATE. Sample period 1970-94. (k1=POP_{RUK1}/POP_{S1})

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7	Equation8
Intercept	.0383 (0.26)	.0886 (0.60)	.0622 (0.38)	.0349 (0.24)	-.0176 (0.41)	-.0419 (0.99)	.0595 (1.84)	-.0253 (0.60)
(1+k1)	-.0039 (0.26)	-.0092 (0.62)	-.0056 (0.34)	-.0036 (0.25)	.0018 (0.45)	.0334 (1.03)	-.0054 (1.79)	.0025 (0.63)
(1+k1)$(rw_S-rw_{RUK})_t$	-.0014 (0.28)	.0027 (0.63)	-.0087 (1.92)	-.0023 (0.47)	-.6103E-3 (0.14)	.0056 (1.97)	-.0087 (2.46)	-.0015 (0.34)
(1+k1)$(rw_S-rw_{RUK})_{t-1}$	.0049 (1.45)	-	.0087 (2.60)	.0063 (2.04)	.0053 (1.73)	-	.0087 (2.81)	.0068 (2.44)
(1+k1)$(u_S-u_{RUK})_t$	.6879E-3 (2.45)	.8785E-3 (3.43)	-	.5515E-3 (2.17)	.6705E-3 (2.48)	.8798E-3 (3.45)	-	.5313E-3 (2.18)
(1+k1)$(u_S-u_{RUK})_{t-1}$	-.2373E-3 (1.10)	-.3595E-3 (1.76)	-.5569E-5 (0.03)	-	-.2396E-3 (1.14)	-.3947E-3 (1.98)	-.5958E-5 (0.03)	-
T	.1648E-3 (0.40)	.3703E-3 (0.93)	.7630E-5 (0.02)	.1772E-3 (0.43)	-	-	-	-
NMGRATE(-1)	-	-	-	-	-	-	-	-
Test Statistics								
R^2	0.61	0.56	0.47	0.58	0.61	0.54	0.47	0.58
R-BAR-SQUARED	0.47	0.44	0.33	0.47	0.50	0.45	0.36	0.49
DW	1.82	1.48	1.58	1.70	1.90	1.65	1.58	1.76
S.E	.0011837	.0012197	.0013382	.0011909	.0011557	.0012152	.001325	.0011650
Diagnostic Tests								

Serial Correlation CHI-SQ(1)	.71576[.398]	3.1277[.077]	2.4552[.117]	1.8397[.175]	.064365[.800]	.99780[.318]	1.4207[.233]	.45785[.499]
Functional Form CHI-SQ(1)	.15326[.695]	2.7586[.097]	2.9165[.088]	.29571[.587]	.074820[.784]	3.9648[.046]	2.9293[.087]	.047149[.828]
Normality CHI-SQ(2)	2.0331[.362]	.47145[.790]	.20383[.903]	.42730[.808]	1.9488[.377]	.46431[.793]	.20613[.902]	.40337[.817]
Heteroscedasticity CHI-SQ(1)	2.8128[.094]	2.3328[.127]	.061062[.805]	3.7450[.053]	3.0352[.081]	1.9398[.164]	.056709[.812]	3.5229[.061]

t-statistics in parentheses beneath the parameters

Table 3.3.2 contd. Dependent variable is NMGRATE. Sample period 1970-94. ($k1=POP_{RUK1}/POP_{S1}$)

Variable	equation 9	equation10	equation11	Equation12
Intercept	.0425 (0.80)	.0443 (0.89)	.0510 (1.91)	.0191 (0.36)
(1+k1)	-.0038 (0.77)	-.0040 (0.86)	-.0046 (1.87)	-.0017 (0.34)
$(1+k1)(rw_S-rw_{RUK})_t$	-.0010 (0.23)	-.7236E-3 (0.21)	-.0014 (0.38)	-.0021 (0.47)
$(1+k1)(rw_S-rw_{RUK})_{t-1}$	.4849E-3 (0.12)	-	.2144E-3 (0.06)	.0035 (0.94)
$(1+k1)(u_S-u_{RUK})_t$	.7939E-4 (0.19)	.6076E-4 (0.16)	-	.3419E-4 (0.08)
$(1+k1)(u_S-u_{RUK})_{t-1}$	-.3261E-3 (1.59)	-.3376E-3 (1.91)	-.3236E-3 (1.62)	-
T	-	-	-	-
NMGRATE(-1)	.6703 (1.73)	.7026 (2.58)	.7279 (3.21)	.5195 (1.32)
Test Statistics				
R^2	0.67	0.67	0.66	0.61
R-BAR-SQUARED	0.55	0.57	0.57	0.51
DW	-	-	-	-
Durbin's h-statistics	.35436	.35086[.726]	.33350[.739]	.45006[.653]
S.E	.0010970	.0010666	.0010672	.0011425
Diagnostic Tests				
Serial Correlatn. CHI-SQ(1)	.34919[.555]	.29986[.584]	.28543[.593]	.22788[.633]

Functional Form CHI-SQ(1)	.20329[.652]	.13509[.713]	.15689[.692]	.054422[.816]
Normality CHI-SQ(2)	.11850[.942]	.074234[.964]	.072026[.965]	.045964[.977]
Hetero-dasticityCHI-SQ(1)	3.7142[.054]	3.4296[.064]	3.2269[.072]	4.9637[.026]

t-statistics in parentheses beneath the parameters

Table 3.3.3

Dependent variable is NMGRATE. Sample period 1970-94. ($k2=POP_{RUK}/POP_S$): The "SHARE" model. With true population.

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7	equation8
Intercept	-.3520	-.1728	-.2928	-.3325	-.0399	-.0578	-.0313	-.0457
	(2.68)	(1.25)	(2.50)	(2.44)	(1.05)	(1.52)	(1.31)	(1.21)
(1+k2)	.0356	.0171	.0298	.0335	.0038	.0055	.0030	.0043
	(2.68)	(1.23)	(2.50)	(2.43)	(1.09)	(1.56)	(1.38)	(1.24)
$(1+k2)(rw_S-rw_{RUK})_t$	.0038	.0094	-	.0024	.0012	.0068	-	.2436E-3
	(1.00)	(2.32)		(0.61)	(0.30)	(2.51)		(0.06)
$(1+k2)(rw_S-rw_{RUK})_{t-1}$	.0090	-	.0105	.0105	.0049	-	.0056	.0064
	(2.93)		(3.91)	(3.42)	(1.67)		(3.18)	(2.41)
$(1+k2)(u_S-u_{RUK})_t$	.7944E-3	.0010	.6328E-3	.6248E-3	.8022E-3	.9868E-3	.7452E-3	.6644E-3
	(3.35)	(3.92)	(3.66)	(2.83)	(2.99)	(3.85)	(4.07)	(2.76)
$(1+k2)(u_S-u_{RUK})_{t-1}$	-.2867E-3	-.4446E-3	-.2439E-3	-	-.2279E-3	-.3791E-3	-.2152E-3	-
	(1.59)	(2.16)	(1.39)		(1.13)	(2.00)	(1.11)	
T	-.9911E-3	-.3483E-3	-.8814E-3	-.9063E-3	-	-	-	-
	(2.46)	(0.86)	(2.27)	(2.18)				
NMGRATE(-1)	-	-	-	-	-	-	-	-
Test Statistics								
R^2	0.73	0.59	0.71	0.69	0.63	0.57	0.63	0.60
R-BAR-SQUARED	0.63	0.48	0.63	0.60	0.53	0.48	0.55	0.52

DW	2.02	1.62	2.17	1.77	1.86	1.63	1.91	1.69
S.E	.9919E-3	.0011821	.9917E-3	.0010330	.0011224	.0011742	.0010951	.0011302
Diagnostic Tests								
Serial Correlation CHI-SQ(1)	.0071055[.933]	.97899[.322]	.24193[.623]	.19686[.657]	.015782[.691]	1.0220[.312]	.052310[.819]	.73183[.392]
Functional Form CHI-SQ(1)	.35325[.552]	4.8720[.027]	.16842[.682]	.47162[.492]	.31775[.573]	3.1627[.075]	.69752[.404]	.32620[.568]
Normality CHI-SQ(2)	2.6615[.264]	.40433[.817]	4.8684[.088]	.46163[.794]	2.0204[.364]	.17906[.914]	2.3905[.303]	.44240[.802]
Heteroscedasticity CHI-SQ(1)	1.6112[.204]	.27010[.603]	.50100[.479]	.81226[.367]	1.5288[.216]	1.8083[.179]	1.2851[.257]	2.4507[.117]

t-statistics in parentheses beneath the parameters

Table 3.3.3 cntd. Dependent variable is NMGRATE. Sample period 1970-94. ($k2=POP_{RUK}/POP_S$)

Variable	equation 9	equation10	equation11	equation12
Intercept	-.0113 (0.25)	-.0073 (0.17)	-.7123E-3 (0.02)	-.0240 (0.53)
(1+k2)	.0012 (0.28)	.7937E-3 (0.20)	.1874E-3 (0.06)	.0023 (0.56)
$(1+k2)(rw_S-rw_{RUK})_t$	.0017 (0.40)	.0028 (0.88)	-	.4260E-3 (0.10)
$(1+k2)(rw_S-rw_{RUK})_{t-1}$	.0017 (0.43)	-	.0027 (0.90)	.0041 (1.11)
$(1+k2)(u_S-u_{RUK})_t$	.4614E-3 (1.16)	.4080E-3 (1.11)	.3961E-3 (1.12)	.3745E-3 (0.94)
$(1+k2)(u_S-u_{RUK})_{t-1}$	-.2708E-3 (1.33)	-.3098E-3 (1.73)	-.2526E-3 (1.30)	-
T	-	-	-	-
NMGRATE(-1)	.4089 (1.15)	.5140 (2.04)	.3966 (1.15)	.3233 (0.91)
Test Statistics				
R^2	0.66	0.65	0.65	0.62
R-BAR-SQUARED	0.54	0.56	0.56	0.52
DW	-	-	-	
Durbin's h-statistics	.14754[.882]	.18407[.859]	.25695[.797]	.62029[.535]
S.E	.0011122	.0010868	.0010859	.0011354
Diagnostic Tests				
Serial Correlation CHI-SQ(1)	.070688[.790]	.078789[.779]	.20818[.648]	.54940[.459]
Functional Form CHI-SQ(1)	.50444[.478]	.069563[.792]	1.0018[.317]	.29248[.589]
Normality CHI-SQ(2)	.39665[.820]	.24577[.884]	.51680[.772]	.0015567[1.00]
Hetero-dasticityCHI-SQ(1)	4.8348[.028]	4.6559[.031]	4.6359[.031]	5.1182[.024]

Table 3.3.4

Dependent variable is NMGRATE. Sample period 1970-94. ($k1=POP_{RUK1}/POP_{S1}$) and ($k2=POP_{RUK}/POP_S$)

Variable	Equation 1	equation 2	equation 3	equation 4	equation 5	equation6
Intercept	.0523	.0728	.0320	.0464	.0393	.0253
	(3.70)	(1.55)	(2.02)	(3.39)	(0.77)	(1.62)
(1+k1)	-.0047	-.0068	-.0029	-	-	-
	(3.64)	(1.44)	(2.01)			
(1+k2)	-	-	-	-.0042	-.0034	-.0023
				(3.33)	(0.66)	(1.60)
$(1+k1)\Delta(rw_S-rw_{RUK})_t$	-.0062	-.0058	-.0027	-	-	-
	(3.64)	(1.76)	(0.84)			
$(1+k2)\Delta(rw_S-rw_{RUK})_t$	-	-	-	-.0058	-.0059	-.0020
				(1.83)	(1.72)	(0.61)
$(1+k1)\Delta(u_S-u_{RUK})_t$	.3367E-3	.3592E-3	.2451E-3	-	-	-
	(1.72)	(1.74)	(1.33)			
$(1+k2)\Delta(u_S-u_{RUK})_t$	-	-	-	.3391E-3	.3334E-3	-.2509E-3
				(1.67)	(1.57)	(1.32)
T	-	.7243E-4	-	-	-.2656E-4	-
		(0.46)			(0.14)	

NMGRATE(-1)	-	-	0.4374 (2.23)	-	-	.4618 (2.23)
Test Statistics						
R^2	0.54	0.55	0.64	0.51	0.51	0.61
R-BAR-SQUARED	0.47	0.45	0.56	0.44	0.41	0.53
DW	1.69	1.64	-	1.71	1.71	-
Durbin's h-statistics	-	-	.20537[.837]	-	-	none
S.E	.0011854	.00102094	.0010823	.0012244	.0012555	.0011181
Diagnostic Tests						
Serial Correlation CHI-SQ(1)	.41399[.520]	.80678[.396]	.029654[.863]	.34597[.556]	.3534[.552]	.020412[[886]
Functional Form CHI-SQ(1)	1.3361[.248]	1.8053[.179]	.14541[.703]	1.0286[.310]	1.1051[.293]	.066646].796]
Normality CHI-SQ(2)	.87910[.644]	1.3491[.509]	.025434[.987]	.68003[.712]	.60148[.740]	.082575[.960]
Heteroscedasticity CHI-SQ(1)	2.0753[.150]	2.2869[.130]	3.1028[.078]	2.3497[.125]	2.1496[.143]	2.7438[.098]

Table 3.3.5

Dependent variable is NMGRATE. Sample period 1970-94. ($k1=POP_{RUK1}/POP_{S1}$): "share" model: stock adjustment: adjusted population.

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7
Intercept	.0733	.0733	.0790	.0838	.0568	.0500	.0449
	(1.50)	(1.52)	(1.58)	(1.69)	(3.53)	(3.69)	(3.02)
(1+k1)	-.0068	-.0069	-.0075	-.0078	-.0051	-.0045	-.0040
	(1.37)	(1.40)	(1.48)	(1.56)	(3.46)	(3.63)	(2.95)
$(1+k1)\Delta(rw_S-rw_{RUK})_t$	-.0029	-	-.0020	-.0066	-.0032	-	-.0024
	(0.69)		(0.46)	(2.02)	(0.79)		(0.58)
$(1+k1)\Delta(rw_S-rw_{RUK})_{t-1}$	-.0045	-.0041	-	-.0051	-.0048	-.0045	-
	(1.41)	(1.33)		(1.59)	(1.59)	(1.52)	
$(1+k1)\Delta(u_S-u_{RUK})_t$	.4130E-3	.5514E-3	.4769E-3	-	.4201E-3	.5801E-3	.5004E-3
	(1.35)	(2.41)	(1.53)		(1.41)	(2.67)	(1.64)
$(1+k1)\Delta(u_S-u_{RUK})_{t-1}$	.1650E-3	.2362E-3	.3217E-3	.1430E-3	.1335E-3	.2016E-3	.2763E-3
	(0.70)	(1.14)	(1.51)	(0.60)	(0.63)	(1.05)	(1.38)
T	.6214E-4	.8449E-4	.1229E-3	.7709E-4	-	-	-
	(0.36)	(0.50)	(0.71)	(0.44)			
NMGRATE(-1)	-	-	-	-	-	-	-
Test Statistics							

R^2	0.64	0.62	0.59	0.59	0.63	0.62	0.58
R-BAR-SQUARED	0.50	0.51	0.47	0.47	0.52	0.53	0.48
DW	1.58	1.46	1.41	1.70	1.63	1.51	1.47
S.E	.0011595	.0011416	.0011925	.0011870	.0011294	.0011178	.0011762
Diagnostic Tests							
Serial Correlation CHI-SQ(1)	1.6164[.204]	2.9584[.085]	3.8459[.050]	.56946[.450]	.62372[.430]	1.5078[.219]	2.0351[.154]
Functional Form CHI-SQ(1)	.5190E-3[.982]	.39415[.530]	.24079[.624]	.043468[.835]	.021038[.885]	.21962[.639]	.085978[.769]
Normality CHI-SQ(2)	.10667[.948]	.25910[.878]	.96736[.617]	.17129[.918]	.20220[.940]	.54615[.761]	.71650[.699]
Heteroscedasticity CHI-SQ(1)	1.1075[.293]	.55900[.455]	.84053[.359]	1.0509[.305]	1.4853[.223]	.78683[.375]	1.5155[.218]

t-statistics in parentheses beneath the parameters

Table 3.3.5 contd. Dependent variable is NMGRATE. Sample period 1970-94. ($k1=POP_{RUK1}/POP_{S1}$)

Variable	equation8	equation 9	equation10	equation11	equation12
Intercept	.0634 (4.01)	.0431 (2.11)	.0377 (2.30)	.0313 (1.91)	.0454 (2.21)
(1+k1)	-.0057 (3.96)	-.0039 (2.09)	-.0034 (2.28)	-.0028 (1.88)	-.0041 (2.20)
$(1+k1)\Delta(rw_S-rw_{RUK})_t$	-.0071 (2.31)	-.0020 (0.47)	-	-.0010 (0.26)	-.0048 (1.38)
$(1+k1)\Delta(rw_S-rw_{RUK})_{t-1}$	-.0055 (1.80)	-.0032 (0.98)	-.0029 (0.92)	-	-.0035 (1.04)
$(1+k1)\Delta(u_S-u_{RUK})_t$	-	.3519E-3 (1.16)	.4343E-3 (1.80)	.3699E-3 (1.22)	
$(1+k1)\Delta(u_S-u_{RUK})_{t-1}$	.1034E-3 (0.48)	.8344E-4 (0.39)	.1160E-3 (0.58)	.1432E-3 (0.69)	.4803E-4 (0.22)
T	-	-	-	-	-
NMGRATE(-1)	-	.26480 (1.08)	.29665 (1.29)	.36801 (1.66)	.32431 (1.33)
Test Statistics					

R^2	0.59	0.66	0.65	0.64	0.63
R-BAR-SQUARED	0.50	0.53	0.55	0.53	0.52
DW	1.73	-	-	-	-
Durbin's h-statistics	.0011599	.51713[.605]	.67008	.49317[.622]	.46630[.641]
S.E		.0011241	.0010981	.0011228	.0011355
Diagnostic Tests					
Serial Correlation CHI-SQ(1)	.27789[.598]	.63794[.424]	1.4445[.229]	.71075[.399]	.45176[.502]
Functional Form CHI-SQ(1)	.052636[.819]	1.1575[.282]	.44471[. 505]	.59668[.440]	1.1631[.281]
Normality CHI-SQ(2)	.61266[.736]	.32354[.851]	1.1472[.563]	.0050624[.997]	1.0531[.591]
Hetero-dasticityCHI-SQ(1)	.56638[.452]	2.5690[.109]	1.7494[.186]	2.6659[.103]	1.5778[.209]

Table 3.3.6

Dependent variable is NMGRATE. Sample period 1970-94. ($k2=POP_{RUK}/POP_S$): "share" model: stock adjustment. true population.

Variable	**equation 1**	**equation2**	**equation3**	**equation4**	**equation5**	**equation6**	**equation7**
Intercept	.0321 (0.56)	.0362 (0.64)	.0462 (0.79)	.0407 (0.77)	.0494 (3.15)	.0445 (3.37)	.0393 (2.74)
(1+k2)	-.0026 (0.44)	-.0031 (0.54)	-.0042 (0.70)	-.0034 (0.64)	-.0044 (3.08)	-.0040 (3.30)	-0035 (2.67)
$(1+k2)\Delta(rw_S-rw_{RUK})_t$	-.0029 (0.65)	-	-.0017 (0.39)	-.0076 (2.59)	-.0025 (0.61)	-	-.0019 (0.44)
$(1+k2)\Delta(rw_S-rw_{RUK})_{t-1}$	-.0047 (1.40)	-.0043 (1.32)	-	-.0061 (2.08)	-.0044 (1.41)	-.0042 (1.37)	-
$(1+k2)\Delta(u_S-u_{RUK})_t$	.4428E-3 (1.37)	.5703E-3 (2.25)	.4964E-3 (1.50)	-	.4270E-3 (1.37)	.5548E-3 (2.46)	.5046E-3 (1.60)
$(1+k2)\Delta(u_S-u_{RUK})_{t-1}$	.1290E-3 (0.50)	.2063E-3 (0.92)	.3055E-3 (1.33)	-	.1668E-3 (0.76)	.2203E-3 (1.11)	.2947E-3 (1.43)
T	-.6924E-4 (0.31)	-.3184E-4 (0.15)	.2641E-4 (0.12)	-.7300E-4 (0.38)	-	-	-
NMGRATE(-1)	-	-	-	-	-	-	-
Test Statistics							

R^2	0.60	0.59	0.55	0.55	0.60	0.59	0.55
R-BAR-SQUARED	0.45	0.47	0.42	0.45	0.48	0.50	0.45
DW	1.64	1.54	1.47	1.71	1.64	1.54	1.47
S.E	.0012120	.0011913	.0012456	.0012155	.0011794	.0011585	.0012110
Diagnostic Tests							
Serial Correlation CHI-SQ(1)	.76554[.382]	1.5761[.209]	2.3295[.127]	.21250[.645]	.60357[.437]	1.2928[.256]	1.9997[.157]
Functional Form CHI-SQ(1)	.069944[.791]	.093252[.760]	.0021165[.963]	.010018[.920]	.072771[.787]	.073958[.786]	.00551832[.943]
Normality CHI-SQ(2)	.52157[.770]	.94584[.623]	.35967[.835]	1.0554[.590]	.35470[.837]	.86127[.650]	.36589[.833]
Heteroscedasticity CHI-SQ(1)	2.334[.127]	1.3063[.253]	1.9801[.159]	.38244[.536]	2.2228[.136]	1.3454[.246]	2.0302[.154]

t-statistics in parentheses beneath the parameters

Table 3.3.6 cntd. Dependent variable is NMGRATE. Sample period 1970-94. ($k2=POP_{RUK}/POP_S$)

Variable	equation8	equation 9	equation10	equation11	equation12
Intercept	.0599 (4.42)	.0345 (1.66)	.0315 (1.90)	.0250 (1.54)	.0381 (1.90)
(1+k2)	-.0054 (4.38)	-.0031 (1.65)	-.0028 (1.88)	-.0022 (1.51)	-.0034 (1.90)
$(1+k2)\Delta(rw_S-rw_{RUK})_t$	-.0073 (2.63)	-.0011 (0.26)	-	-.3478E-3 (0.08)	-.0044 (1.29)
$(1+k2)\Delta(rw_S-rw_{RUK})_{t-1}$	-.0059 (2.09)	-.0026 (0.75)	-.0024 (0.73)	-	-.0032 (0.97)
$(1+k2)\Delta(u_S-u_{RUK})_t$	-	.3616E-3 (1.15)	.4084E-3 (1.63)	.3775E-3 (1.21)	-
$(1+k2)\Delta(u_S-u_{RUK})_{t-1}$	-	.1135E-3 (0.51)	.1312E-3 (0.63)	.1571E-3 (0.73)	-
T	-	-	-	-	-
NMGRATE(-1)	-	.2911 (1.09)	.3117 (1.26)	.3840 (1.64)	.3679 (1.45)
Test Statistics					
R^2	0.55	0.63	0.63	0.61	0.59
R-BAR-SQUARED	0.47	0.49	0.51	0.50	0.50
DW	1.71	-	-	-	-
Durbin's h-statistics	.0011878	.51919[.604]	.61106[.541]	.52906[.597]	.42536[.671]
S.E		.0011731	.0011404	.0011581	.0011546
Diagnostic Tests					
Serial Correlation CHI-SQ(	.12025[.729]	.67494[.411]	1.1352[.287]	.80132[.371]	.13970[.709]

1)					
Functional Form CHI-SQ(1)	.0079324[.929]	.98326[.321]	.46884[.494]	.51645[.472]	.50862[.476]
Normality CHI-SQ(2)	.47208[.790]	.99121[.609]	1.6920[.429]	.26043[.878]	1.1907[.551]
HeteroscedasticityCHI-SQ(1)	1.0123[.314]	2.5063[.113]	1.9279[.165]	2.2867[.130]	1.9544[.162]

t-statistics in parentheses beneath the parameters

Table 3.3.7

Dependent variable is NMGRATE. Sample period 1970-94. (k1=POP_{RUK1}/POP_{S1}). "share" model: lagged Flow model with adjusted population.

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7	equation8	equation9
Intercept	.0154 (0.51)	.0463 (2.48)	.0284 (1.75)	-.1533 (1.18)	.0527 (0.72)	-.1543 (1.22)	.0460 (2.03)	.0362 (2.76)	.0311 (1.01)
(1+k1)	-.0012 (0.45)	-.0041 (2.46)	-.0024 (1.61)	.0159 (1.21)	-.0048 (0.64)	.0161 (1.26)	-.0041 (1.98)	-.0032 (2.74)	-.0011 (0.92)
$(1+k1)(rw_S-rw_{RUK})_{t-1}$	.0029 (1.29)	-	.0020 (1.39)	.0061 (1.87)	-	.0059 (1.95)	-.9704E-3 (0.54)	-	.0016 (1.41)
$(1+k1)(u_S-u_{RUK})_{t-1}$	.1180E-3 (0.51)	-.1038E-3 (0.67)	-	.4671E-4 (0.20)	-.8814E-4 (0.38)	-	-.3343E-3 (1.74)	-.2501E-3 (2.26)	-
T	-	-	-	-.5254E-3 (1.34)	.2524E-4 (0.09)	-.5438E-3 (1.46)	-	-	-
NMGRATE(-1)	-	-	-	-	-	-	.7804 (4.48)	.7358 (4.89)	.6220 (4.00)
Test Statistics									
R^2	0.31	0.25	0.30	0.36	0.25	0.36	0.66	0.66	0.61
R-BAR-SQUARED	0.20	0.18	0.23	0.23	0.14	0.27	0.59	0.61	0.55
DW	0.78	0.70	0.75	1.11	0.69	1.10	-	-	-

Durbins' h-statistics	-	-	-	-	-	-	.26678[.790]	.022084[.982]	.75869[.448]
S.E	.0014575	.0014804	.0014318	.0014297	.0015167	.0013950	.0010428	.0010241	.0010940
Diagnostic Tests									
Serial Correlation CHI-SQ(1)	11.6250[.001]	12.1388[.000]	9.0898[.003]	9.7164[.002]	12.2456[.000]	7.5180[.006]	.17087[.679]	.0073719[.932]	.81419[.367]
Functional Form CHI-SQ(1)	11.7152[.001]	5.8997[.015]	10.8891[.001]	9.9982[.002]	7.1376[.008]	8.9154[.003]	.052045[.820]	.063859[.800]	.0016748[.967]
Normality CHI-SQ(2)	1.2367[.539]	1.2791[.528]	1.7028[.427]	.42525[.808]	1.2688[.530]	.46627[.792]	.021335[.989]	.044945[.978]	.14059[.932]
Heteroscedasticity CHI-SQ(1)	4.2226[.013]	4.8698[.027]	5.3494[.021]	.030803[.861]	5.3454[.021]	.011749[.914]	2.9361[.087]	3.7758[.052]	4.9794[.026]

t-statistics in parentheses beneath the parameters

Table 3.3.8

Dependent variable is NMGRATE. Sample period 1970-94. ($k2=POP_{RUK}/POP_S$). "Share" model: lagged Flow model with true population.

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7	equation8	equation9
Intercept	.0118 (0.42)	.0429 (2.39)	.0259 (1.69)	-.3793 (2.58)	.0327 (0.42)	-.3802 (2.66)	.0309 (1.41)	.0308 (2.35)	.0092 (0.74)
(1+k2)	-.9187E-3 (0.35)	-.0038 (2.37)	-.0022 (1.55)	.0390 (2.60)	-.0028 (0.34)	.0391 (2.69)	-.0027 (1.36)	-.0027 (2.32)	-.7430E-3 (0.64)
$(1+k2)(rw_S-rw_{RUK})_{t-1}$	.0030 (1.39)	-	.0021 (1.45)	.0108 (3.12)	-	.0107 (3.27)	-.1383E-4 (0.01)	-	.0017 (1.54)
$(1+k2)(u_S-u_{RUK})_{t-1}$	.1352E-3 (0.59)	-.1034E-3 (0.66)	-	.1606E-4 (0.08)	-.1273E-3 (0.53)	-	-.2348E-3 (1.20)	-.2336E-3 (2.02)	-
T	-	-	-	-.0012865 (2.70)	-.4217E-4 (0.13)	-.0013 (2.85)	-	-	-
NMGRATE(-1)	-	-	-	-	-	-	.7280 (4.09)	.7274 (4.60)	.6282 (3.94)
Test Statistics									
R^2	0.30	0.24	0.29	0.50	0.24	0.50	0.63	0.63	0.60
R-BAR-SQUARED	0.20	0.16	0.22	0.39	0.12	0.42	0.55	0.57	0.54
DW	0.80	0.75	0/78	1.04	0.74	1.03	-	-	-
Durbin's h-statistics	-	-	-	-	-	-	.10490[.916]	.10114[.919]	.67637[.499]

S.E	.0014603	.0014920	.0014373	.0012743	.0015282	.0012422	.0010932	.0010655	.0011054
Diagnostic Tests									
Serial Correlation CHI-SQ(1)	9.9649[.002]	10.6452[.001]	8.5624[.003]	6.5560[.010]	11.2502[.001]	4.9860[.026]	.050660[.822]	.043332[.835]	.50830[.476]
Functional Form CHI-SQ(1)	12.0025[.001]	7.6522[.006]	12.2498[.000]	.33538[.563]	9.1108[.003]	.29319[.588]	.062687[.802]	.062131[.803]	.013834[.906]
Normality CHI-SQ(2)	1.1542[.562]	1.1834[.553]	1.6686[.434]	.14055[.932]	1.1888[.552]	.14690[.929]	.0047512[.998]	.0044581[.998]	.12331[.940]
HeteroscedasticityCHI-SQ(1)	5.9046[.015]	3.9799[.046]	4.7229[.030]	.94125[.332]	3.5716[.059]	.82305[.364]	3.8531[.050]	3.8677[.049]	5.5800[.018]

t-statistics in parentheses beneath the parameters

Table 3.3.9

Dependent variable is NMGRATE. Sample period 1970-94. ($k1=POP_{RUK1}/POP_{S1}$) and ($k2=POP_{RUK}/POP_S$)

Variable	equation 1	equation 2	equation 3	equation 4	equation 5	equation6	equation7	equation8
Intercept	-.0928	.0618	-.0941	-.0807	.8645E-3	-.0094	-.8617E-3	-.0087
	(1.60)	(0.44)	(1.81)	(0.63)	(1.25)	(1.83)	(1.27)	(1.56)
	.0095	-.0079	-	-	-	-	-	-
k1	(1.62)	(0.51)						
k2	-	-	.0096	.0081	-	-	-	-
			(1.83)	(0.56)				
$(rw_S-rw_{RUK})_t$	-1.718	-1.6723	-1.7170	-1.7356	-.6198	-1.8193	-.5697	-1.6847
	(2.04)	(2.01)	(2.21)	(2.13)	(1.20)	(2.38)	(1.17)	(2.12)
$(u_S-u_{RUK})_t$	-.0741	-.0614	-.0779	-.0751	-.0938	-0.6406	-.0970	-.0650
	(1.27)	(1.05)	(1.47)	(1.26)	(1.58)	(1.17)	(1.76)	(1.17)
$k1(rw_S-rw_{RUK})_t$	.1759	.1674	-	-	.0634	.1840	-	-
	(2.08)	(1.99)			(1.27)	(2.42)		
$k2(rw_S-rw_{RUK})_t$	-	-	.1756	.1771	-	-	.0584	.1701
			(2.25)	(2.18)			(1.24)	(2.16)
$k1(u_S-u_{RUK})_t$	.0079	.0066	-	-	.0097202	.0069	-	-
	(1.34)	(1.13)			(1.63)	(1.20)		

$k2(u_S-u_{RUK})_t$	-	-	.0083 (1.55)	.0080 (1.34)	-	-	.0101 (1.82)	.0069 (1.25)
T	-	.4796E-3 (1.22)	-	.5170E-4 (0.11)	-	.3039E-3 (2.01)	-	.2862E-3 (1.72)
Test Statistics								
R^2	0.50	0.54	0.53	0.53	0.43	0.53	0.45	0.52
R-BAR-SQUARED	0.37	0.38	0.41	0.37	0.32	0.41	0.34	0.39
DW	1.24	1.27	1.22	1.26	1.02	1.26	1.05	1.40
S.E	.0012753	.0012594	.0012376	.0012710	.0013256	.0012347	.0013078	.0012478
Diagnostic Tests								
Serial Correlation CHI-SQ(1)	6.0635[.014]	5.6859[.017]	5.6838[.017]	6.4332[.011]	9.8913[.002]	5.7892[.016]	8.5946[.003]	3.1939[.074]
Functional Form CHI-SQ(1)	2.5310[.112]	6.8102[.009]	3.7160[.054]	4.7287[.030]	1.0191[.313]	4.6138[.032]	2.0438[.153]	2.2404[.134]
Normality CHI-SQ(2)	1.2195[.543]	2.0074[.367]	1.8031[.406]	1.9263[.382]	.87504[.646]	1.5199[.468]	1.5728[.455]	2.8195[.244]
Heteroscedasticity CHI-SQ(1)	.37146[.542]	3.6922[.055]	.31660[.574]	.47418[.491]	2.7558[.097]	1.9439[.163]	2.5030[.114]	1.5262[.217]

t-statistics in parentheses beneath the parameters

Table 3.3.9 contd. Dependent variable is NMGRATE. Sample period 1970-94.

($k1=POP_{RUK1}/POP_{S1}$) and ($k2=POP_{RUK}/POP_S$)

Variable	**equation 9**	**equation 10**
Intercept	-.0266 (0.46)	-.0563 (1.09)
k1	.0027624 (0.47)	-
k2	-	.0058 (1.11)
$(rw_S-rw_{RUK})_t$	-.9625 (1.01)	-.8696 (0.86)
$(u_S-u_{RUK})_t$	.0461 (0.64)	.0355 (0.49)
$k1(rw_S-rw_{RUK})_t$	.0960 (1.01)	-
$k2(rw_S-rw_{RUK})_t$	-	.0895 (0.90)
$k1(u_S-u_{RUK})_t$	-.0050 (0.69)	-

$k2(u_S-u_{RUK})_t$	-	-.0036 (0.49)
T	-	-
$NMGRATE_{t-1}$	.9255 (2.76)	.7343 (2.24)
Test Statistics		
R^2	0.65	0.64
R-BAR-SQUARED	0.53	0.51
DW	-	-
Durbin's h-statistic	None	none
S.E	.0011166	.0011439
Diagnostic Tests		
Serial Correlation CHI-SQ(1)	.010760[.917]	.25545[.613]
Functional Form CHI-SQ(1)	.85480[.355]	.25672[.612]
Normality CHI-SQ(2)	.025484[.987]	.043327[.979]
Heteroscedasticity CHI-SQ(1)	1.6077[.205]	1.6836[.194]

t-statistics in parentheses beneath the parameters

Table 3.3.10

Dependent variable is NMGRATE. Sample period 1970-94. ($k1=POP_{RUK1}/POP_{S1}$)

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7
Intercept	-.1860 (1.78)	-.1849 (1.84)	-.1714 (1.56)	.0972 (0.94)	.1889 (1.71)	.1519 (2.59)	-.0694 (1.47)
k1	-.0220 (1.88)	-.0219 (1.94)	-.0204 (1.65)	-.1172 (1.02)	-.0244 (1.83)	-.0172 (2.50)	.0071 (1.48)
$(rw_S-rw_{RUK})_t$	.2888 (0.14)	-	-2.7915 (3.45)	-2.3262 (2.96)	1.5781 (1.72)	-	-2.3542 (2.81)
$(rw_S-rw_{RUK})_{t-1}$	-2.7987 (1.67)	-2.5788 (4.15)	-.0591 (1.54)	-	-3.8932 (4.45)	-	-
$(u_S-u_{RUK})_t$	-.1528 (0.920)	-.1739 (2.37)	-.3796 (3.89)	-.2772 (3.72)	-	-.1736 (2.40)	-.2696 (3.39)
$(u_S-u_{RUK})_{t-1}$	.0872 (0.56)	.1063 (1.37)	.3056 (3.55)	.2159 (3.25)	-	.1888 (2.47)	.8164 (2.68)
$k1(rw_S-rw_{RUK})_t$	-.0336 (0.16)	.0045 (1.13)	.2774 (3.45)	.2283 (2.95)	-.1668 (1.81)	-	.2353 (2.86)
$[k1(rw_S-rw_{RUK})]_{t-1}$	.2799 (1.63)	.2574 (4.14)	-	-	.3942 (4.54)	-	-
$k1(u_S-u_{RUK})_t$	.0158	.0180	.0390	.0285	-	.0184	.0277

	(0.93)	(2.42)	(3.97)	(3.84)		(2.52)	(3.50)
$[k1(u_S-u_{RUK})]_{t-1}$	-.0091 (0.56)	-.0111 (1.40)	-.0317 (3.60)	-.0224 (3.33)	-	-.0195 (2.53)	-.0190 (2.76)
T	.9286E-3 (2.66)	.9291E-3 (2.76)	.8897E-3 (2.42)	.5646E-3 (1.79)	.8929E-3 (2.57)	.5725E-3 (1.98)	-
Test Statistics							
R^2	0.86	0.86	0.83	0.80	0.79	0.68	0.76
R-BAR-SQUARED	0.75	0.77	0.72	0.69	0.72	0.57	0.65
DW	2.02	2.00	2.10	2.29	1.55	1.58	2.41
S.E	.8172E-3	.7881E-3	.8644E-3	.9033E-3	.8659E-3	.0010680	.9633E-3
Diagnostic Tests							
Serial Correlation CHI-SQ(1)	.48605[.486]	.15741[.692]	.84449[.358]	1.6772[.195]	.77264[.379]	1.8776[.171]	1.8518[.174]
Functional Form CHI-SQ(1)	1.8494[.174]	1.8820[.170]	6.9787[.008]	8.4990[.004]	1.1654[.280]	1.4885[.222]	3.6830[.055]
Normality CHI-SQ(2)	.76238[.683]	.46275[.793]	1.1369[.566]	.31970[.852]	4.8046[.091]	.27032[.874]	.12259[.941]
Heteroscedasticity CHI-SQ(1)	.30384[.581]	.27251[.602]	.71111[.399]	1.6136[.204]	1.1304[.288]	2.7927[.095]	.68425[.408]

t-statistics in parentheses beneath the parameters

Table 3.3.10 continued. Dependent variable is NMGRATE. Sample period 1970-94. ($k1=POP_{RUK1}/POP_{S1}$)

Variable	equation8	equation 9	equation10	equation11
Intercept	.8252E-3 (1.35)	-.0874 (1.33)	-.0872 (1.38)	-.0974 (1.73)
k1	-	.0090 (1.35)	.0090 (1.39)	.0100 (1.75)
$(rw_S-rw_{RUK})_t$	-1.8503 (2.33)	.7029 (0.27)	-	-
$(rw_S-rw_{RUK})_{t-1}$	-	-2.9828 (1.26)	-2.4028 (2.62)	-2.3334 (2.67)
$(u_S-u_{RUK})_t$	-.2884 (3.55)	-.1019 (0.48)	-.1444 (1.08)	-.1490 (1.15)
$(u_S-u_{RUK})_{t-1}$	.1683 (2.42)	-.0113 (0.06)	.03145 (0.33)	.0449 (0.52)
$k1(rw_S-rw_{RUK})_t$	.1818 (2.37)	-.0726 (0.27)	-.0019 (0.39)	-
$[k1(rw_S-rw_{RUK})]_{t-1}$	-	.3054 (1.26)	.2458 (2.61)	.2379 (2.67)
$k1(u_S-u_{RUK})_t$	.0294	.0108	.0151	.0156

	(3.64)	(0.50)	(1.08)	(1.16)
$[k1(u_S-u_{RUK})]_{t-1}$	-.0177 (2.51)	.9419E-3 (0.05)	-.0035 (0.36)	-.0049 (0.55)
NMGRATE(-1)	-	-.3247 (0.47)	-.2719 (0.43)	-.2684 (0.43)
Test Statistics				
R^2	0.72	0.78	0.78	0.78
R-BAR-SQUARED	0.63	0.62	0.64	0.66
DW	2.14	-	-	-
Durbin's h-statistics	.9968E-3	none	none	None
S.E		.0010069	.9729E-3	.9451E-3
Diagnostic Tests				
Serial Correlation CHI-SQ(1)	.30351[.582]	2.8406[.092]	1.7362[.188]	1.3393[.247]
Functional Form CHI-SQ(1)	4.7631[.029]	.14486[.704]	.56564[.452]	.67287[.412]
Normality CHI-SQ(2)	.26687[.875]	.98670[.611]	.52390[.770]	.67212[.715]
Heteroscedasticity CHI-SQ(1)	.69703[.404]	1.0529[.305]	.92050[.337]	.41533[.519]

t-statistics in parentheses beneath the parameters

Table 3.3.11

Dependent variable is NMGRATE. Sample period 1970-94. ($k2=POP_{RUK}/POP_S$)

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7
Intercept	-.2535	-.2659	-.3283	-.2858	-.2046	-.1831	-.1064
	(2.76)	(2.99)	(3.35)	(3.28)	(2.22)	(1.63)	(3.16)
k2	.0280	.0293	.0366	.0316	.0223	.0193	.0109
	(2.66)	(2.88)	(3.28)	(3.21)	(2.11)	(1.51)	(3.19)
$(rw_S-rw_{RUK})_t$	.7977	-	-1.1643	-1.4432	2.2142	.0046	.9860
	(0.74)		(1.56)	(2.11)	(2.73)	(0.12)	(0.86)
$(rw_S-rw_{RUK})_{t-1}$	-2.0598	-1.5265	.0324	-	-3.1052	-1.9332	-2.6849
	(2.25)	(2.75)	(0.96)		(4.21)	(2.83)	(3.00)
$(u_S-u_{RUK})_t$	-.1465	-.1872	-.2634	-.2957	-	-	-.1138
	(1.85)	(3.35)	(3.83)	(4.94)			(1.39)
$(u_S-u_{RUK})_{t-1}$	.0939	.1226	.1900	.2219	-.0020	-	.0865
	(1.33)	(2.12)	(2.94)	(4.02)	(1.42)		(1.15)
$k2(rw_S-rw_{RUK})_t$	-.0750	.0049	.1234	.1527	-.2181	-	-.0955
	(0.69)	(1.45)	(1.68)	(2.29)	(2.71)		(0.83)

$[k2(rw_S-rw_{RUK})]_{t-1}$	.2111 (2.29)	.1568 (2.85)	-	-	.3185 (4.34)	.2012 (3.00)	.2715 (2.99)
$k2(u_S-u_{RUK})_t$	.0155 (1.94)	.0196 (3.44)	.0274 (3.96)	.0307 (5.12)	.7207E-3 (3.38)	.4317E-3 (1.89)	.0122 (1.46)
$[k2(u_S-u_{RUK})]_{t-1}$	-.0099 (1.37)	-.0129 (2.19)	-.0200 (3.02)	-.0232 (4.14)	-	-	-.0091 (1.18)
T	-.6631E-3 (1.70)	-.6612E-3 (1.82)	-.9586E-3 (2.45)	-.7421E-3 (2.33)	-.4308E-3 (1.18)	-.1942E-3 (0.45)	-
Test Statistics							
R^2	0.90	0.90	0.86	0.85	0.88	0.79	0.88
R-BAR-SQUARED	0.83	0.83	0.77	0.78	0.81	0.71	0.80
DW	2.01	1.87	2.12	2.17	2.36	1.51	1.85
S.E	.6787E-3	.6676E-3	.7743E-3	.7723E-3	.7133E-3	.8747E-3	.7234E-3
Diagnostic Tests							
Serial Correlation CHI-SQ(1)	.0022773[.962]	.15444[.694]	.17562[.675]	.26908[.604]	1.9651[.161]	3.2253[.073]	.10554[.745]
Functional Form CHI-SQ(1)	2.7620[.097]	2.0062[.157]	4.2762[.039]	6.3487[.012]	1.8651[.172]	1.7941[.180]	8.4007[.004]
Normality CHI-SQ(2)	.11987[.942]	.31784[.853]	1.1592[.560]	.65441[.721]	.29097[.865]	.058845[.971]	.52078[.771]
Heteroscedasticity CHI-SQ(1)	.20177[.653]	.0015604[.968]	1.5161[.218]	2.8790[.090]	1.8181[.178]	.80521[.370]	.77747[.378]

t-statistics in parentheses beneath the parameters

Table 3.3.11 contd. Dependent variable is NMGRATE. Sample period 1970-94. ($k2=POP_{RUK}/POP_S$)

Variable	equation8	equation 9	equation10	equation11
Intercept	-.1021	-.1160	-.1244	-.1099
	(3.22)	(3.02)	(3.46)	(3.51)
k2	.0105	.0119	.0127	.0112
	(3.27)	(3.05)	(3.49)	(3.55)
$(rw_S-rw_{RUK})_t$	2.0960	.8543	-	-
	(2.57)	(0.71)		
$(rw_S-rw_{RUK})_{t-1}$	-3.4341	-2.6746	-2.1455	-2.2619
	(4.96)	(2.92)	(4.03)	(4.44)
$(u_S-u_{RUK})_t$	-	-.1530	-.2034	-.1894
		(1.41)	(2.51)	(2.41)
$(u_S-u_{RUK})_{t-1}$	-.0017	.1070	.14152	.11484
	(1.21)	(1.26)	(2.06)	(1.90)
$k2(rw_S-rw_{RUK})_t$	-.2077	-.0825	.0030	-
	(2.56)	(0.70)	(0.85)	
$[k2(rw_S-rw_{RUK})]_{t-1}$	.3494	.2713	.2174	.2308
	(5.04)	(2.91)	(4.04)	(4.52)
$k2(u_S-u_{RUK})_t$	.6522E-3	.0163	.0214	.0198
	(3.15)	(1.46)	(2.54)	(2.44)

$[k2(u_S-u_{RUK})]_{t-1}$	-	-.1120 (1.29)	-.0148 (2.11)	-.0120 (1.96)
NMGRATE(-1)	-	-.2016 (0.57)	-.2505 (0.73)	-.2621 (0.78)
Test Statistics				
R^2	0.86	0.88	0.88	0.87
R-BAR-SQUARED	0.80	0.79	0.80	0.80
DW	2.14	-	-	-
Durbin's h-statistics	.7220E-3	none	none	None
S.E		.7415E-3	.7285E-3	.7216E-3
Diagnostic Tests				
Serial Correlation CHI-SQ(1)	.38894[.533]	.69383[.405]	1.6451[.200]	.93131[.335]
Functional Form CHI-SQ(1)	4.4004[.036]	9.5756[.002]	5.3918[.020]	5.6258[.018]
Normality CHI-SQ(2)	.78695[.675]	.40403[.817]	.60420[.739]	.59619[.742]
Heteroscedasticity CHI-SQ(1)	1.7075[.191]	1.4694[.225]	.24284[.622]	.26944[.604]

t-statistics in parentheses beneath the parameters

Table 3.3.12

Dependent variable is NMGRATE. Sample period 1970-94. ($k1=POP_{RUK1}/POP()_{1}$) and ($k2=POP_{RUK}/POP_{S}$): With SA model

Variable	equation 1	equation 2	equation 3	equation 4	equation 5	equation6
Intercept	.0384	.0677	.0275	.0344	.0291	.0215
	(2.40)	(1.49)	(1.72)	(2.13)	(0.54)	(1.32)
	-.0038	-.0071	-.0027	-	-	-
k1	(2.33)	(1.40)	(1.67)			
k2	-	-	-	-.0034	-.0028	-.0021
				(2.07)	(0.45)	(1.29)
$\Delta(rw_S-rw_{RUK})_t$	.0392	.3390	.6407	.2893	.2188	.7223
	(0.02)	(0.19)	(0.39)	(0.17)	(0.12)	(0.45)
$\Delta(u_S-u_{RUK})_t$	-.1382	-.1302	-.0497	-.0978	-.1018	-.0287
	(0.96)	(0.88)	(0.35)	(0.73)	(0.71)	(0.22)
$k1\Delta(rw_S-rw_{RUK})_t$	-.0078	-.0374	-.0667	-	-	-
	(0.04)	(0.20)	(0.40)			
$k2\Delta(rw_S-rw_{RUK})_t$	-	-	-	-.0328	-.0258	-.0741
				(0.19)	(0.13)	(0.45)
$k1\Delta(u_S-u_{RUK})_t$	.0145	.0137	.00534	-	-	-
	(0.98)	(0.91)	(0.36)			

$k2\Delta(u_S - u_{RUK})_t$	-	-	-	.0104 (0.75)	.0108 (0.73)	.0032 (0.24)
T	-	.1127E-3 (0.69)	-	-	-.2089E-4 (0.10)	-
NMGRATE(-1)	-	-	.3997 (1.89)	-	-	.4383 (1.97)
Test Statistics						
R^2	0.59	0.60	0.66	0.54	0.54	0.63
R-BAR-SQUARED	0.47	0.46	0.54	0.42	0.38	0.50
DW	1.50	1.39	-	1.53	1.54	-
Durbin's h-statistics	-	-	none	-	-	none
S.E	.0011854	.0012029	.0011091	.0012466	.0012823	.0011576
Diagnostic Tests						
Serial Correlation CHI-SQ(1)	1.1263[.289]	2.4629[.117]	.067393[.795]	.89431[.344]	.98384[.321]	.050475[.822]
Functional Form CHI-SQ(1)	.25714[.612]	.052750[.818]	1.8162[.178]	.042642[.836]	.050524[.822]	.67585[.411]
Normality CHI-SQ(2)	.16661[.920]	.016490[.992]	.48845[.783]	.22865[.892]	.29117[.865]	.68047[.712]
Heteroscedasticity CHI-SQ(1)	2.1348[.144]	1.9666[.161]	1.8254[.177]	2.4482[.118]	2.4091[.121]	1.7871[.181]

t-statistics in parentheses beneath the parameters

Table 3.3.13

Dependent variable is NMGRATE. Sample period 1970-94. (k1=POP_{RUK1}/POP_{S1}): Adjusted population. With SA model.

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7
Intercept	.0772	.1013	.0666	.1037	.045676	.0421	.0285
	(1.21)	(2.41)	(1.79)	(2.48)	(1.48)	(3.23)	(2.81)
k1	-.0081	-.0109	-.0071	-.0112	-.0045	-.0042	-.0028
	(1.13)	(2.30)	(1.70)	(2.37)	(1.43)	(3.17)	()2.71
$\Delta(rw_S-rw_{RUK})_t$	.7934	1.9765	-	-	.5548	1.4221	-
	(0.31)	(1.69)			(0.23)	(1.25)	
$\Delta(rw_S-rw_{RUK})_{t-1}$	-.5313	-	-	-	-1.0852	-	-
	(0.21)				(0.47)		
$\Delta(rw_S-rw_{RUK})_{t-2}$	-	-	-	-.0587			
				(2.13)			
$\Delta(u_S-u_{RUK})_t$	-.1000	-	-.1868	-.2008	-.0871	-	-.1926
	(0.42)		(2.37)	(2.09)	(0.37)		(2.44)
$\Delta(u_S-u_{RUK})_{t-1}$	.0375	.0042	-	-	.0186	.0030	-
	(0.20)	(1.90)			(0.10)	(1.41)	
$k1\Delta(rw_S-rw_{RUK})_t$	-.0811	-.2015	-	-.3056E-3	-.0579	-.1481	-
	(0.31)	(1.72)		(0.07)	(0.23)	(1.29)	
$[k1\Delta(rw_S-rw_{RUK})]_{t-1}$	.0502	-	-	-	.10541	-	-
	(0.19)				(0.44)		

$k1\Delta(u_S-u_{RUK})_t$	.0106 (0.44)	.3201E-3 (1.51)	.0196 (2.44)	.0210 (2.16)	.0093631 (0.40)	.2775E-3 (1.28)	.0201 (2.51)
$[k1\Delta(u_S-u_{RUK})]_{t-1}$	-.0035 (0.18)	-	-	-	-.0016696 (0.09)	-	-
T	.1339E-3 (0.57)	.2407E-3 (1.48)	.1377E-3 (1.06)	.2629E-3 (1.56)	-	-	-
NMGRATE(-1)	-	-	-	-	-	-	-
Test Statistics							
R^2	0.68	0.65	0.59	0.71	0.67	0.61	0.57
R-BAR-SQUARED	0.41	0.53	0.51	0.59	0.44	0.50	0.50
DW	1.37	1.31	1.31	1.86	1.43	1.40	1.30
Durbin's h-statistics	-	-	-	-	-	-	-
S.E	.0012545	.0011169	.0011258	.0010261	.0012213	.0011532	.0011293
Diagnostic Tests							
Serial Correlation CHI-SQ(1)	3.0244[.082]	4.2502[.039]	3.1229[.077]	.0088360[.925]	1.5285[.216]	2.5144[.113]	2.6852[.101]
Functional Form CHI-SQ(1)	.81412[.367]	.34447[.557]	.080654[.776]	.94256[.332]	.61846[.432]	.0021862[.963]	.21660[.642]
Normality CHI-SQ(2)	.084987[.958]	.23732[.888]	.056657[.972]	.81696[.665]	.23174[.891]	.012653[.994]	.18044[.914]
Heteroscedasticity CHI-SQ(1)	.63840[.424]	.27151[.602]	1.6853[.194]	.62815[.428]	.90812[.341]	1.1925[.275]	1.8257[.177]

t-statistics in parentheses beneath the parameters

Table 3.3.13 cntd. Dependent variable is NMGRATE. Sample period 1970-94. (k1=POP_{RUK1}/POP_{S1}): Adjusted population. With SA model.

Variable	equation8	equation 9	equation10	equation11	equation12
Intercept	.0418 (3.04)	.0371 (1.25)	.0292 (2.02)	.0213 (2.02)	.0352 (1.97)
k1	-.0041 (2.97)	-.0037 (1.22)	-.0029 (2.01)	-.0021 (1.99)	-.0035 (1.95)
$\Delta(rw_S - rw_{RUK})_t$	-	1.3130 (0.55)	1.1840 (1.08)	-	-
$\Delta(rw_S - rw_{RUK})_{t-1}$	-	-1.3401 (0.61)	-	-	-
$\Delta(rw_S - rw_{RUK})_{t-2}$	-.0596 (2.07)	-	-	-	-.0461 (1.25)
$\Delta(u_S - u_{RUK})_t$	-.1502 (1.59)	-.0213 (0.10)	-	-.1054 (1.26)	-.1276 (1.23)
$\Delta(u_S - u_{RUK})_{t-1}$	-	.0982 (0.55)	.0016 (0.76)	-	-
$k1\Delta(rw_S - rw_{RUK})_t$	-.0012 (0.30)	-.1334 (0.55)	-.1217 (1.11)	-	-.8242E-3 (0.19)
$[k1\Delta(rw_S - rw_{RUK})]_{t-1}$	-	.1322 (0.59)	-	-	-
$k1\Delta(u_S - u_{RUK})_t$	.0159 (1.67)	.0026 (0.11)	.2215E-3 (1.06)	.0111 (1.29)	.0135 (1.28)

$[k1\Delta(u_S-u_{RUK})]_{t-1}$	-	-.0099 (0.54)	-	-	-
T	-	-	-	-	-
NMGRATE(-1)	-	.4596 (1.57)	.3656 (1.73)	.4101 (2.18)	.1544 (0.59)
Test Statistics					
R^2	0.66	0.73	0.67	0.65	0.67
R-BAR-SQUARED	0.55	0.50	0.55	0.58	0.53
DW	1.94	-	-	-	-
Durbin's h-statistics	-	none	.80145[.423]	.84262[.399]	none
S.E	.00100714	.0011580	.0010946	.0010585	.0010940
Diagnostic Tests					
Serial Correlation CHI-SQ(1)	.010918[.917]	.84454[.358]	1.6389[.200]	.085693[.770]	.3752E-3[.985]
Functional Form CHI-SQ(1)	.84237[.359]	.024979[.874]	.79784[.372]	1.8547[.173]	1.9479[.163]
Normality CHI-SQ(2)	.97904[.613]	.22456[.894]	.20472[.903]	.68769[.709]	.92246[.631]
Heteroscedasticity CHI-SQ(1)	1.0067[.316]	.26314[.608]	1.4476[.229]	1.6661[.197]	1.6099[.205]

t-statistics in parentheses beneath the parameters

Table 3.3.14

Dependent variable is NMGRATE. Sample period 1970-94. ($k2=POP_{RUK}/POP_S$): True population. With SA model.

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7
Intercept	.0281 (0.34)	.0774 (1.57)	.0329 (0.78)	.0675 (1.23)	.0419 (1.35)	.0364 (2.87)	.0248 (2.45)
k2	-.0025 (0.27)	-.0083 (1.48)	-.0033 (0.70)	-.0071 (1.14)	-.0041 (1.30)	-.0036 (2.82)	-.0024 (2.36)
$\Delta(rw_S\text{-}rw_{RUK})_t$	.7367 (0.27)	1.7039 (1.36)	-	-	.9526 (0.40)	1.3517 (1.15)	-
$\Delta(rw_S\text{-}rw_{RUK})_{t-1}$	-1.4444 (0.56)	-	-	-	-1.2280 (0.56)	-	-
$\Delta(rw_S\text{-}rw_{RUK})_{t-2}$	-	-	-	-.0582 (1.85)	-	-	-
$\Delta(u_S\text{-}u_{RUK})_t$	-.0468 (0.21)	-	-.1553 (1.99)	-.1339 (1.37)	-.0393 (0.19)	-	-.1589 (2.15)
$\Delta(u_S\text{-}u_{RUK})_{t-1}$	-.0042 (0.02)	.0042 (1.68)	-	-	.0083 (0.05)	.0032 (1.46)	-
$k2\Delta(rw_S\text{-}rw_{RUK})_t$	-.0758 (0.27)	-.1734 (1.39)	-	-.2947E-3 (0.06)	-.0974 (0.40)	-.1400 (1.19)	-
$[k2\Delta(rw_S\text{-}rw_{RUK})]_{t-1}$	.1416	-	-	-	.1199	-	-

	(0.54)				(0.54)		
$k2\Delta(u_S-u_{RUK})_t$	.0053 (0.23)	.2811E-3 (1.22)	.0163 (2.06)	.0142 (1.44)	.0045 (0.02)	.2686E-3 (1.18)	.0167 (2.22)
$[k2\Delta(u_S-u_{RUK})]_{t-1}$	.6782E-3 (0.04)	-	-	-	.5709E-3 (0.03)	-	-
T	-.5601E-4 (0.18)	.1784E-3 (0.86)	.3092E-4 (0.20)	.1383E-3 (0.59)	-	-	-
NMGRATE(-1)	-	-	-	-	-	-	-
Test Statistics							
R^2	0.64	0.60	0.53	0.62	0.64	0.58	0.53
R-BAR-SQUARED	0.33	0.45	0.44	0.47	0.38	0.46	0.46
DW	1.43	1.38	1.43	1.99	1.42	1.38	1.40
Durbin's h-statistics	-	-	-	-	-	-	-
S.E	.0013374	.0012047	.0012060	.0011678	.0012866	.0011961	.0011781
Diagnostic Tests							
Serial Correlation CHI-SQ(1)	2.1298[.144]	2.7803[.095]	1.6538[.198]	.078174[.780]	1.7438[.187]	2.7434[.098]	1.8077[.179]
Functional Form CHI-SQ(1)	.47681[.490]	.64594[.422]	.31816[.573]	.92767[.335]	.57772[.447]	.0025058[.960]	.24113[.623]
Normality CHI-SQ(2)	.49823[.779]	.047500[.977]	.21164[.900]	.83627[.658]	.29365[.863]	.047420[.977]	.28519[.867]
Heteroscedasticity CHI-SQ(1)	1.2458[.264]	1.1746[.278]	2.0288[.154]	1.5825[.208]	1.2666[.260]	1.5558[.212]	1.9790[.159]

t-statistics in parentheses beneath the parameters

Table 3.3.14 cntd. Dependent variable is NMGRATE. Sample period 1970-94. ($k2=POP_{RUK}/POP_S$): True population. With SA model.

Variable	equation8	equation 9	equation10	equation11	equation12
Intercept	.0362 (2.54)	.0293 (0.96)	.0229 (1.58)	.0171 (1.63)	.0274 (1.45)
k2	-.0035 (2.48)	-.0029 (0.94)	-.0023 (1.57)	-.0017 (1.59)	-.0027 (1.43)
$\Delta(rw_S-rw_{RUK})_t$	-	1.4779 (0.64)	1.1064 (0.98)	-	-
$\Delta(rw_S-rw_{RUK})_{t-1}$	-	-1.7362 (0.83)	-	-	-
$\Delta(rw_S-rw_{RUK})_{t-2}$	-.0580 (1.89)	-	-	-	-.0393 (0.97)
$\Delta(u_S-u_{RUK})_t$	-.1222 (1.31)	-.0039 (0.02)	-	-.0770 (0.98)	-.0971 (0.96)
$\Delta(u_S-u_{RUK})_{t-1}$	-	.0594 (0.37)	.0018 (0.80)	-	-
$k2\Delta(rw_S-rw_{RUK})_t$	-.7044E-3 (0.16)	-.1488 (0.64)	-.1128 (1.00)	-	-.1422E-3 (0.03)
$[k2\Delta(rw_S-rw_{RUK})]_{t-1}$	-	.1728 (0.80)	-	-	-
$k2\Delta(u_S-u_{RUK})_t$	.0131 (1.38)	.7952E-3 (0.04)	.2192E-3 (1.00)	.0082 (1.02)	.0104 (1.01)

$[k2\Delta(u_S-u_{RUK})]_{t-1}$	-	-.0059 (0.35)	-	-	-
T	-	-	-	-	-
NMGRATE(-1)	-	.4781 (1.55)	.3849 (1.40)	.4378 (2.21)	.2089 (0.72)
Test Statistics					
R^2	0.61	0.70	0.64	0.62	0.62
R-BAR-SQUARED	0.49	0.44	0.51	0.54	0.47
DW	1.93	-	-	-	-
Durbin's h-statistics	-	none	.85531[.392]	.71759[.473]	none
S.E	.0011439	.0012227	.0011378	.0011025	.0011616
Diagnostic Tests					
Serial Correlation CHI-SQ(1)	.0029681[.957]	1.3949[.238]	1.9387[.164]	.0049570[.944]	.016891[.897]
Functional Form CHI-SQ(1)	.57820[.447]	.012500[.911]	.45081[.502]	1.1385[.286]	1.4012[.237]
Normality CHI-SQ(2)	.93936[.625]	.19290[.908]	.52098[.771]	.89542[.639]	.97434[.614]
Heteroscedasticity CHI-SQ(1)	1.8411[.175]	.072929[.787]	1.6700[.196]	1.8263[.177]	2.1967[.138]

t-statistics in parentheses beneath the parameters

Table 3.3.15

Dependent variable is NMGRATE. Sample period 1970-94. ($k1=POP_{RUK1}/POP_{S1}$): Adjusted population.

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7	equation8	equation9
Intercept	-.1214 (3.44)	-.1244 (3.42)	-.1220 (3.67)	-.0805 (0.91)	-.0550 (0.63)	-.0562 (0.66)	-.0624 (1.42)	-.0557 (1.33)	-.0861 (2.49)
k1	.0124 (3.49)	.0127 (3.47)	.0125 (3.72)	.0077 (0.76)	.0047 (0.47)	.0049 (0.50)	.0064 (1.44)	.0058 (135)	.0088 (2.52)
$(rw_S-rw_{RUK})_{t-1}$	-2.9489 (4.84)	-2.5490 (4.52)	-2.5617 (4.69)	-3.1136 (4.44)	-2.8932 (4.19)	-2.8886 (4.28)	-1.8779 (2.41)	-1.6040 (2.58)	-1.8033 (2.96)
$(u_S-u_{RUK})_{t-1}$	-.0742 (1.49)	-	-	-.0669 (1.27)	-	-	-.0307 (0.60)	-	-
$[k1(rw_S-rw_{RUK})]_{t-1}$	.2990 (4.90)	.2597 (4.57)	.2607 (4.72)	.3144 (4.53)	.2923 (4.28)	.2915 (4.38)	.1894 (2.40)	.1620 (2.56)	.1839 (2.99)
$[k1(u_S-u_{RUK})]_{t-1}$	.0075 (1.40)	.3442E-4 (0.19)	-	.0068 (1.28)	.6690E-4 (0.36)	-	.0029 (0.56)	-.2398E-3 (1.24)	-
T	-	-	-	.1809E-3 (0.51)	.3048E-3 (0.87)	.2797E-3 (0.84)	-	-	-
NMGRATE(-1)	-	-	-	-	-	-	.4293 (1.99)	.4850 (2.54)	.3516 (2.19)

Test Statistics									
R^2	0.70	0.67	0.67	0.71	0.68	0.68	0.76	0.75	0.73
R-BAR-SQUARED	0.62	0.60	0.61	0.60	0.59	0.61	0.67	0.69	0.68
DW	1.63	1.36	1.36	1.47	1.15	1.17	-	-	-
Durbin's h-statistics	-	-	-	-	-	-	none	none	none
S.E	.0010058	.0010379	.0010126	.0010272	.0010444	.0010202	.9317E-3	.9151E-3	.9283E-3
Diagnostic Tests									
Serial Correlation CHI-SQ(1)	.82633[.363]	2.8821[.090]	2.4944[.114]	2.3232[.127]	5.7248[.017]	4.7231[.030]	1.6953[.193]	1.4326[.231]	.1118E-3[1.00]
Functional Form CHI-SQ(1)	.82894[.363]	.10719[.743]	.047469[.828]	1.3764[.241]	.47473[.491]	.24724[.619]	.044813[.832]	.071516[.789]	.065139[.799]
Normality CHI-SQ(2)	1.5275[.466]	1.0364[.596]	1.1777[.555]	1.6548[.437]	1.5249[.467]	1.9317[.381]	1.4804[.477]	1.2446[.537]	.24113[.886]
HeteroscedasticityCHI-SQ(1)	2.7625[.097]	2.5387[.111]	2.7762[.096]	2.5919[.107]	3.3867[.066]	3.4488[.063]	1.1109[.292]	.45405[.500]	.64828[.421]

t-statistics in parentheses beneath the parameters

Table 3.3.16

Dependent variable is NMGRATE. Sample period 1970-94. ($k2=POP_{RUK}/POP_S$): True population.

Variable	equation 1	equation2	equation3	equation4	equation5	equation6	equation7	equation8	equation9
Intercept	-.1326	-.1383	-.1396	-.2418	-.1948	-.1940	-.0905	-.0905	-.1101
	(3.83)	(4.06)	(4.34)	(2.11)	(1.76)	(1.80)	(2.83)	(2.92)	(3.71)
k2	.0136	.0142	.0143	.0263	.0207	.0206	.0093	.0093	.0112
	(3.88)	(4.12)	(4.39)	(1.99)	(1.63)	(1.66)	(2.87)	(2.95)	(3.75)
$(rw_S-rw_{RUK})_{t-1}$	-2.9761	-2.8089	-2.7929	-2.5869	-2.5762	-2.5638	-2.1239	-2.1199	-2.1338
	(5.14)	(5.08)	(5.29)	(3.71)	(3.63)	(3.72)	(3.80)	(4.30)	(4.17)
$(u_S-u_{RUK})_{t-1}$	-.0437	-	-	-.0623	-	-	-.669E-3	-	-
	(0.97)			(1.28)			(0.02)		
$[k2(rw_S-rw_{RUK})]_{t-1}$	.3014	.2853	.2839	.2654	.2636	.2625	.2143	.2140	.2172
	(5.20)	(5.14)	(5.33)	(3.89)	(3.79)	(3.89)	(3.81)	(4.30)	(4.20)
$[k2(u_S-u_{RUK})]_{t-1}$	.0043	-.2509E-4	-	.0062	-.3626E-4	-	-.1792E-3	-.2464E-3	-
	(0.97)	(0.15)		(1.28)	(0.20)		(0.04)	(1.59)	
T	-	-	-	-.4978E-3	-.2516E-3	-.2403E-3	-	-	-
				(1.00)	(0.54)	(0.53)			
NMGRATE(-1)	-	-	-	-	-	-	.4704	.4714	.3743
							(3.01)	(3.33)	(2.81)
Test Statistics									
R^2	0.72	0.71	0.70	0.74	0.71	0.71	0.82	0.82	0.79

R-BAR-SQUARED	0.64	0.64	0.66	0.64	0.63	0.65	0.75	0.77	0.75
DW	1.19	1.02	1.01	1.27	1.01	1.01	-	-	-
Durbin's h-statistics	-	-	-	-	-	-	none	none	none
S.E	.9761E-3	.9748E-3	.9506E-3	.9761E-3	.9936E-3	.9682E-3	.8110E-3	.7882E-3	.8194E-3
Diagnostic Tests									
Serial Correlation CHI-SQ(1)	5.2257[.022]	7.4628[.006]	6.1953[.013]	4.3037[.038]	7.6072[.006]	6.0769[.014]	.8179E-3[.977]	.9450E-3[.975]	2.4393[.118]
Functional Form CHI-SQ(1)	2.3024[.129]	.89672[.344]	.92933[.335]	.27627[.599]	.22077[.638]	.28630[.593]	1.5892[.207]	1.2219[.269]	1.3922[.238]
Normality CHI-SQ(2)	1.0243[.599]	1.2175[.544]	1.0073[.604]	.85544[.652]	.93287[.627]	.68893[.709]	1.6647[.435]	1.6574[.437]	.10767[.948]
HeteroscedasticityCHI-SQ(1)	2.0675[.150]	2.6610[.103]	2.6828[.101]	1.8496[.174]	2.3412[.126]	2.3567[.125]	.78059[.377]	.78671[.375]	.96292[.326]

t-statistics in parentheses beneath the parameters

PART II.

Chapter 4. A Theoretical Analysis of the Effects of the Migration Process on the System-Wide Impact of Demand and Supply Disturbances.

4.1. Introduction.

In Part I of the dissertation we only considered the determinants of net migration. In Part II of the dissertation we turn our attention to the likely effects of such flows on the regional economy. This chapter comprises three main sections. In section 4.2 we discuss the theoretical effects of the migration process on the impact of a demand disturbance and in section 4.3 we consider the impact of this process on the effects of a supply disturbance. In both sections we include the case of zero geographic labour mobility since this is a useful benchmark when seeking to assess the importance of migration processes to system-wide behaviour. In these analyses we assume that regional labour markets behave in accordance with the regional bargaining hypothesis, according so that the bargained real wage varies directly with the regional employment rate. Later, in section 4.4 we explore the theoretical effects of the migration process on the impact of a demand and supply disturbances under the national wage bargaining system.. We discuss the theory under three different conceptual time periods, namely: the short-run, over which population and capital stocks are fixed, so that no migration effect is yet apparent; the medium-run during which the migration process is completed but capital stocks remain fixed, and the long-run in which capital stocks as well as population, are fully adjusted. In the impact interval capital stocks and population are both fixed and the economy is characterised by flow equilibrium. The impact interval is sufficiently short so as not to be affected by migration flows, and so the results over this interval are common to all models.

In many studies of regional labour markets, in the UK context, it is assumed that the nominal wage is rigid, usually motivated in terms of the nominal wage being determined in national bargaining system. Harris (1991) and Roper and O'Shea (1991) are examples of studies which make this assumption. In contrast Kaldor

(1970) argues for real wage resistance at the regional level. However it is not clear whether the latter favour the perfectly competitive definition of an infinitely elastic labour supply curve as argued by Mc.Gregor *et. al.* (1995). Work by Layard, Nickell and Jackman (1991) shows regional wages are responsive to regional labour market conditions. Minford and Stoney (1991) argue that such linkages exist through the operation of competitive regional labour markets for unskilled labour and local union bargaining in the sheltered sector. McGregor *et. al.* (1995) argue that the empirical evidence is not strong enough to rule out any of the earlier views. They suggest that even if we are convinced as to which regional wage determination process is taking place, it may be of interest to know how sensitive comparative static results are to variations in the nature of the local labour market. They provide an extensive discussion of the impact of these alternative views (see McGregor *et. al*; 1995).

In our subsequent analysis we focus mainly on the bargained real wage hypothesis, according to which the bargained real wage in any region is positively related to workers bargaining power as reflected in the employment rate[1]. Our choice is motivated by growing evidence that regional wages are sensitive to market forces of demand and supply of labour. Our main interest is in comparing the results of the stock adjustment (SA) and the flow adjustment (FA) models under the same BRW closure. We also include zero mobility as a benchmark case. However, later we contrast the results we get with the BRW closure with that for national wage bargaining. Our interest is in comparing the results of the SA and the FA models under the national wage bargaining with that of BRW.

4.2. A Theoretical Analysis of a Demand Stimulus.

4.2.1. Impact interval effects.

We begin this section by discussing the theoretical elements of the model. The bargained real wage curve we impose in our study follows the wage function specified by Layard *et al* (1991). The regional consumption wage is directly related to workers' bargaining power, and hence is inversely related to the unemployment rate.

[1] Although we do contrast our results under the bargained real wage closure with that of national wage bargaining case.

The bargained real wage curve in Figure 4.1 is therefore positively sloped in employment rate real consumption wage space. This implies that any increase in labour demand tends to increase the employment rate and the real consumption wage, because the increase in labour demand means that workers can bargain for higher wages. The demand functions, D_1 and D_2 in Figure 4.1 are the general equilibrium demand curves for labour; they incorporate all of the consequences of a change in the real consumption wage on employment, including any induced changes in income and demand.[2] D_1 shows the initial position of the general equilibrium demand curve for labour. The negative slope of the demand curve implies that the higher the real wage the less labour is demanded. The initial equilibrium is at point A in Figure 4.1, where the equilibrium real wage and employment rates are determined by the intersection of the bargained real wage (BRW) and original general equilibrium labour demand curves.

An increase in aggregate demand, that would result for example from an increase in demand for manufacturing exports, causes a shift in the labour demand schedule from D_1 to D_2 in real-consumption-wage employment rate space. This means that, at any level of real wage, employment demand is higher than before. The source of this rightward shift in the general equilibrium demand curve for labour is the real wage "wedge". The increase in demand for labour increases wages, but less than in proportion to domestic prices because import prices are fixed. This implies that the real product wage (that is the real wage paid by firms) falls at any given real consumption wage and employment increases. On the other hand, the real consumption wage rises (through the bargained real wage effect) to induce an overall increase in labour supply. But labour is not mobile in the impact period. Hence initially the increase in demand increases real wage and local employment rates. The increase in demand also implies price increases for domestically produced goods. The existence of the wedge caused by the presence of extra-regional imports and imports ensures that natural-rate results do not apply at this period. But, if there is no "wedge" effect the demand curve for labour in real wage-employment rate space

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[2] The curve need not be negatively sloped, but for small, open regions like Scotland we would expect it to be because the impact of wages on competitiveness would outweigh their impact on incomes. This proves to be the case for all the AMOS simulations we report subsequently.

would not shift out as exports demand increase[3]. Since migration has not occurred during this interval, the impact of the demand stimulus on the system is the same irrespective of the degree of labour mobility. Thus the impact interval results for the flow adjustment migration model, the stock adjustment model and for zero mobility, are identical. In the short-run the economy is in a temporary equilibrium state (point B of Figure 4.1).

Next, we consider the impact of differing degrees of labour mobility in post-impact interval periods, that is we consider results over both medium-run and long-run intervals.

4.2.2. The Flow Adjustment Model Of Migration.

The demand stimulus we impose takes the form of an increase in the demand for manufacturing exports. In this sub-section we explain the medium- and the long-run effects of an increase in export demand on the labour market when migration is allowed in the model. The migration function and the wage function take the same form as those in Layard *et al* (1991). In particular, we assume the flow adjustment form of the migration function.

[3] In this case, of a closed economy, the model would have "classical" features.

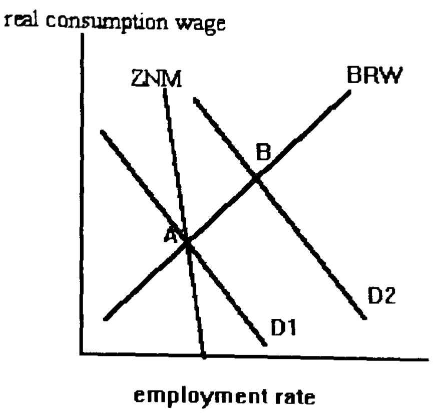

Figure 4.1. The impact of demand stimulus: the flow model of migration

4.2.2a. The impact of migration on medium-run equilibrium.

We have seen that in the short-run the stimulus to demand results in an increase in real consumption wages and a fall in unemployment rates in Scotland. Once migration is possible, these changes tend to attract net in-migration into Scotland from RUK (and elsewhere). With the flow adjustment model, very specific results arise in the medium-run which correspond to the flow[4] adjustment model's implied zero-net-migration condition. The ZNM locus is a negatively sloped schedule in employment rate – real consumption wage space. It is negatively sloped because a higher real consumption wage would, ceteris paribus, attract higher net in-migration, so for zero net migration the employment rate has to be lower. The ZNM locus summarises the conditions under which net migration is zero. Points above and to the right of the ZNM curve imply net in-migration because at such points the real wage is higher (and unemployment rate is lower) than is required for zero-net-migration. So, people will be attracted to move into Scotland from RUK. Points below and to the left of the ZNM curve imply net out-migration, where the real consumption wage is lower (and unemployment rate is higher) than it needs to be for zero net migration (at any employment rate), hence people leave Scotland for RUK.

[4] The flow model is essentially a variant of Harris-Todaro(1971) model

The short-run equilibrium at point B lies above and to the right of the ZNM locus and so is associated with net in-migration. This is exactly what we would expect, with migrants responding to the higher real take home consumption wage and lower unemployment rate in Scotland. Scotland's population expands through net in-migration into Scotland. This implies a further increase in local demand and therefore employment. However, the increase in population is greater than the increase in employment (given stability conditions) and so in real wage-employment rate space the demand curve begins to shifts back inwards towards its initial position. Referring to Figure 4.1 again, the labour demand schedule contracts back to D_1, where the original real wage and unemployment rates are restored. The ZNM condition implied by the Flow model of migration means that the original equilibrium is ultimately restored in real consumption wage –employment rate space. Migrants continue to respond to the real wage differential and unemployment differential between Scotland and RUK until this differentials are returned to their original equilibrium levels.[5]

Suppose we define the ZNM for the flow model as follows:

$$\phi^{Flow} = \alpha_0 - \alpha_1 (rw_S - rw_{RUK}) + \alpha_2 (u_S - u_{RUK}) \qquad (1)$$

If $\alpha_0 = 0$, equation $(1) = 0$ if and only if $\alpha_1 (rw_S - rw_{RUK}) = \alpha_2 (u_S - u_{RUK})$

which implies, $\left(rw_S - rw_{RUK}\right) = \frac{\alpha_2}{\alpha_1}\left(u_S - u_{RUK}\right)$ or $rw_S = \frac{\alpha_2}{\alpha_1} u_S + \bar{Z} \qquad (2)$

where $\bar{Z} = \left(\alpha_1 rw_{RUK} - \alpha_2 u_{RUK}\right)$

The variables are as previously defined. Equation (2) implies that the zero net migration condition is only satisfied in the flow model when the relative real wage differential, $(rw_S - rw_{RUK})$ equals α_2 / α_1 of the relative unemployment rate differential, $(u_S - u_{RUK})$. Furthermore, given the exogeneity of u_{RUK} and rw_{RUK}, we can derive the negatively sloped ZNM curve (noting employment rate, n = (1-unemployment rate)) by taking the first derivative of equation (2) with respect to the employment rate of Scotland, n_S. Since $n=1-u$, it implies that $u_S=1-n_S$, Equation (1) can be written as

[5] Migration inflows continue as long as $u_S < u_{RUK}$ and $rw_S > rw_{RUK}$. The fact that u_{RUK} and w_{RUK} are exogenous imply that the Scottish economy has to adjust until original rw_S and u_S equilibrium is

$$rw_S = \frac{\alpha_2}{\alpha_1} - \frac{\alpha_2}{\alpha_1} n_S + \overline{Z} \qquad (3)$$

Taking first derivative of (3) the ZNM slope is obtained as follows,

$$\frac{drw_S}{dn_S} = -\frac{\alpha_2}{\alpha_1}$$

As more migrants come into Scotland attracted to the high real wage and low unemployment rate, there will be downward pressure on real wage and an upward pressure on the unemployment rate. Migrants stop coming into Scotland once the real wage and unemployment rate return to the original equilibrium level. In the Layard *et al* (1991) (flow adjustment) model, according to McGregor *et. al.* (1995b) across the ZNM equilibria a region exhibits a natural rate or non-accelerating inflation rate of unemployment (NAIRU). Real wage and unemployment rates are invariant to demand disturbances across medium run equilibria. But as we shall see in Section 4.2.3, with the SA model this result does not apply. Notice, however, that the levels of population and economic activity do increase with a demand stimulus: wage and unemployment rates are unaffected, but the scale of the regional economy varies directly with regional demand.

4.2.2b. The long-run: capital stock adjustment.

Under the FA model, in the long-run, over which capital stock as well as population adjustment is complete, the economy is in a steady state on the ZNM schedule, with the initial equilibrium real wage and unemployment rate. The labour market returns to the original equilibrium position, point A in Figure 4.1. However, the whole economy is actually at a new higher level of output, with the levels employment and population (permanently) expanded because of the demand shock and the effects it induces on the real economy. In the long-run eventually I-O results are established. The demand stimulus initially increases capital rental rates above user costs which are "tied" to a fixed UK interest rate. Over the impact interval the stimulus to demand causes capital rental rates to increase above the user costs of capital and hence stimulate the demand for capital in the short-run. Once capital is

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restored.

variable, the investment stimulated by increased profitability adds to capital stocks, and puts downward pressure on rental rates. Eventually, rental rate and user cost equality is restored. With the bargained real wage closure and the flow adjustment model of migration the system operates "as if" it is an input-output system with respect to the demand disturbance, because prices are not ultimately affected by the demand disturbance (McGregor *et. al*; 1995 and McGregor *et al*;1993). Real wage and unemployment rates return to their initial equilibrium levels, as do user costs and rental rates. Over the long-run it is 'as if' there is an infinitely elastic supply of both labour and capital to the region and, following a demand stimulus, all inputs increase equi-proportionately with sectoral outputs across long-run equilibria.

In the following section we discuss the likely impact of the demand disturbance when migration takes the form of a stock adjustment specification. In Chapter 6 we discuss the likely scale of the impact of the demand disturbance given default parameters of the AMOS simulation model.

4.2.3. The Stock Adjustment Model of Migration.

In this sub-section we explain the medium-run and the long-run effect of an increase in (manufacturing) export demand on the labour market when migration takes the form of a stock adjustment specification. As already noted, the short-run effects are independent of labour mobility since migration is assumed to occur with a one-period lag, and so is unaffected over this interval.

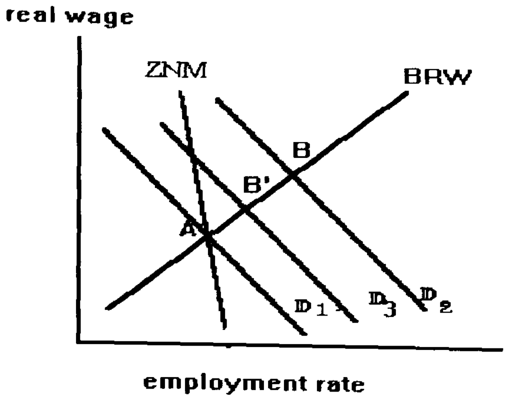

Figure 4.2. The impact of Demand stimulus: the stock adjustment model of migration

4.2.3a. The impact of migration on medium-run equilibrium.

In the short-run, as before, there is an increase in real wage and fall in unemployment rates in Scotland. Once migration is possible, this begins to attract net in-migration into Scotland. However, this does not occur continuously because the nature of our stock adjustment model assumes that there is a one-off migration response to changes in real wage and unemployment rate differentials. In general igration in the stock adjustment model does not continue until the original equilibrium levels of real wage and unemployment rates is re-established.

In the medium-run with complete population adjustment, but fixed capital stocks Scotland's population expands in response to the demand stimulus because of in-migration into Scotland in response to the higher real wage and lower unemployment rates. This implies a further increase in local demand and therefore employment. But the increase in population is greater than the increase in employment and so in real wage-employment rate space the labour demand schedule shifts in. This is also a feature of the flow adjustment model. However, in Figure 4.2 the labour demand schedule moves in from D_1, but here only as far as D_3. There is a one-off movement of migrants into Scotland as a consequence of the rise in real wage rates and fall in unemployment rates there, but it is insufficient to restore differentials to their original levels. The ZNM condition set in the Flow model does not apply here because in the stock adjustment case migrants only respond to the ***change*** in the real wage differential and the ***change*** in the unemployment differential between Scotland and RUK. Hence, given our assumption that the only source of population change is through migration, migration in the stock adjustment (SA) model is not a continuous process as it is in the flow model.[6] The way we specify the SA net out-migration model[7] suggests that the real wage-unemployment rate relationship summarised in the zero-net-migration condition does not exist here. Thus with the SA model we obtain radically different results from the flow adjustment (FA) model.

The above framework suggests that under the bargained real wage closure, with the chosen (real) wage function and SA migration model we should get an adjustment pattern that leads to long-run (and medium-run) equilibria diverging from the original equilibrium position[8]. These are qualitatively similar to the flow model in the sense that all variables tend to move in the same direction across the FA and SA models, but the scale of adjustments are likely to be different. In particular, real wage and unemployment rates do not return to their initial equilibrium levels. Instead, real wage and unemployment rates in Scotland are permanently affected in the SA model, in contrast to the FA model. And since the unemployment rate is permanently affected the results with the SA model do not exhibit natural rate or the NAIRU, results. Our SA results are thus quite different from the traditional disequilibrium models of migration such as Evans (1990), Harrigan and McGregor (1993) and McGregor *et.al.* (1995).[9]

Recall that, in the SA model migrants exhibit a discrete response to a one time change in the relative real wage differential and unemployment differential. As a result the increased population will cause the real wage (and prices) to fall relative to the short-run result but not (necessarily) to the initial equilibrium level. As migrants

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[6] In the flow adjustment model, the process is continuous until the old equilibrium in terms of wages and unemployment rate is restored.

[7] The net migration functions and the wage function we use are explained in the appendix that follows the text.

[8] This is the most likely outcome, but not the only possibility. If the stock adjustment is large enough, we could restore the original equilibrium.

[9] They do not regard regional economies as typically following the market clearing and steady state equilibria continuously. McGregor *et. al.* (1995) theoretical work shows that, except for steady-states condition the impact of the demand shock on wages and employment rates depends on what is assumed about the wage determining process in the local economy. They hypothesised that across the ZNM equilibria (with real wage setting) a region should exhibit a natural rate of unemployment (or a

come into Scotland this implies that the real take home wage remains higher and the unemployment rate remains lower than in the original equilibrium. The nature of the SA migration model that we specified earlier, given that neither wages nor unemployment rate return to the original equilibrium, suggests that labour remains a scarce, regional-specific factor in the medium-run.

In this case migration fails to ensure that labour is not a regional-specific factor: it is not ultimately in infinitely elastic supply in this case. Hence the migration process in the SA model stops with the labour market settling at the new equilibrium position B' in Figure 4.2. In contrast in the FA model the process continues until the real wage and employment rate fall to their initial equilibrium values. In the FA model migration continues as long as the unemployment and wage rates in Scotland differ from their original equilibrium values. Hence in the long-run the SA model does not typically converge to the I-O result as with the FA model, and labour remains a "scarce" factor within the region even in the long-run. In the FA model, as we have seen, across the ZNM equilibria, a region exhibits a natural rate of unemployment or NAIRU. Real wage and unemployment rates are invariant to demand disturbances across medium and long-run equilibria. This result does not apply to models of the SA type.

The medium run equilibrium solution to the SA model is based on the following net migration function:

$N/L = m(\Delta w, \Delta u) \quad m_W<0;\ m_u>0 \text{ and } m_{cpi}>0 : w=W/cpi \quad (4)$

Where m_W, m_u and m_{cpi} explains how migrants react in relation to the change in wages, change in unemployment rate and to prices. N/L is the labour force. Since migration is complete we can obtain the long-run equilibrium solution by setting the zero-net-migration condition for the SA model as:

$$0 = \beta_0 - \beta_1 \Delta(rw_S - rw_{RUK}) + \beta_2 \Delta(u_S - u_{RUK}) \qquad (5)$$

Equation (5) assumes a particular functional form for equation (4)

If $\beta_0 = 0$, (5) = 0 if and only if

$$\beta_1 \Delta(rw_S - rw_{RUK}) = \beta_2 \Delta(u_S - u_{RUK})$$

implies $\Delta(rw_S - rw_{RUK}) = \beta_2 / \beta_1 \Delta(u_S - u_{RUK})$

NAIRU) and real wages are invariant to demand disturbances. The NAIRU results are thus obtain only

Since real wage in RUK and unemployment rate in RUK are exogenous, zero-net-migration equilibrium requires that[10]

$\beta_1\, \Delta(rw_{St}-rw_{St-1}) = \beta_2\, \Delta(u_{St}-u_{St-1})$

Thus $\beta_1 \Delta rw_S = \beta_2 \Delta u_S$

which implies $\Delta rw_S = \beta_2/\beta_1(\Delta u_S)$ (6)

For zero net migration in the SA model equation (6) holds. In Harris-Todaro it is assumed that $\beta_2=\beta_1$ and hence equilibrium necessitates the change in real wage to be equal to the change in unemployment rate in Scotland. However, notice that, regardless of β_1 and β_2 values, if there is no change in the real wage and unemployment rate of Scotland ($\Delta rw_S=\Delta u_S=0$) then net migration is zero. Here if we are dealing with comparative statics, zero net migration prevails as long as there are no changes in real wage or unemployment rate.

4.2.3b. The impact of migration on long-run equilibrium.

In the short-run we know that an increase in demand will cause capital rental rates to increase above the user costs of capital (in the impact period) and hence stimulate the demand for capital. With capital variable, the bargained real wage closure flow (FA) model operates "as if" it is an input-output system with respect to the demand disturbance: because prices are not ultimately affected by the demand disturbance (McGregor *et. al.*1995 and McGregor 1993). However, in the SA model the bargained real wage closure model does not operate as an input-output system in the long-run, even with respect to demand disturbances. This is because the real wage, and therefore prices, are permanently increased by the demand disturbances because labour is not in infinitely elastic supply in this case, even in the long-run. The unemployment rate (unlike the FA model) does not exhibit a natural rate of

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when the flow migration model is used.

[10] The net migration equation can also be written as

$NMGRATE^{SA} = \beta_0 - \beta_1[(rw_S - rw_{RUK})_t - (rw_S - rw_{RUK})_{t-1}] + \beta_2[(u_S - u_{RUK})_t - (u_S - u_{RUK})_{t-1}]$. If the real wage and unemployment of RUK is exogenous, the ZNM equation now becomes

$$\beta_1[(rw_S - \overline{rw}_{RUK})_t - (rw_S - \overline{rw}_{RUK})_{t-1}] = \beta_2[(u_S - \overline{u}_{RUK})_t - (u_S - \overline{u}_{RUK})_{t-1}]$$

unemployment that is invariant to demand. Hence with the SA model: the impact of the (export) demand shock on the system depends on the magnitude of the "shock" and how much it changes the real wage and unemployment rates. Accordingly, the results under the SA model are radically different from the FA model and subsequent numerical simulations in Chapter 6 confirm this.

4.2.4. Zero Labour Mobility.

In this sub-section we study the effect of an increase in manufacturing export demand on the labour market when zero labour mobility is assumed.

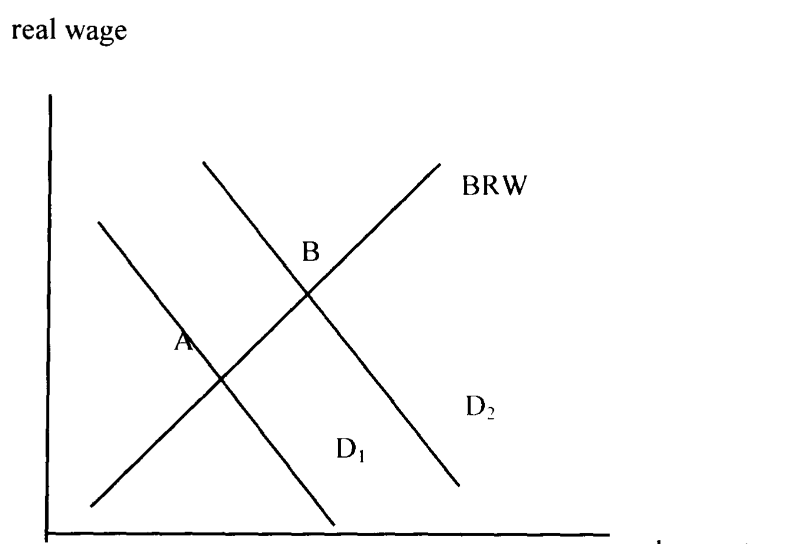

Figure 4.3. The impact of demand stimulus: with zero labour mobility

The zero labour mobility case provides us with a useful benchmark; since labour is not mobile the increase in wages and fall in unemployment rate that occur in the impact interval generate no migration response. With zero labour mobility the increase in the real take home wage encourages employment of the local Scottish population, which permanently reduces the unemployment rate. Referring to Figure 4.3, point B is the new equilibrium position. Although wage rates in Scotland are higher and the unemployment rate is lower than at A, households are immobile and so no migration occurs. The permanent increase in the real wage (unless accompanied by an offsetting increase in labour productivity) will result in increased prices. Output and employment are rising in the short-run.

In the long-run with zero labour mobility, only capital can expand. As before capital rental rates will rise in the short-run creating an incentive to invest. Output will rise further as capital accumulates, but will be constrained by the limited labour supply. As wage and price increases continue consequence Scottish goods will be less competitive relative to goods produced outside Scotland, and this loss of competitiveness will be true of the long-run, as well as the short-run. This implies a rise in imports, while exports fall. Since labour is not mobile any further increase in the demand for labour will push the wage even higher. The wage increase causes prices to further increase and reduces exports even further in the long-run. Wages may be lower than in the short-run, and if the initial stimulus is an export shock overall exports will rise. With zero labour mobility, in the long-run the unemployment rate is permanently reduced, while real wages and prices are permanently increased. Population remains fixed given the zero mobility assumption. The long-run effect is greater than the short-run effect because of the stimulus to capital in the long-run. This does induce further partial crowding-out, but only because of the greater stimulus to demand in the longer-run.

4.3. Theoretical Analysis of a Supply Stimulus.

The supply stimulus we consider throughout is the introduction of a (nationally funded) regional labour subsidy. We analyses this using the same three conceptual time intervals: the short-run or impact interval; the medium-run and the long-run.

4.3.1. Impact interval effects.

The impact interval effect occurs during a time interval of sufficiently short deviation that migration effects have not occurred, hence the results are identical irrespective of the degree of labour mobility we assume. BRW is the bargained real wage function, as defined earlier.

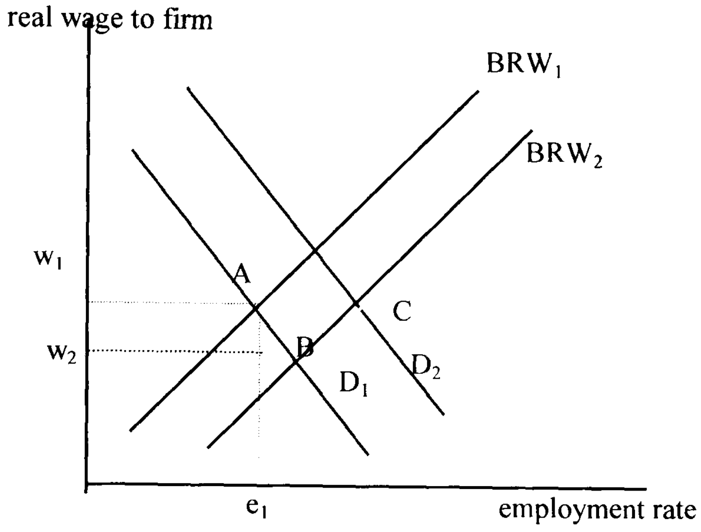

Figure 4.4. The impact of supply stimulus:
with zero labour mobility

Recall that the demand curve for labour here is a general equilibrium demand curve, which takes full account of all the effects of wage falls including any impact on workers incomes and consumption. D_1 is the original general equilibrium demand curve for labour. The labour subsidy causes a vertical downward shift in BRW by the amount of the subsidy. It is assumed that the general equilibrium demand curve is negatively sloped (as it proves to be in all the simulations reported subsequently). But in general this depends on technology (ease of substitution) and on the price elasticity of demand for output. Hicks' (partial equilibrium) analysis of the laws of derived demand implies that the wage-elasticity of labour demand depends positively upon: the elasticity of substitution of capital for labour; the price elasticity of demand for output; the elasticity of supply of capital and the share of labour in value-added.

Since, in the present case the labour subsidy is assumed to be externally financed, there will be a fiscal effect taking place simultaneously. The increased government spending (due to the subsidy) immediately causes the demand curve to shift to D_2 in Figure 4.4. The regional labour market is initially in equilibrium at point A, where the labour demand schedule D_1 intersects the bargained real wage curve, BRW_1, at employment rate e_1 and equilibrium real wage to the firm, w_1. Introducing a labour subsidy causes a wedge between the cost of labour to the firm and the wage received by the worker. The labour subsidy makes labour cheaper to producers hence they are willing to hire more. In the short-run the labour subsidy causes a shift in the wage-setting curve to BRW_2 in the real-wage-to-the-firm-employment rate space as shown by Figure 4.4. Initially the labour subsidy causes the real wage to the firm to fall to w_2 while the real take home consumption wage remains unchanged. However at this lower wage to firms, the demand for labour exceeds supply hence pushing up the real take home consumption wage. Thus the labour market is now in temporary equilibrium at point B, at a higher real product wage than w_2. If the demand for labour does not increase the economy stays at B. The direct effect of the subsidy on wages is shown by the vertical shift of BRW: the employment impact depends on the elasticities of the demand and BRW curves. Movement along the demand curve to position B shows what the impact of the subsidy would be in the absence of a demand shift on the real wage to firm; the fall in the real wage to the firm increases the employment rate which simultaneously pushes up the real take home consumption wage.

The fiscal stimulus that arises due to increased government spending on the labour subsidy is reflected in an outward shift of the general equilibrium labour demand curve from D_1 to D_2. The increase in demand pushes up prices and real consumption wages to a new level at point C. The real product wage also increase as a result of the increased demand but the wedge induced by the subsidy curbs the increase, so that the real product wage is still lower than w_1. According to Harrigan *et.al.* (1996) this shift in the labour demand curve depicts one aspect of regional factor subsidies that is not captured in partial equilibrium approach: the income effect of the fiscal injection associated with the externally financed subsidy.

In the impact period the economy is now in temporary equilibrium at point C. In the following sections we discuss the medium-run and long-run effect of the supply stimulus under different degree of labour mobility.

4.3.2. The Flow Model Of Migration.

4.3.2a. The impact of migration on medium-run equilibrium.

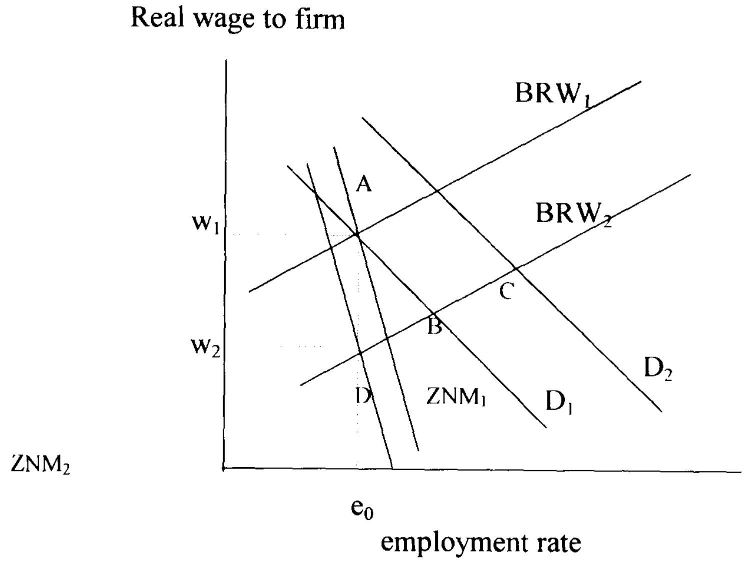

Figure 4.5. The impact of supply stimulus: the flow model of migration

The short-run increase in the real wage and fall in unemployment induces in-migration into Scotland. At point C, as more people come into Scotland, the labour supply expands hence putting a downward pressure on wages. Initially the real wage to the firm falls by the amount of the subsidy. The economy is now in equilibrium at D on ZNM_2 (see Figure 4.5). The ZNM[11] schedule shifts downwards to ZNM_2 because the fall in the real wage to the firm is externally financed, hence for the same employment rate (as before the subsidy) for example at e_0, the firm now pays a lower real wage. Notice that ZNM is now lower than before the subsidy. The vertical

[11] Here ZNM shows the wage required to be paid by firm at any given employment rate, to ensure zero net migration.

downward shift in the ZNM curve equals the size of the fall in the bargained real wage, in real-wage-to-the-firm – employment rate space. Since capital is fixed and population movement is complete, as more people migrate into Scotland attracted to the increased real wages and the higher employment rate, the level of employment increases but the employment rate falls (since the increase in labour supply predominates). This causes the unemployment rate to rise towards the original equilibrium rate. In the medium-run equilibrium is established at D; as migrants come into Scotland the ratio of employment relative to labour force falls and the pressure on the real take home wage falls. As a consequence the pressure on the real wage to the firm is alleviated, and hence the real wage to firm falls by the amount of the subsidy, but the real wage received by households remains unchanged. In effect, NAIRU results hold over the medium-run in response to a supply disturbance, just as they do for a demand disturbance under the flow-adjustment model of migration.

Notice that with the supply shock three impacts occur. First, the bargained real wage paid by the firm falls, and producers are willing to hire more workers. On the demand side, since the subsidy is externally financed, the impact is similar to the impact of increased government spending (in the form of transfer payment); causing the demand in terms of intermediate and consumption goods to rise. Finally, in the medium-run the migration effects expand demand even further. The demand curve for labour will shift all the way back to point D. The real wage to the firm falls by the amount of the labour subsidy while the real consumption wage remains at point A. In general the regional economy is better off than without the labour subsidy and more jobs are created.

4.3.2b. The impact of migration on long-run equilibrium.

In the long-run where capital stock adjustment as well as population adjustment is complete, the labour subsidy enhances capital stocks since it stimulates profitability in the short and medium-runs, more jobs are created and prices fall to maintain the equilibrium real take home consumption wage. The real take home wage returns to its original equilibrium level and prices fall to a level below the initial equilibrium price level. GDP increases because demand for both consumption goods and intermediate demand have increased as has employment and capital stocks. The economy settles at a higher equilibrium level of employment (population increase due to in-migration into Scotland), but the unemployment rate returns to its original level because the real wage returns to the original equilibrium level. The long-run results thus should exhibit the natural rate result or the NAIRU result. Notice that again in the long-run the real wage to firm falls by the full amount of the subsidy, while the real consumption wage remains at the initial equilibrium level (and so is unaffected).

4.3.3. The Stock Adjustment Model of Migration.

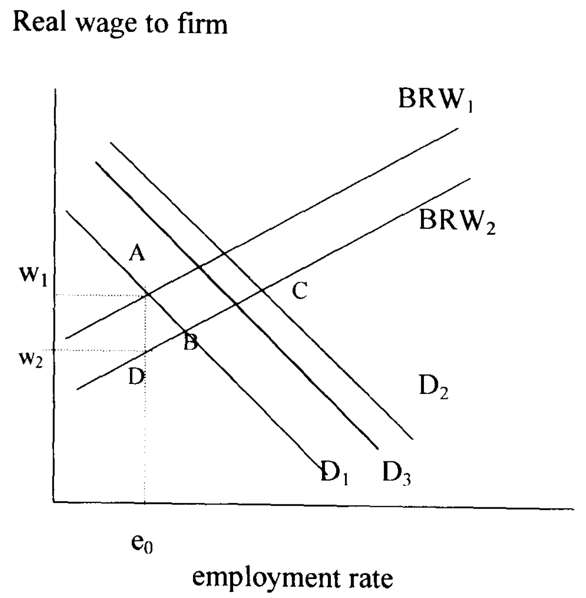

Figure 4.6. The impact of supply stimulus: the stock adjustment model of migration

As with the flow model, the regional labour market is initially in equilibrium at point A (see Figure 4.6). Short-run equilibrium is established at B following the imposition of the subsidy, with a lower employment rate and higher real consumption wage. Under the bargained real wage closure the increase in the real wage and employment rates attracts migrants into Scotland thus pushing down the employment rate from its short-run equilibrium level. But this does not continue until the old equilibrium is restored. The nature of our stock adjustment model suggests migrant responds to the change in the real wage and unemployment rate in Scotland relative to the previous period. Unlike in the flow model, the pressure of in-migration does not continue until the real wage and employment rates return to their initial equilibrium levels. Hence with the stock adjustment model the NAIRU result is not achieved. Labour in the stock adjustment model remains a regionally -specific scarce factor in the medium and long-runs, as well as in the short-run. Since migration here is not a continuous process the labour demand curve D_2 will shift in but only to D_3. In the long-run when capital and population are fully adjusted, the economy is in a steady state with a new equilibrium real wage and new employment rate. The unemployment rate is permanently reduced. The labour subsidy thus has a desirable policy implication if the target is to reduce the unemployment rate permanently. The economy is at a new level of output, with employment and population permanently expanded.

4.3.4. Zero Labour Mobility.

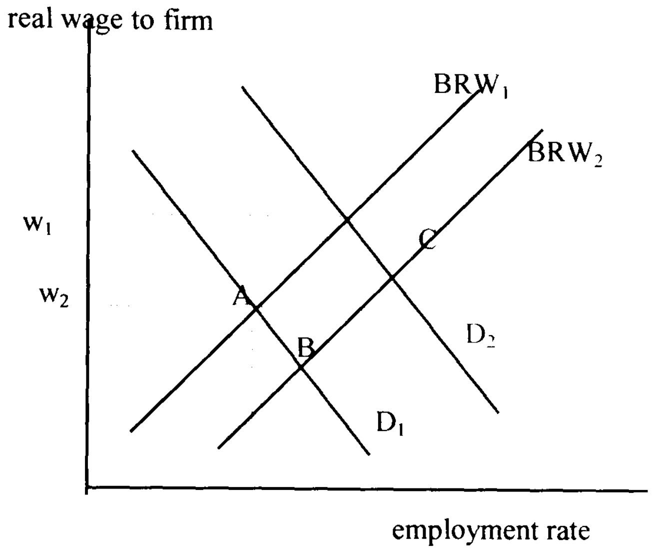

Figure 4.7. The impact of supply stimulus: with zero labour mobility

In this sub-section we study the effect of zero mobility. When there is no migration allowed into the region, the impact of the supply shock will be fully absorbed by the region's own labour market. In the medium-run, the region economy remains at C because no migration occurs despite the higher real take home wage and employment rates, as labour is geographically immobile.. The larger the size of the subsidy, the cheaper will be the cost to producer, and in turn producers will hire more workers. Since the size of the labour market is limited in the zero migration case, the unemployment rate will be permanently reduced but the real wage to producers will not be as low as the real wage to producer when migration is allowed. This is because, under real wage bargaining, the limited supply of labour will cause the real wage to the producer to increase as workers demand higher wages in response to the stimulus to economic activity..

In the long-run, with capital fully adjusted (in the no migration case), the regional economy will settle at a new equilibrium at a point like C, with a permanently higher real take home wage rate, an increased employment rate and hence a lower unemployment rate. Hence with zero mobility there is no NAIRU established. But effects on income and employment levels will be higher in the long-run.

4.4. National Wage Bargaining.

Up to now we have assumed that the bargained real wage curve accurately captures the behaviour of regional labour markets. We have chosen this as our main assumption about regional wage determination because of the mounting evidence in favour of regional "wage curves" of this type. However, we noted in our introduction to this chapter that there are alternative hypotheses. One of the most widely adopted traditional views was that of national bargaining, according to which the nominal wage is effectively dictated to the region as a consequence of a system of integrated national bargaining. In this section we explore the consequences of such a bargaining system for the results we have derived so far.

4.4.1. The Demand Stimulus.

In this sub-section we discuss the impact of the demand stimulus under a system of national bargaining. We begin by assuming the flow migration model and then consider the implications of the stock adjustment specification.

Consider first the consequences of the demand stimulus over the impact interval. Since the demand stimulus results in a rise in prices, the real wage actually ***falls*** in this case initially. In terms of Figure 4.1 equilibrium is not re-established at a point like B, as it was under the BRW closure. Instead the short-run equilibrium position will be established at a point on D2 associated with a ***lower*** real wage than at point A. The major implication of national bargaining over the impact interval is that it implies a much bigger stimulus to employment, and therefore output, and a fall in the real wage.

Strictly, the impact on migration flows seems ambiguous because although unemployment falls by more than under regional bargaining (BRW), the real consumption wage actually falls. However, we assume that the effect on employment predominates (as it does in fact in the simulations reported below). So exactly the same forces operate on the demand curve in the medium run under this treatment of the labour market as under regional bargaining. In particular, in-migration occurs and gradually pushes the demand curve for labour backwards. However, in this case, since prices continue to rise, medium run equilibrium cannot be re-established at A. Rather, it the demand curve for labour must shift a little further back to ensure that the medium run equilibrium established along ZNM is associated with a ***lower*** real wage than that associated with the initial equilibrium position at A. So NAIRU results do not apply to the medium run equilibrium under national bargaining.

In the long-run similar pressures operate to increase capital stocks under national bargaining as under regional bargaining: rental rates rise in the short-run relative to user costs and stimulate investment. However, the pressures that gradually restore prices to their original levels under regional bargaining also apply here. Eventually prices are restored to their initial values, which implies that, with the nominal wage given, the real wage is also restored to its original level. In the long-run therefore, national bargaining leads to identical results to regional bargaining: if prices do not change and unemployment rates do not change across long-run equilibria the distinction between the different treatments of the labour market disappears. Again, it is "as if" the system operates as an input-output model over the longer term. The long-run equilibrium of the system therefore is again at point A. However, of course output, employment and population will all be higher than in the initial equilibrium position.

Of course, the stock adjustment model of migration would make no differenc to the impact interval results identified above for the national bargaining model: there is a substantial increase in employment, significantly greater than under regional bargaining, and a fall in the real consumption wage. So in Figure 4.2 short run equilibrium is not at B, but on D2 at a lower real wage than that prevailing at A (and so much lower than that established in the short run under regional bargaining). Again, once migration is possible, inflows of migrants tend to shift the general equilibrium demand curve for labour back to the left. Under the stock adjustment model, the unemployment rate does not return to the initial equilibrium rate in the medium run, but remains permanently lower. Labour remains a scarce, regional-specific factor in the medium- and long-runs. So in the long-run with the stock adjustment migration model, under national wage bargaining we get the I-O results. But no NAIRU result is achieved as the unemployment rate is permanently changed.

4.4.1. The Supply Stimulus.

The supply stimulus in the form of labour subsidy means that it is cheaper for producers to hire more workers now than before the subsidy. In Figure 4.5 the main difference is the replacement of the BRW schedule with the assumption of a fixed nominal wage (variously referred to as the "Keynesian" or "national bargaining" closure). As before there is a vertical shift down in the ZNM function and the real wage to the employer is immediately reduced by the same amount as under the BRW closure. However, here the stimulus to demand that accompanies the wage subsidy because it is externally financed results in a more substantial stimulus to output and employment than occurs under BRW: the nominal wage is fixed and any tendency for prices to increase will actually reduce the real wage where demand effects are predominant in the short-run (as is the case in our simulations).

In the medium run, we know that the short-run changes do attract in-migration, as the unemployment rate effects dominate the real wage rate impact (in all of our simulations). The consequences for the real take-home wage depend entirely on the impact of prices given nominal wage rigidity. While prices rise initially, this impact is mitigated as capacity adjusts and is ultimately more than offset as the influence of the supply shock dominates in the long run.

When the supply shock is imposed, price changes occur throughout the adjustment period. Initially prices increase, as there is a demand stimulus but a capacity constraint so that rental rates rise. In the medium-run and long-run periods, prices fall. However, these price changes and falling unemployment rate do not influence national bargaining, nor, therefore do they impact on local nominal wages. We know that a pure demand shock would have no lasting impacts on prices under the flow-adjustment model of migration. However, here the beneficial supply-side stimulus of the labour subsidy implies that prices must fall in the longer-term (concentrated in the sector where the subsidy is targeted). Since the nominal wage is fixed, the real take home wage must rise in the long-run, and given the zero net migration condition, unemployment (employment) rates must ultimately ***rise*** (fall). NAIRU results are not established in this case – either in the medium or long-runs. If prices rise over the medium run (as they do in our simulations) a similar result holds, although of course economic activity will be stimulated much more in the long-run as capacity expands. Notice that unemployment rates are ultimately forced to rise in this case, though they fall initially, hardly a very "Keynesian" result. Of course the reason is the power of the zero net migration condition that is binding in the flow adjustment case.

The short-run results under the stock-adjustment migration model are, of course, identical to those just discussed. In this case, however, there is much greater scope for unemployment rates (and real wage rates) to vary from base even across medium-run and long-run equilibria, because the zero-net-migration condition is no longer binding. The same holds true with even greater force for the zero labour mobility case. In these cases we expected major falls in unemployment rates in response to the supply and demand stimuli.

However, under national bargaining, we expect that the macroeconomic consequences of alternative labour mobility assumptions will be much less dramatic than under the regional bargaining case. This reflects the fact that under national bargaining labour is a much less binding constraint on regional economic activity since labour is taken to be in infinitely elastic supply at the prevailing nominal wage. Under regional bargaining with no mobility, for example, is entirely regional specific, and increased labour supply can only be induced through real wage rises, which tend to moderate the scope of any expansionary impact.

4.5. Conclusions.

It is very clear from our analysis that the degree of labour mobility, as reflected in our flow-adjustment, stock-adjustment and zero mobility cases may be critical even for the qualitative behaviour of the system. This is especially marked in the case of regional bargaining where labour is an entirely regional-specific factor in the absence of migration. Under national bargaining labour constitutes less of a constraint on regional economic activity, and so variations in assumption about the degree of labour mobility are likely to matter rather less quantitatively. However, the nature of the migration process does continue to matter for the qualitative behaviour of the system, but less so than under regional bargaining.

In Chapters 6 and 7 we provide the simulation results for the demand and supply disturbances respectively. We also conduct sensitivity tests to see how the results vary as we change the migration elasticities with respect to the real wage and unemployment rates.

Chapter 5. AMOS: A Regional Computable General Equilibrium Model.

AMOS is a computable general equilibrium (CGE) model parameterised on data from Scotland.[1] This chapter provides a short description of AMOS, and a full listing of the model is provided in Harrigan *et al* (1991). However, for the purposes of this thesis the social accounting matrix[2] data base of the model has since been updated to 1989. Table 5.1 provides a condensed variant of the model and Table 5.2 defines the variables included in Table 5.1.

AMOS has four domestic transactor groups, namely: households; the non-household personal sector; corporations and government. The three commodities/ sectors are manufacturing, non-manufacturing traded and a sheltered sector[3]. AMOS assumes that Scotland is a price-taker in competitive UK financial markets: the interest rate is exogenous to Scotland. The AMOS framework allows a high degree of flexibility in the choice of key parameters values and model closures. The crucial characteristic of the model is that, no matter how it is configured, cost minimisation in production occurs with multi-level production functions. The production functions are generally of a CES form, but Leontief and Cobb-Douglas are available as special cases. AMOS has four major components of final demand, namely, consumption, investment, government expenditure and exports. Real government expenditure is exogenous. Consumption is a linear homogeneous function of real disposable income. Exports and imports are determined via an Armington link (Armington, 1969) and are therefore sensitive to relative prices. Investment in the short-run is considered exogenous throughout.

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[1] AMOS is an acronym for A Macro-Micro Model of Scotland.

[2] A social accounting matrix is a framework for reconciling and presenting data on the whole economy, including the structure of production and the pattern of expenditure. A double entry book keeping system is used for each economic agent. The information is then presented in matrix form, with the rows and columns representing the income and expenditure accounts respectively.

[3] Manufacturing comprises sectors 12-89, non-manufacturing traded sectors 1-10 and 91-97, 99-102 and 109-111; and non-manufacturing non-traded sectors 11, 90 and 98, 103-108 and 112-114 in the 1989 Scottish Input-Output Tables (Industry Department for Scotland).

For this study, in all simulations we impose a single Scottish labour market characterised by perfect mobility among sectors. Typically, we also assume that the Scottish labour market is accurately characterised by the bargained real wage (BRW) labour market closure, which is motivated by the recent literature on regional wage curves (Blanchflower and Oswald, 1994, Layard *et. al.* 1991). Many researchers have found evidence of a regional bargained real wage in which the regional real consumption wage is directly related to workers' bargaining power and hence inversely related to the regional unemployment rate. The underlying idea here is of a regional bargaining system in which the state of the regional economy influences the bargaining power of workers. We adopt the specification of the BRW function reported in the regional econometric work of Layard *et. al.* (1991):

$$w_{S,t}=\alpha_0 - 0.113u_S$$

Where w_S and u_S are the natural logarithms of the real take home wage and unemployment rate of Scotland respectively. Note that the real wage in Scotland is negatively related to the unemployment rate in Scotland. This reflects the hypothesis that that higher the unemployment rate in Scotland, the less bargaining power workers have and hence the lower the Scottish real wage will be. We imposed the BRW closure in our study following McGregor *et al* (1995). A similar "wage curve" is now commonly used in the regional context (Blanchflower and Oswald,1994).

While we normally assume the presence of a regional bargaining system, given the cumulating evidence in favour of this perspective on labour market behaviour, we do also explore the impact of a national bargaining system, given the emphasis that this hypothesis received in the earlier regional macroeconomics literature e.g. Harris (1991) and Roper and O'Shea (1991). The basic idea here is that wages are determined in an integrated national bargaining system, so that the nominal wage effectively becomes exogenous to peripheral regions such as Scotland. This generates a model of the regional macroeconomy that has distinctly Keynesian features. This view of labour markets has been influential in the regional literature and it is therefore very useful to explore its consequences for our analysis, and compare results with those obtained under the BRW closure. Accordingly, we often report the results of simulations that use this national bargaining, or Keynesian, closure of labour markets.

AMOS is a multi-sectoral model in which markets, and relative prices are modelled endogenously. In the short-run, sectoral capital stocks are fixed but commodity markets clear continuously. The capital rental rate indicates the profitability of physical capital and the user cost is the total cost to the firm of using a unit of capital. Since we take interest, capital depreciation and tax rates as exogenous, the capital price index is the only endogenous component of the user cost. If the capital rental rate is greater than the user cost then desired capital stock is greater than the actual capital stock and there is an incentive to increase capital stock. As capital accumulates there is downward pressure on the capital rental rates that tends to restore equilibrium. Thus, in the long-run, capital rental rates are equal to user costs in each sector and the rate of return to capital is equalised between sectors. In the long-run capital stocks adjust until these conditions are satisfied.

Table 5.1. A condensed version of AMOS, adapted from McGregor *et. al.* (1995)

	Equations	
	short-run	Long-run
1. Price determination	$p = p_i\,(W_p, W_k)$	
2. Labour supply	$W = W(u); \quad u = 1 - (N/L)$	
3. Labour subsidy	$W^p = (1-s)\,W^c$	
4. Labour force	$L = \overline{L}$	$\frac{N}{L} = \frac{N}{L}(W, cpi,.)$
5. Consumer price index	$cpi = \sum_i \theta_i p_i + \sum_j \theta_j^{RUK} \overline{P}_j^{RUK} + \sum_j \theta_j^{ROW} \overline{P}_j^{ROW}$ i = m, nmt, nt; j = m, nmt	
6. Capital supply	$K_i^s = \overline{K}_i^s$	$K^s = K^s(w_s, kpi)$
7. Capital price index	$kpi = \sum_i \gamma_i p_i + \sum_j \gamma_j^{RUK} \overline{P}_j^{RUK} + \sum_j \gamma_j^{ROW} \overline{P}_j^{ROW}$ i = m, nmt, nt; j = m, nmt	
8. Labour demand	$N_i^d = N_i^d(Q_i, W_p, W_k)$	
9. Capital demand	$K_i^d = K_i^d(Q_i, W_p, W_k)$	
10. labour market clearing	$N^s = \sum_i N_i^d = N$	
11. Capital market clearing	$K_i^s = K_i^d$	$K^s = \sum_i K_i^d = K$

12. Household income	$Y = \psi_i N w_c - \psi_k \sum_i K_i w_{ki} - \overline{T}$ | $Y = \psi_i N w_c + \psi_k \sum_i K_i w_{ki} + \overline{T}$
13. Commodity demand	$Q_i = C_i + I_i + G_i + X_i$

	Equations	
	short-run	Long-run
14.Consumption demand	$C_i = C_i(p_i, \overline{p}_i^{RUK}, \overline{p}_i^{ROW}, Y, cpi)$ $i = m, nmt$ $C_{nt} = C_{nt}(Y, cpi)$	
15. Investment demand	$I_i = I_i(p_i, \overline{p}_i^{RUK}, \overline{p}_i^{ROW}, \sum_j b_{ij} I_j^d)$ for $i = m, nmt$ and $j = m, nmt, nt$ $I_{nt} = \sum_j b_{ij} I_j^d$ $j = m, nmt, nt$	
	$I_j^d = \overline{I}_j^d$	$I_j^d = d_j K_j$
16. Government demand	$G_i = \bar{G}_i$	
17. Export demand	$X_i = X_i(p_i, \overline{p}_i^{RUK}, \overline{p}_i^{ROW}, \overline{D}^{RUK}, \overline{D}^{ROW})$ $i = m, nmt$ $X_{nt} = 0$	
Multi-period model	Stock up-dating equations	
18. Labour force	$L = L_{t-1} + nmg_t$	
19. Migration: a) Flow adjustment	$\frac{nmg_t}{L_{t-1}} = nmg[(W^S / cpi)_t - (W^{RUK} / cpi)_t, (u_t^S - u^{RUK}_t), Z]$	
b) Stock adjustment	$\frac{nmg_t}{L_{t-1}} = nmg[(W^S / cpi)_t - (W^S / cpi)_{t-1}, (u_t^S - u^S_{t-1}), \overline{W}^{RUK}, \overline{u}^{RUK}, Z$	

20. Capital Stock	$K_{it} = (1-d_i)K_{it-1} + I_i^d \quad i = m, nmt, nt$
21. Investment	$I_{it}^d = \lambda_i (K_{it}^d - K_t) \quad i = m, nmt, nt$

Table 5.2 Definitions of variables used in AMOS

Activity-Commodities

m = Manufacturing, nm = Non-Manufacturing, nt = Non-traded

Transactors

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

Functions

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

Variables

B	Elements of capital matrix
D	physical depreciation
cpi, kpi	consumer and capital price indices

P	price of commodity/activity output
S	labour subsidy rate
W_c, W_p, W_k	wage to the worker, price of labour to the firm, capital rental rate
C	consumption
D	exogenous export demand
G	government demand for local goods
I	investment demand for local goods
I^d	investment demand by activity
K^d, K^s, K	capital demand, capital supply, capital employment
N^d, N^s, N	labour demand, labour supply and labour employment
Nmg	net migration
Q	commodity/activity output
T	nominal transfers from outwith the region
X	Exports
Y	household nominal income
ψ	share of factor income retained in the region
θ	consumption weights
γ	capital weights
U	unemployment rate

In Table 5.1 we provide a condensed version of AMOS. Price determination is a function of the price of labour to the firm and the capital rental rate. The supply side of the labour market reflects our general assumption of regional wage bargaining , and is in fact a BRW function, according to which the bargained real wage is inversely related to the unemployment rate, defined as unity minus the employment rate. However, when we simulate the model under the assumption of national bargaining, equation 2 is replaced by the assumption of a fixed nominal wage. A labour subsidy affects the price of labour to the firm by the amount of the subsidy. In the short-run the labour force is fixed and in the long-run it varies with the real wage and the employment rate through the zero net migration condition.. The consumer price index is a Paasche index which takes a base year value of 100. The index is the ratio of the current quantities of Scottish, RUK and ROW traded commodities valued at current and base year prices. Capital supply is fixed in the short-run and is fully adjusted in the long-run. The capital price index is the sum of price indices in Scotland, RUK and ROW. Labour and capital demands depend on commodity or activity output, price of labour to the firm and capital rental rate. Market clearing is assumed in both the labour and capital markets; labour supply equals labour demand which in turn equals labour employment. Household income is equal to total labour income. After deducting employers' statutory contributions (to national insurance and superannuation funds) and income tax, we arrive at the total labour income to employees. The employees' take home pay is determined after deductions are made for employees' statutory contributions and income tax and (negative) income tax allowances. Commodity demand is equal to the sum of consumption, investment, government and export demands for local goods.

Consumption demand is a function of local, RUK and ROW prices of commodity or activity output, household nominal income and consumer price index. The structure of investment demand, and therefore the determination of the prices for investment goods, takes a form very similar to that of consumption. Aggregate investment in manufacturing, non-manufacturing traded and non-traded activity is based upon the steady state solutions to the dynamic investment functions estimated for the Scottish manufacturing and non-manufacturing sectors. Capital stocks are fixed in the short-run.

Total government expenditure is generally exogenous. But if a regional government budget constraint is imposed (which we do not do in our simulations, since we assume the labour subsidy is externally financed) with the adjustment occurring on the expenditure side, government expenditure becomes endogenous and adjusts to meet a target ratio of the public sector deficit to GDP. Demand for exports is based on Armington assumptions, with exports to ROW and RUK a function of the Scottish export prices, the RUK, ROW goods prices and export demand factors to RUK and ROW.

In the multi-period model, the labour force is the sum of the previous period's labour force and current net in-migration. Migration in the flow adjustment form is a function of the relative real wage and unemployment rate differentials between Scotland and RUK, plus a constant factor which captures the influences of other variables not included in the model (such as relative amenities). The stock adjustment migration model is a function of the change in the wage and unemployment rate differentials in Scotland and RUK, and a constant factor that captures the influences of other variables not included in the model. RUK wages and unemployment rates are treated as exogenous (and so are not included in the reported stock adjustment function for simplicity). Current period capital stock in each sector is equal to the existing (depreciated) capital stock plus investment demand by activity. Investment demand by activity is a function of capital demand minus capital employment.

We investigate alternative visions of labour mobility in our simulations. First, we explore the implications of assuming that net migration follows the flow adjustment process, with migration being positively related to the real wage differential and negatively related to the unemployment rate differential. We follow the estimated model reported in Layard *et. al.* (1991). Based on the Harris Todaro (1970) model. This model is commonly employed in studies of US migration (for example Greenwood *et. al.*,1991 and Treyz *et. al.*, 1993). The flow adjustment net migration function we employ is as follows:

$$NMGRATE^{Flow} = \alpha_0 + 0.06(rw_S - rw_{RUK}) - 0.08(u_S - u_{RUK})$$

where NMGRATE is the net in-migration rate as a proportion of the indigenous population; rw_{RUK} and u_{RUK} are the natural logarithms of the real take home wage and unemployment rates, respectively, in RUK. In the multiperiod simulations we report in Chapters 6 and 7 the net migration flows in any period are used to update population stocks at the start of the next period, analogous to the updating of capital stocks. The net-migration flows ultimately re-establish a zero-net-migration equilibrium.

The second hypothesis we explore assumes that net migration follows the stock adjustment (SA) process where migration is positively related to the ***change*** in the real wage differential and negatively related to the ***change*** in the unemployment rate differential. Again, we follow the estimated model reported in Layard *et. al.* (1991). The stock adjustment net migration function we employ is as follows,

$$NMGRATE^{SA} = \beta_0 + 0.06\Delta(rw_S - rw_{RUK}) - 0.08\Delta(u_S - u_{RUK})$$

Where: Δ is the first difference operator that characterises the stock adjustment specification; the other variables are as previously defined. Zero-net-migration occurs when there is no change in the real wage and unemployment rate differentials.

Finally, as a benchmark for our analysis we assume labour is immobile, which is an assumption often implicit in past UK regional policy analyses. Comparison with alternative characterisations of the migration process allow us to assess their significance. Of course, this formulation does not deny the existence of migration flows, but rather assumes that these flows are not systematically related to developments in the regional economy. This case therefore effectively always imposes the assumption of an exogenous labour force (as in the short-run version of equation 4 of Table 5.1).

Chapter Six. Simulations of Demand Disturbances.

6.1. Introduction

This chapter comprises five main sections, in addition to this one, each of which examines the impact of a 10% increase in the demand for manufacturing exports. In section 6.2 we discuss the simulation results that we obtain from the flow migration model. In section 6.3 we discuss the effects with the stock adjustment migration model, and in section 6.4 we consider the impact of the demand stimulus with zero labour mobility. In each of the relevant sections we also discuss the results of conducting sensitivity tests to see how the results vary as we change the migration elasticities with respect to both the real wage and the unemployment rate. For much of our analysis we employ the regional bargaining closure of the labour market in our simulations reflecting, as noted earlier, the increasing evidence in favour of the existence of regional "wage curves", or a bargained real wage curve. However, it is instructive to investigate the consequences if, instead, wages are determined in accordance with the national bargaining hypothesis, and we do this in Section 6.5. Section 6.6. provides a brief conclusion.

We conduct the simulations using the AMOS model that we discussed in some detail in Chapter 5. The migration parameters we use are based on the Layard *et al* (1991) specification of the net migration function.

6.2. The Flow model of migration.

6.2.1. Simulations with the default migration parameters.

In Table 6.2.1 we report the changes generated by the export demand disturbance over three conceptual time periods, namely the short-, medium- and long-runs The short-run corresponds to a period of time over which population and capital stocks are both fixed. The medium-run is a conceptual period during which population is optimally adjusted and the long-run allows complete adjustment of capital stocks.

Here we present the percentage changes in selected key variables as a result of the introduction of the 10% stimulus to manufacturing export demand.

The short-run effects of the export shock confirm the theoretical analysis and also offer quantitative estimates of the effects. The export demand stimulus increases GDP (by 0.68%), total employment (by more, 0.84%, since capital and population are fixed initially) and the real take home consumption wage (by just less than 1.00%).The increase in the real consumption wage necessary to increase employment, given bargained real wage (BRW) closure, pushes wages and prices up, so that there is some crowding out in the other sectors, through an induced reduction in net exports.

Two conflicting forces operate on the non-manufacturing sectors throughout. There is an adverse competitiveness effect, in the form of increased wages, as a result of the increase in labour demand and a positive effect in the form of increased demand from intermediate and consumption demands. The net effect on the system depends on the relative size of these two forces. In the short-run, the real wage effect dominates. The increase in labour demand increases wages but less than in proportion to domestic prices because import prices are fixed. The real wage to the firm falls and employment rises. But the real take home consumption wage rises because of bargaining, to induce an overall increase in labour supply.

Since migration has no effect in the short-run , the results are identical irrespective of the degree of labour mobility. In the short-run, most of the expansion is concentrated in the manufacturing sector as shown by the results in first column of Table 6.2.1. In the short-run, with fixed capital and population, the 10 percent increase in manufacturing export demand causes the demand for labour to increase, stimulating an increase in the real take home consumption wage by 0.98% from the base value. This increase in real wages is necessary to increase total employment by 0.84%, given the BRW function. The price of value added in the manufacturing sector increases by 4.21%, while in the other two sectors, prices increase by only 1.47% and 1.62%. Value added in the manufacturing sector increases (by 3.46%), while in the other two sectors, value added falls by 0.18% and 0.13% respectively. Since migration only affects population in the next period, there is no change in population in period one and the employment created by the increase in demand is fully absorbed by the indigenous population. (Equally, while investment is stimulated capital stock is not.) Simultaneously, the unemployment rate falls, by 8.29%. GDP rises by 0.68 percent as a result of the increased export demand that triggers local demand. Employment and value added increase by 4.22% and 3.46% respectively, in the manufacturing sector. While in the other two sectors crowding out occurs: in the non-manufacturing and sheltered sectors this effect generates a reduction in employment (by 0.24% and 0.15% respectively) and value-added (by 0.18% and 0.13% respectively). The intermediate and consumption demands are stimulated by the expansion of manufacturing sector. Here, however, the beneficial effects are more than offset by the wage increase. Capital stocks are fixed, so there is obviously no change in these, but the demand expansion causes an increase in capital rental rates. The greatest increase occurs in the manufacturing sector, where capital rental rates rise by 16.72%. In the non-manufacturing traded and sheltered sectors capital rental rates increase by 0.86% and 1.18% respectively. Exports from the (target) manufacturing sector increase by 5.48% since the initial 10% stimulus is partially offset by the induced increases in the wage and prices, while in the other two sectors exports contract by 2.15% and 2.90% respectively.

Next consider the medium-run, over which migration adjustments are complete (see column 2 of Table 6.2.1). The impact of the demand shock on output and employment rises relative to short-run. As we have seen, initially the real consumption wage rises and the unemployment rate declines, encouraging in-migration to Scotland from the rest-of-the UK (RUK). During this period, the positive effect of the increase in intermediate and consumption demand comes to dominate as the real wage is forced to return to its initial level, from the higher level established in the short-run. In the medium-run, over which the zero-net-migration condition becomes binding, the impact on GDP increases to 1.22% and that on total employment increases to 1.53% from the base period. The real take home consumption wage and unemployment rates return to their original equilibrium values. These results exhibit "natural rate" properties where the real consumption wage and the unemployment rate return to equilibrium values, as our theoretical analysis implies. Over the medium-run, the increase in the number of people coming into Scotland offsets the short-run rise in the wage. This constrains price rises in all sectors, thus reducing the crowding out effect in the other two sectors. Total employment in the non-manufacturing traded and sheltered sectors actually increase over the medium-run, by 0.61% and 0.22% respectively, while value added expands in these sectors by 0.45% and 0.19% respectively. The expansion in the manufacturing sector continues throughout: employment increases by 5.21% and value added increase by 3.66%. In addition, the stimulus to consumption demands (increase by 1.88%) actually outweighs the decline in the exports (-1.40%) of the non-manufacturing traded and the sheltered sectors (-0.94%) (see Table 6.2.1), so that all sectors expand over this interval. Since capital stocks remain fixed, there is no change in capital stocks, but the additional stimulus to activity over the medium run raises capital rental rates further. Capital rental rates increase by 18.93% in the manufacturing sector. While in the other sectors, they increase by 2.47% and 1.14% respectively. Exports from the manufacturing sector rise by more than in the short-run (6.21% as compared to 5.48%).

Finally, in the long-run, over which population and capital stocks are fully adjusted, the effectively infinitely elastic supplies of labour and capital limit all price rises to zero. The positive effect of the increase in demand from intermediate and consumption demands is the only effect that prevails in this case. The adverse competitiveness effects of real wage and price increases is non-existent over this interval because the increase in the real wage is limited to zero, and ultimately prices do not rise at all. The system now operates as an input-output (I-O) model[1] (augmented to accommodate endogenous population). Equal proportionate expansions in employment, capital and value-added occur within each of the three sectors. In the manufacturing sector employment, capital stock and value added all increase by 8.79 percent. While in the non-manufacturing traded and sheltered sectors they increase by 3.45 and 1.92, percent respectively. The manufacturing sector experiences the full 10% increase in export demand because there is no change in price in this case. The complete adjustment of capital stocks limits the change in

[1] These results are similar to the findings by McGregor et al. (1995).

capital rental rates in all sectors to zero over this interval. All sectors expand significantly and generate a 4.04 percent increase in GDP. Thus the long-run, steady state result has the characteristics of a solution to an (augmented) I-O model. This is a key feature of system-wide responses to demand disturbances under the flow adjustment model of migration.

In Table 6.2.2 we provide the results of the demand stimulus on key economic variables at several time periods, using the multi-period simulation capacity of AMOS. We present the results for periods 1, 5, 10, 20, 30, 40, 60, 80, 85 and 90 to illustrate the variations over time. The period one result is identical to the short-run equilibrium discussed above. The increase in wages and the fall in the unemployment rates both attract migrants into Scotland in period one, but population expansion begins to take effect only in period 2. In period 5 population has expanded by 1.26 percent from base; that is about 65 thousand people come into Scotland from RUK by period 5. This is a response to the increase in wages and reduction in unemployment rates triggered by the 10% increase in manufacturing export demand. Also in period 5 value added has increased by 5.73 percent (from the base) in the manufacturing sector. While in the other two sectors value added has increased by 0.61% and 0.37% respectively. Note that the crowding out that occurs in the other two sectors in period 1 is eliminated by period 5. Although the exports of the non-manufacturing traded and sheltered sectors continue to fall from the base value these two sectors actually experience an expansion in value added through the stimulus to intermediate and consumption demand as in-migration and capital accumulation limit wages and price increases, so that beneficial demand effects are strengthened relative to the adverse influence of trade crowding out through price and wage rises.

Population has increased by the same proportionate amount as the increase in total employment from period 60. It is "as if" the increase in employment is absorbed by the migrants that come into Scotland from RUK. Equi-proportionate expansions in employment, capital and value added of the three sectors occur from period 60. Population stops increasing from period 80 onwards which corresponds to zero change in prices and real take home wage. As the real wage (and prices) and unemployment rates return to the old equilibrium level, no further migration into

Scotland from RUK occurs. GDP only settles to the long-run steady-state value at period 85, while capital stocks in the manufacturing sector only settle down to the steady state value (8.79% from base) at period 90. It takes 90 periods for the complete adjustment of the economy to occur as a result of the demand stimulus. While a very long period is required for complete adjustment, most of it is over fairly rapidly. For example more than 90 percent of the adjustment occurs by period 30, while about 50 percent of adjustment occurs by period 10.

Figure 6.1 shows the dynamics of the adjustment. On the whole, most of the adjustments occur in the earlier time periods. There is a gradual increase in GDP and total employment; both reach 90 percent of the long-run steady state value around period 30. The real take home consumption wage rises the most in period one. This is a response to the initial increased labour demand. After period 1 the real take home consumption wage falls gradually towards its original equilibrium value. Simultaneously the unemployment rate initially falls and then gradually increases towards the old equilibrium rate. In period 1 the unemployment rate falls by the greatest percentage (-8.29% from the base value). From period two onwards the unemployment rate rises (although it remains below its base value) and moves gradually towards its original level. Initially the increase in the real wage and the falling unemployment rate attract migrants into Scotland from RUK that creates further stimulus to demand and therefore employment. Simultaneously there is even greater stimulus to labour supply. This implies that the level of employment rises, but by less than labour supply so that the employment rate falls (and the unemployment rate rises). Under the bargained real wage closure the real wage falls as the unemployment rate rises. By period 5 GDP rises to 1.69% from base and employment increases by more (1.83% from base). In periods 10 through 80 GDP keeps increasing until it reaches 4.03% higher than the base. Total employment increases by more (4.10%) and reaches the long-run steady state value by period 80. In the long-run, the I-O results are established, eventually there is zero change in prices and wages, and in each sector, capital, labour employment, value added and output change by same percentage.

In the next sub-section we conduct sensitivity tests of the impact of the 10% increase in manufacturing exports to changes in migration elasticities with respect to both the real wage and the unemployment rate.

6.2.2. Sensitivity Analysis.

We report the results in terms of the induced changes in GDP, real take home wage, unemployment rate and total employment. We use the Layard *et al* (1991) (LNJ) migration model with default parameters (real wage elasticity, α_1=0.06, and unemployment rate elasticity α_2=-0.08) as the basis of comparisons. The demand disturbance that we continue to use is the 10% increase in manufacturing exports. Note that despite the different signs attributed to the real wage and unemployment rate parameters due to their different impact on the net migration function, we discuss the impacts in terms of their absolute values. In our simulations we find that the steady state value of all the endogenous variables is insensitive to the choice of key parameters of the migration function. This is expected because our theory implies that, with the LNJ flow specification of the migration function, results should converge to a unique equilibrium, with elasticities simply affecting speed of adjustment. Figure 6.2 confirms the theory that changes in the degree of mobility have no effects on the final equilibrium level of GDP in the flow model. Notice that the larger the absolute magnitude of the parameters (α_1 and α_2), the more accessible is Scotland's labour market and the larger the short-run impact is.

To assist in the interpretation of our sensitivity tests we calculate the net present value (NPV) of GDP changes generated by the stimulus to exports. The NPV of GDP varies directly with the speed of adjustment. We calculate the NPV as follows:

$$NPVGDP_t = \sum_{t=1}^{90} \frac{GDP}{(1+r)^t} \qquad t=1,....,90.$$

Where: NPV is the net present value and r is the discount rate. The discount rate we employ is the 6% rate which is currently recommended by the UK Treasury (H M

Treasury, 1991). We report the results in Table 6.2.3[2]. Moving from left to right in a row indicates NPVGDP is not terribly sensitive to the changes in the elasticity of migration with respect to real wage, α_1; but moving down a column shows it is very sensitive with respect to unemployment rate elasticity α_2. For example (see column 4) increasing the absolute unemployment elasticity from 0.05 to 0.10 causes NPVGDP to increase by about £15 million but doubling α_1 from 0.06 to 0.12 only increases GDP by about £1.7 million (with the default unemployment elasticity). The impact of the demand stimulus is highest on NPVGDP (increased by about £176 million) when the unemployment elasticity is -0.40 and α_1=0.25. This should be contrasted with the £152.1 million increase when default values of α_1 and α_2 are assumed. The demand shock causes the demand for labour to increase, so the unemployment rate to falls while the real wage rises simultaneously. This induces in-migration into Scotland from RUK and increases Scottish population, as we have seen in our earlier discussion of results.

We summarise the demand shock impact on NPVGDP in Figures 6.3 and 6.4. In Figure 6.3 we show the magnitude of adjustment relative to α_1 and α_2. Clearly the impact of the 10% increase in manufacturing export demand on the NPVGDP is sensitive to the changes in the migration parameters with respect to real wage and unemployment and unemployment rates. The impact of the 10% increase in manufacturing export demand on NPVGDP is less sensitive to changes in α_1 than α_2. As α_1, the (absolute) real wage elasticity moves closer to zero, the migration parameter with respect to unemployment becomes more important in influencing the net migration behaviour relative to the real wage influence. Hence at α_1 = -0.01 the change in NPVGDP as we vary α_2 is greater than when α_1=-0.13.

Next, as we move α_2 towards zero, for example at α_2 = -0.03, the impact of the export demand stimulus on NPVGDP becomes very sensitive to changes in α_1. This is so because α_2 now is very close to being inelastic and hence the influence of the real wage now dominates. To highlight this effect let us consider the change in NPVGDP when we vary each elasticity. To show the relative dominance of α_2 we

[2] We use different combinations of the real wage and unemployment rate elasticities because we want to include as many variations as possible. Further more the extend to which the real wage elasticity can

evaluate its effect when α_1=0.13 (since the increase in NPVGDP is smallest at this level of α_1) and compare this with the increase in NPVGDP when α_2= -0.03 where the change in NPVGDP as we vary α_1 is at its greatest. As we move α_1 from 0.03 to 0.13 (α_2=-0.03) the NPVGDP increases by £8440 thousand whereas changing α_2 from -0.03 to -0.13 when α_1= 0.13 results in an increase in NPVGDP of £27,930 thousand.

Where NPVGDP is greater than the NPVGDP calculated with default values of parameters this implies that the speed of adjustment is faster (since GDP levels once final equilibrium is attained are equal irrespective of elasticities) and of course were equal prior to the (export demand) shock.

Figure 6.4 gives clear representation of the export demand shock on NPVGDP in a slightly different way. Here we show how the NPVGDP changes as we vary the unemployment elasticity, α_2 while fixing the real wage elasticity α_1 at the respective values. The NPVGDP seems to be more sensitive to changes in the unemployment elasticity than to the real wage elasticity as the Flow theory depicts. The way we change the elasticities of migration with respect to real wage and unemployment is constrained by the LNJ migration parameters and real wage function that we use. Recall that the LNJ net migration function suggests that migration is more sensitive to unemployment differential than to real wage differential between Scotland and RUK. We limit the increase in real wage elasticity to 0.25 because above that our simulation gives erratic result and later breaks down. As for the unemployment elasticity we limit the increase to 0.40 after which the simulation breaks down. However we limit the discussion of our results to α_1 = 0.13 and α_2= -0.15 because at higher absolute values of α_1 and α_2 the NPVGDP does not differ much.

6.3. The Stock Adjustment Model of Migration.

6.3.1. Simulations with the default migration parameters.

The stock adjustment model assumes migration depends on changes in the real wage and unemployment rate differentials. In the net migration equation, the

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be expanded is different from that of the unemployment rate elasticity.

coefficient on log real wage differential is 0.06 and coefficient on log unemployment rate differential is -0.08. Table 6.3.1 compares the results of the impact of the 10% change in manufacturing export on key economic variables using the Layard *et al* (1991) flow-adjustment (FA) and stock adjustment (SA) models over the short- and long-run periods. The short-run results with SA models of migration are identical to the short-run FA results that we discussed earlier because migration has no impact over this interval. It is the medium-run and long-run steady-state results that vary significantly between the two models.

The last two columns of Table 6.3.1 compare the long-run steady state impacts of the 10 percent increase in the demand for manufacturing export on the LNJ and SA models. The long-run results we obtain are radically different from the long-run flow results in magnitude, are also associated with different adjustment speeds, and are quite different qualitatively. In the "long-run", over which interval both capital stock adjustment and migration is complete, with the SA model the impact of the demand stimulus on GDP is comparatively small[3] (as can be seen from Table 6.3.1) compared to the impact when the flow (FA) model is used because migrants are now responding to ***changes*** in the real wage differential and the unemployment rate differential between Scotland and RUK. Our findings confirms our stock adjustment theory that, with heterogeneous migrants, the migration process may have radically different implications for the behaviour of the regional macroeconomy. The real wage in Scotland may be higher than before, and the unemployment rate lower than before, but only some individuals will be attracted to migrate into Scotland, given the heterogeneity assumption. Whereas in the FA model, migrants are assume to be homogeneous, and so it is "as if" migration into Scotland becomes attractive to all. Hence the increase in real wage and fall in unemployment rate in Scotland, attracts in-migration into Scotland continuously until the initial real wage and unemployment rates are re-established.

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[3] Thus our findings confirm our theory that migration in the LNJ model is a continuous process that goes on until the old equilibrium (position A in Figure 4.1 of Chapter 4) is re-established. While in the SA model (given the constraint that migrants respond to a one time change in real take home wage and unemployment differentials), migration is not a continuous process, it responds to a one time

GDP increases by only 1.66 percent with the SA model but GDP increases by more than twice as much (4.04% from base) with the FA model. Similarly, total employment increases by much more (4.10%) when the FA model is assumed in the simulations than it does when this is replaced with the SA model (by 1.61%).

Referring to the last SA column of Table 6.3.1, the 10 percent increase in manufacturing export demand induces the real take home consumption wage to increase (by 1.34%) and the unemployment rate to fall by more 11.13%. This steady state result implies that the SA model does not imply the idea of "compensating differentials" where the unemployment rate may need to be high in order to compensate for high-wage attractive region, in contrast to FA model. The increase in population (by 0.48%) due to net in-migration into Scotland is not identical to the increase in total employment (1.61%) but in the FA model it is (both increase by 4.10% from base). This implies that it is "as if" migrants absorb the increase in employment in the flow (FA) model. While in the SA model it seems that more jobs are created than the migrants could absorb, hence most of the jobs created are for local people.

In the long-run, employment in all three sectors increases in the stock-adjustment model. In the manufacturing sector employment increases by 8.79%, while in the non-manufacturing trading and sheltered sectors employment increases by 3.45% and 1.92% respectively, with the flow-adjustment model of migration. But in the SA model employment in the manufacturing and non-manufacturing traded sector increases by much less (6.21% and 0.48% respectively), while employment in the sheltered sector falls by 0.06%. The employment results are different between the two models because in the FA model the long-run results converge to I-O and all effects must be non-negative given zero wage and price changes. In the SA model, this wages increase even in the long-run equilibrium, because migration does not continue until the initial wage and unemployment rate is restored. Here this offsets other stimuli to the sheltered sector. As mentioned above, GDP in the long-run increases in both models but the magnitude is much larger with the LNJ (FA) model: more than double that with the SA model. This finding is consistent with our theory

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change in the factors that affects it and stays there, establishing a new equilibrium position, such as B' that macroeconomic impacts are larger with the FA model than with the SA model because in the FA model it is "as if" labour is in infinitely elastic supply, while it remains to a degree, region-specific in the SA model.

Exports to RUK (and ROW) do not increase by the full 10 percent impact in the long-run under the SA specification (unlike in the long-run solution to the FA model). The real take home consumption wage increases permanently because the unemployment rate is permanently reduced, which adds to production costs and so to prices Crowding out occurs in the other two sectors in terms of export demand because of higher prices, but simultaneously employment and value added actually increase in the non-manufacturing traded sector because of the stimulus to demand from, for example, intermediate and consumption demand. The exports from the non-manufacturing and sheltered sectors fall by 2.42% and 3.29% (from base values) respectively. In the LNJ (FA) model, in contrast, the manufacturing export sector ultimately receives the full 10% impact and there is equi-proportionate expansion in value added, employment and capital stocks in all the three sectors. Price increase are constrained to zero and there is no change in capital rental rates or wage rates and hence in value added prices. Hence, with the FA model, the export crowding out which occurs in the non-manufacturing and sheltered sectors during the impact (and possibly medium-run periods, see Table 6.3.1 again) disappears in the long-run. With the SA model export crowding out remains in the other two sectors but is offset by the expansion of intermediate and consumption demand in the non-manufacturing trading sector, in which employment and value added expand. Hence with the SA model both the manufacturing and non-manufacturing sectors actually expand in terms of production and employment. In the sheltered sector, as for non-traded sector, there are two opposing forces and the outcome depends on balance between the increase in intermediate and consumption demand, and the increase in wages and its adverse impact on competitiveness.

The manufacturing sector expands because of the increase in export demand while expansion in the non-manufacturing trading occurs because demand (for consumption goods by both indigenous and migrant populations) and intermediate

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(see Figure 4.2 of Chapter 4).

demand in general has increased. However the expansions are not equi-proportionate in nature, as they are in the Flow model because, as mentioned earlier, wages and prices (in the SA model) never return to the original equilibrium level. In this model labour remains a "scarce" factor even in the long-run, and so wages and prices rise permanently and there is also substitution away from labour in favour of capital. Referring to the last column of Table 6.3.1, in the long-run capital stocks in the manufacturing sector increase by 6.66%, while employment increases by 6.21%. In the non-manufacturing traded sector capital stocks increase by 0.91% and employment increases by 0.48%, while in the sheltered sector capital stocks increase by 0.37% and employment actually falls, by 0.06%.

Next we consider the multi-period results of the stock adjustment model of migration apparent from Figure 6.5. In the stock adjustment model the steady state result is achieved faster than in the flow model.[4] Figure 6.5 shows the impact of the demand stimulus on GDP, real take home wage, unemployment rate and total employment when the SA model is used. GDP increases steadily from period one and completes almost 70 percent of the adjustment by period 5. The 10% increase in the demand for Scottish manufacturing exports initially expands labour demand, and as a result the real take home wage increases to stimulate employment. Simultaneously the unemployment rate (defined as unity minus the employment rate) falls. Migration flows only affect population in the next period. Hence the increased employment will initially be absorbed by the indigenous population. The initial increase in GDP is contributed by the increase in export demand and increase in local demand. In period 5 (see column 2 of Table 6.3.2) population has expanded by 0.38 percent from base (and assuming that the population change occurs only through migration): migrants then contribute to the increase in GDP through consumption spending. GDP reached more than 70 percent of the total adjustment by period 5. Almost 95 percent of the total adjustment of GDP occurs by period 20. Due to the increase in manufacturing export demand, exports from the manufacturing sector to RUK increase by 5.48% in period 1. More than 90 per cent of the full adjustment of the manufacturing exports

[4] The steady state value is arrived at by period 30 in the SA model and about period 90 in the LNJ (LNJ is interchangeably refer to as the Flow or FA model) as our subsequent simulations show.

occurs by period 5, where it increases by 7.13%. In the other sectors, exports decline through out the adjustment period.

The real take home wage increases the most in period 1 after which it levels out towards its long-run steady state value, which is, of course, greater than its initial value. The failure of the real take home wage rate to return to its initial equilibrium level confirms our theory in Chapter 4[5]. Initially, the migration effect dominates, as migrants come into Scotland responding to the increase in real wage and fall in the unemployment rate which occur in the impact period. However, the in-flow is not sufficient to bring down the employment relative to labour force as in the FA model. The unemployment rate falls steadily after period 2. Thus unemployment seems to fall despite in-migration which implies that capital stock adjustment effect dominates. Almost 90 percent of the total adjustment in the unemployment rate and the real wage occurs by period 5.[6]

Finally, but importantly, the impact of the demand shock on prices is permanent in the SA model. This explains why the manufacturing export sector does not receive the full 10 percent increase in real terms, in contrast to the flow model. In other words the price changes in the SA model do not converge to zero as in the Flow model, and wages remain higher than in the original equilibrium. As a result, the unemployment rate does not return to the initial equilibrium value so that no NAIRU is established. Thus the steady state solutions of the SA model do not converge to the I-O results, unlike with the Flow (LNJ) model. The steady state result occurs at period 30 in the SA model (as in Figure 6.5) but in the LNJ (FA) model it occurs at period 90 (see Figure 6.1 of the Flow model above).

We present the percentage changes in selected key economic variables as a result of the introduction of the 10% demand shock on the SA model at various time periods in Table 6.3.2. The period one result is identical to the period one result of the flow model discussed in the previous section. Migration flows occur during period one but stocks are only affected in the next period.

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[5] The real take home consumption wage does not return to the original level in the SA model but in the flow model it converges to the original equilibrium.

By period 5 GDP has increased by 1.26% from the base value (mainly contributed by the expansion in the manufacturing exports and induced consumption demand, which rise by by 7.13% and 2.23%, relative to base, respectively) while total employment increases by more (1.32%). Ultimately, of course, all expansions are due to the increase in manufacturing exports which is the exogenous disturbance we applied to the system. The employment in the target manufacturing sector expands by the most (5.52%). Employment expands in the non-manufacturing trading sector by 0.15% but in the sheltered sector it improves from the period one result, but is still lower than the base value even in the long-run (-0.06% from the base value). As expected, value added in the manufacturing sector expands the most (by 5.27% from the base). In the other two sectors value added also improves relative to the impact effect. The non-manufacturing traded sector improves markedly relative to its position in the first period, while in the non-manufacturing non-traded sector value added has also improved (relative to the the period 1 result) although it is still lower than the base value (by -0.03%).

By period 10 GDP has increased by 1.51 percent and total employment rises by less (1.50% from base). The increased population helps to increase the demand for local goods further hence increasing GDP. Throughout the adjustment period substitution of capital for labour occurs because of the higher real wage, and eventually the change in capital is greater than the change in value added, which in turn is higher than the change in employment. Employment in the target manufacturing sector increases by the most (6.01%); while it more than doubles the employment rate of the period 5 results in the non-manufacturing trading sector. However, by period 10 employment in the sheltered sector falls, by -0.07% from the base. More migrants come into Scotland during this period, this further expands the population (by 0.44% from base). By period 20, more than 90 percent of the capital stock adjustment has occurred. As a result the capital rental rate in the manufacturing sector falls although it is still higher (by 2.36%) than the base value.

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[6] Comparatively in the flow adjustment model unemployment rate returns to the original rate as shown

By period 20, the capital stock in the manufacturing sector increases by 6.60%. This causes the return to capital to fall further relative to period 10, although it is still higher than the base value by 0.76%. The other two sectors also experience an increase in capital stocks (by 0.59% and 0.30% respectively) which causes smaller returns to capital in those sectors (but they are still higher than the base values by 0.70% and 0.61% respectively). Total employment increases by 1.60 percent. The greatest impact is on the target, manufacturing sector that experiences a 6.19 percent increase. Crowding out of employment in the sheltered industry[7] stays at around -0.06 percent (from base) but in the non-manufacturing sector employment has actually increased (by 0.46 percent from base).[8] Value added increases further; in the manufacturing sector it increases by 6.26 percent and in the non-manufacturing trading sector it increases by 0.56 percent. While in the non-manufacturing non-trading sector value added has improved from period 10 but is still lower than its base value (by -0.01%).

Simultaneously, the unemployment rate falls (by -11.04 percent) causing an increase in real take home consumption wage (by 1.33%). Hence the unemployment rate falls by about ten times[9] the increase in real wage (in percentage terms). This finding is important to policy makers because the demand stimulus causes the unemployment rate to fall by about the same amount as the stimulus to demands over this interval. The fall in unemployment rate by 11.04 percent from the base value is relatively significant especially in the small (Scotland) region context where the unemployment rate is usually higher than the national level (UK as a whole)[10]. Full adjustment of the population occurs at this period: by period 20 migrants stop coming into Scotland.

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in the sub-chapter that discuss the FA model.

[7] This is because the real wage increase is as yet incomplete (i.e. it has not yet reached its long-run steady state value).

[8] In fact in the non-manufacturing sector crowding out stops by period 5; the induced demand from migrants and increased local demands due to increased real take home wage actually expands this sector.

[9] This result confirms the BRW relationship we used in this study. Referring to the LNJ BRW function (see AMOS chapter), a 1% change (fall) in the unemployment rate causes real take home consumption wage to increase by only 0.1%.

Finally, by period 30, full adjustment occurs, and the economy settles at the new long-run equilibrium as suggested by the theory. Consumption demand has increase by 2.55 percent, which contributes to the increase in GDP. Exports from the manufacturing sector receive a long-run 8.04% boost from the (10%) export demand stimulus. Total employment increases by 1.61%, with maximum impact (as expected) on the manufacturing sector in which employment increases by 6.21% (as compared to 8.79% under the FA model). Employment in the non-manufacturing trading sector expands (by 0.48% from base) but employment in the sheltered industry falls (by 0.06%). However, the fall is less than the period one fall (0.15% from base).

The price of value added in the manufacturing sector declines markedly relative to period one, although it is still higher than the base value. While in the other two sectors the prices of value added have increased from the period one values because demand for these sectors output increases through time as the wage increase is moderated by in-migration and capital stock expands (especially in manufacturing). The increased demand from both consumption and intermediate consumption extends into the non-manufacturing sector while the sheltered sector mainly expands via a consumption effect. Hence, in the long-run with the SA migration model, the real consumption wage is permanently higher as labour is region-specific, implying higher prices. The higher prices mean lower exports. In contrast, in the flow model discussed above, the real take home wage and prices return to the initial equilibrium level.

The above results show that adjustment is more rapid under the stock adjustment model of migration, but the impact on output and employment is much greater under the flow-adjustment model of migration.. On the other hand, the impact on the unemployment and real wage rates is obviously much greater under the SA model (since the changes equal zero in FA model in long-run). With the SA model the policy maker can observe 90 percent of the impact of their policies within a fairly

[10] The unemployment rate in Scotland is in general relatively higher than the unemployment rate in UK as shown by Figure A.

short time period, in contrast to the FA model. Given the typically short-run focus of policy, this difference may be of considerable significance.

6.3.2. The Impact of the Demand Disturbance with Variations in the Migration parameters.

In this sub-section we change the "elasticity" of migration with respect to the real wage and unemployment differentials to explore how this affects the impact of the stimulus to manufacturing export demand. We concentrate on the long-run steady-state impact of such variations. Column 1 of Table 6.3.3 provides the results when we run the simulations of stock-adjustment (SA) model with Layard *et al* (1991) (LNJ) default parameters. We call this the LNJSA default case, which we have discussed in the preceding sub-section. Columns 2 through 7 of Table 6.3.3 provide the steady-state results of the impact of a 10% increase in manufacturing exports on key economic variables as we vary the elasticities of migration with respect to the real wage and unemployment rates.

In column 2 we set the real wage elasticity, rw equal to 0.01 and the absolute value of the unemployment elasticity equal to 0.05 (both lower than the default parameters). The 10 percent increase in the export demand causes GDP to increase by 1.54% as compared to 1.66% when default parameters are use. Total employment increases by 1.49 percent from the base value. The greatest impact is on the manufacturing sector which expands by 6.16 percent from the base. As expected the result is smaller in magnitude than the LNJSA result because we are using absolute parameters smaller than the LNJ defaults. Employment in the non-manufacturing trading sector increases while that in the sheltered sector falls. Value added expands in the manufacturing sector by 6.16 percent while in the non-manufacturing trading sector it expands by less (0.45% from base). In the sheltered sector value added falls (by -0.10%). The price of value added increase in all the three sectors. The magnitude of the impact on prices is greater here because the real take home consumption wage increases by more than in the LNJSA results and unemployment rate falls by more (11.67%).

Next in column 3 we increase the real wage elasticity, α_1 to 0.04 and set the absolute unemployment rate elasticity, α_2 equals to 0.08. The results we get do not differ much from the default values. This is because we are using the unemployment elasticity identical to the LNJSA default parameter. In column 4 we increase the real take home wage elasticity to 0.06 (the default real wage elasticity) and set the absolute unemployment elasticity to 0.12. This results in bigger macroeconomic effects than in the LNJSA case. The equilibrium level of GDP increases by 1.77% from base. This is mainly contributed by the expansion in the exports to RUK and ROW and also from the increased consumption demand (by 2.62% from base). Value added in all the three sectors expands, in contrast to the default case. In the manufacturing sector value added expands by 6.41%, while in the non-manufacturing traded and sheltered sectors value added falls by 0.73% and 0.09% respectively. Notice that pointing this case, even the sheltered sector expands (in employment and value added) whereas in the LNJSA results it contracts. The real take home wage increases by less than in the default case (by 1.27% from base value) so as to raise employment, especially in the target manufacturing sector (by 6.34% from base). Simultaneously, the unemployment rate falls by less (by 10.61%) as greater in-migration limits the extent of this and wage increase. Notice that the steady state unemployment rate does not return to the old equilibrium level. As discussed in our theory, the solution for our SA model will not converge to the old equilibrium solution because of the nature of our SA migration model (migrants respond to a one time change in real take home consumption wage and unemployment rate between Scotland and RUK). As a result, the real wage and the prices of value added in all the three sectors increase permanently .

In columns 5 and 6 of Table 6.3.3 we set the real wage elasticity equal to 0.07 and 0.09, respectively and set the absolute value of the unemployment elasticity to 0.15 and 0.20 respectively. The general descriptions of the results of the key economic variables are as before except with greater magnitude. In column 6 consumption demand increases by 2.75 percent from base and value added increases in the three sectors. Correspondingly, the prices of value added in the three sectors are lower than in the LNJSA results (although they are still higher than their base values). Exports to

RUK and ROW from the manufacturing sector rise to 8.30% from the base. However this is only about 3.00% higher than that of the LNJSA result. GDP increases to 1.97% from base, which is about 4.00% higher than that of the LNJSA result.

As we increase the migration parameter with respect to the unemployment rate away from the LNJ default parameter while fixing the real wage elasticity we find that the magnitude of the impact increases. However there is a limit to this because when we increase the absolute unemployment elasticity further than 0.25 (while maintaining real wage elasticity), our simulation breaks down.

Our simulation results above suggest that the impact of the 10 percent increase in manufacturing exports is very sensitive to the variations in the migration parameters with respect to real take home consumption wage and unemployment rate. Moving (see column 2 through column 7 of Table 6.3.3) from the left to right we see that as we increase both the elasticities of real take home consumption wage and unemployment rate away from the LNJSA default parameters we obtain steady state solutions that are greater in magnitude than the results given with the LNJSA default assumptions, though all remain lower than those of the "flow" model results.

Figures 6.6 through 6.11 confirm our findings. As we move away from the LNJSA default parameters the magnitude of the impact on GDP increases in the expected direction. However note that the increase is not equi-proportionate. This is clearly shown by columns 1 and 4 of Table 6.3.3 where we set both real wage elasticities equal 0.06 but we increase the absolute unemployment elasticity in column 4 by 50 percent relative to that of column 1. The results show that GDP of column 4 increases by about 6 percent more than the increase in GDP of column 1.

We now consider how the sensitivity changes as we fix the migration parameter with respect to real wage but vary the unemployment rate elasticity. Figures 6.8, 6.12, 6.13 and 6.14 show how the demand stimulus affects GDP, real take home consumption wage, total employment and unemployment rate respectively, when we fix α_1 at 0.06 and change the absolute value of α_2 from 0.05 to 0.25. The results confirm the above finding that as we move α_2 away from its LNJSA default value, the magnitude of the impact increases. Figure 6.8 shows GDP increases as we increase α_2 from 0.05 to 0.25. However the impact on GDP is quite erratic during the first 17 periods with α_2 set equal to 0.25. Figure 6.12 shows how the impacts on the real take home wage vary as we change α_2 as before. Similarly the first seventeen periods' impacts are rather unstable when α_2 is at 0.25. However the result stabilises soon afterwards and reaches the steady-state value by period 20. Figures 6.13 and 6.14 show how the impact on total employment and unemployment rate rises and falls respectively as we increase the absolute value of α_2 from 0.05 to 0.25. Again instability of the impact occurs in the first 17 periods of the adjustment time when α_2 equals 0.25. These results suggest that the impact of the demand stimulus on GDP, real take home consumption wage, total employment and unemployment rate respectively is sensitive to changes in the unemployment elasticity, α_2.

Next we fix the absolute value of α_2 and change α_1, the real take home wage elasticity to see how the sensitivity of the impact changes as we vary α_1. When we fix α_2 absolute and vary α_1 accordingly we find the magnitude of the impact of the demand stimulus does not change very much. In Figure 6.15 when the absolute value of α_2 equals 0.05 and α_1 varies from 0.01 to 0.13, the impact of the demand stimulus clusters together quite differently from the default impact. When we fix the absolute value of α_2 at 0.08 (the default α_2) the impact on real take home consumption wage does not vary much from the default value (see Figure 6.16). As we increase the absolute value of α_2 to 0.25 and vary α_1 as before the result shows that the impacts of the demand stimulus on real take home consumption wage moves further away from the default result, but between them the impact does not vary much (see Figure 6.17).

6.4. The impact of the demand stimulus if there is zero labour mobility.

We provide the short-run and long-run equilibrium results of the impact of the 10 per cent demand stimulus on key economic variables in Table 6.4.1. The short-run results are identical to those of the flow and stock adjustment models, since migration has no impact immediately.

Since here there is "no migration" as labour demand increases, the real take home wage increase is not moderated by in-migration. So, the scale of effects here is smaller in the long-run than in both the FA and the SA cases. For example, GDP increases by, 4.04% in the flow model, by 1.66% in the stock adjustment model and in the zero mobility case GDP increases by only 1.33%. In the long-run, the impact of the demand stimulus on the real take home consumption wage differs markedly among the three models. In the flow model, there is zero increase in the real take home wage, implying the initial equilibrium wage rate is restored and thus the crowding out which occurs in earlier periods is eventually eliminated. In the stock adjustment model, in contrast, the real take home wage finally increases by 1.34%, implying some crowding out that occurs in the sheltered sector remains. (But the extent of this is moderated by the presence of in-migration). Finally, with zero mobility greater crowding out occurs because the real take home wage increases by the most, 1.53%. The increase in wages due to the increase labour demand is entirely offset by in-migration in the flow model, as migration continues until the initial equilibrium real wage and unemployment rates are restored. In contrast, the increase in wages in the stock adjustment model is only partially offset by in-migration because this does not continue until the initial equilibrium is restored. Conversely in the zero mobility case, there is no in-migration, hence there is no increase in the labour supply to limit the increase in the wage rate in response to the demand stimulus. As wages increase, employment crowds out exports in the other two sectors, and workers are attracted to the manufacturing sector. In the other two sectors, expansion occurs mainly due to demand from consumption and intermediate goods. The crowding out subsides totally from the two sectors in the flow model, but in the stock adjustment model, crowding out remains in the sheltered sector, in which employment falls by 0.06%. In the zero-mobility model, greater crowding out occurs in the sheltered sector where employment falls by 0.33%. Also, the unemployment rate in the flow or FA model returns to the initial equilibrium level, establishing a NAIRU, while in the stock adjustment model, unemployment rates fall by 11.13% and in zero mobility case, the unemployment rate falls by more (12.60%). The unemployment rate falls by the most in the zero mobility case because there is no-migration, and the increase wages increase the employment rate (thus reduceing the unemployment rate).

Price increases are limited to zero in the FA model, while in the SA model and zero mobility model, the cpi increase by 0.68% and 0.77% respectively. In the FA model employment, value added and capital stock increase by the same percentage in within each of the three sectors, establishing Input-Output results. But with the SA model, in manufacturing and non-manufacturing traded sectors employment increases by 6.21% and 0.48% respectively, while capital stocks increases in these two sectors by more, 6.66% and 0.91% respectively. These results imply that substitution in favour of capital away from labour occurs. In the zero mobility case, employment in manufacturing and non-manufacturing traded sectors increase by 5.86% and 0.08% respectively, while capital stocks in these sectors increase by 6.38% and 0.57%, which implies a greater substitution in favour of capital and away from labour. With the labour market constrained by zero mobility, obviously expansion will be towards capital intensive production.

Notice that the 10 per cent impact of the export stimulus is fully realised in the FA model because price increases are ultimately eliminated. In the SA model the increase in prices limits exports increase in the manufacturing sector to only 8.04%. While the other sectors' exports contract. With zero mobility, the increase in prices limits the increase in exports to only 7.77% in the long-run, while in the other sectors exports contract by 2.74% and 3.74% respectively.

Figure 6.18 shows the dynamics of adjustment. Notice that GDP, real take home wage, total employment and unemployment rate reach more than 90 per cent of the long-run steady state values by period 10.

6.5 Simulations with the default migration parameters under the national wage bargaining closure.

As noted earlier, while the evidence is increasingly suggesting the presence of regional wage bargaining, it is instructive to explore the impact of national wage bargaining for our analysis. Recall that this labour market closure takes wages to be determined within an integrated bargaining system, and implies that nominal wages are exogenous to small, open regions such as Scotland. This is the assumption that many earlier studies of regional macroeconomies were predicated upon. Our theoretical analysis suggested that the impact on GDP and other economic variables should be higher initially as real wages actually fall in response to a demand stimulus. Strictly, the overall impact on migration is ambiguous, but the major unemployment rate reduction dominates. In the long-run, however, the national bargaining system should converge on the regional bargaining system under flow migration, because in these circumstances prices do not change, and the distinction between the bargaining systems becomes irrelevant. Under a stock-adjustment view of the migration process, this equivalence does not hold. In what follows we concentrate on emphasising the main differences that would arise in the national bargaining case.

6.5.1. The Flow-Adjustment (FA) Model.

Table 6.5.1 shows the impact of 10% increase in manufacturing exports on key economic variables at various time periods with the national wage bargaining closure, with the flow adjustment model. We show the impact at time periods 1, 2, 10, 20, 50, 80 and 90. The impact on GDP under national bargaining is more than double that under regional bargaining in period 1. The nominal take home wage does not change. The increase in demand attracts employment in all sectors especially in the manufacturing sector, where employment increases by 5.60%. Capital rental rates increase in all sectors, but obviously capital stocks remains unchanged. Exports to RUK from the manufacturing sector increase by 6.40%, while they contract in the non-manufacturing traded sector and sheltered sector by 1.37% and 0.85%. Not surprisingly, these results are favourable relative to the BRW case reported in Table 6.3.1, because here the adverse competitiveness effects that arise through the hike of the real wage are not present in this case: indeed the real consumption wage actually falls as prices rise with the nominal wage fixed.

The increase in demand causes price to increase, and since there is no change in nominal take home wage, the real take home wage actually falls. This condition persists until period 20. Notice that the long-run steady state values are achieved more rapidly under national bargaining than under regional bargaining. With national bargaining total adjustment is reached by period 50, while it takes until about period 90 for full adjustment with the regional bargained real wage (BRW) closure. Similar to the BRW closure, the long-run results approach the Input-Output results, as there is equiproportionate increase in capital stocks, total employment and value added in all the three sectors.

Figure 6.19 shows the dynamic of the adjustment. Notice that real wage falls initially and but gradually increases throughout the adjustment period until it returns to its original equilibrium level. The unemployment rate falls by the most in period one, after which it begins to increase towards its initial equilibrium rate. GDP and total employment increase gradually throughout. The increase in demand for manufacturing exports causes CPI to increase initially. Since the regional nominal take home wage does not change because of our restriction (that wages are determined at national level) the real take home consumption wage actually falls initially. The unemployment rate falls; the increase in demand for manufacturing exports increases the demand for labour hence reduces unemployment rate. The increase in labour demand attracts migration into Scotland, but as more people come into Scotland, the employment to labour force ratio falls thus unemployment rate later moves toward the initial equilibrium rate.

Figure 6.19a shows the impact when the export shock is applied, but with fixed capital stocks (to allow simulation of adjustment paths to a medium-run equilibrium). Notice that the expansion in GDP, and total employment is being restricted by the fixed capital stock. The increase in export demand increase the general demand for consumption goods and intermediate goods. This increase in demand means producer are encouraged to produce more, hence employing more labour and capital goods. But because capital stocks are fixed, the increase in demand will lead to increase in capital rental rates. Expansion in the key economic variables is thus constrained by the existing capital stocks. Unemployment rate falls initially but not as much as in Figure 6.19 where the restriction on capital stocks is not imposed.

6.5.2. The Stock-Adjustment (SA) Model.

In Table 6.5.2 we provide the results of the impact of a 10% increase in export demand at various time periods, namely, periods 1, 2, 10, 20 and 35 with the stock adjustment model of migration under the bargaining closure. As with the BRW closure, the long-run results are achieved more rapidly than with the flow adjustment model. However the main distinction here is that the long-run results with the SA model, under the national wage bargaining closure seem to approach the input-output (I-O) results; there is equi-proportionate expansion in capital stocks, total employment and value added in all the three sectors. Essentially, the assumption of a fixed nominal wage is tantamount to assuming an infinitely elastic supply of labour at this wage. Here real wage and prices return to their initial equilibrium levels. However the NAIRU result is not achieved with the stock adjustment migration model, when the national wage bargaining closure is assumed to hold. The unemployment rate is permanently reduced by 23.15% in the long-run. Hence we obtain unique results here, where input-output results are emulated in the long-run, but with a permanent changed in the unemployment rate.

Figure 6.20 shows the dynamics of the adjustment. Notice that real take home wage remains at the initial level except for the first few periods where it falls, and the unemployment rate is permanently changed. GDP and total employment increase gradually from period one. Figure 6.20a shows the impact of the export shock on GDP, real take home consumption wage, total employment and unemployment rate with the same migration function (stock adjustment) and national wage bargaining closure, but with fixed capital stocks. The magnitude of the impact of the export shock on GDP and total employment are reduced because of the constraint imposed by limited capital stocks. The real wage is permanently reduced. The unemployment rate is reduced permanently, but to la lesser extent than when capital stocks are not restricted.

6.5.3. With Zero Labour Mobility.

In Table 6.5.3 we provide the results of the impact of a 10% increase in manufacturing exports at time periods 1, 2, 10, 20 and 35 with zero labour mobility under the national wage bargaining closure. Of course, as in the other cases discussed above, there is no change in the nominal take home wage. The increase in demand causes prices to increase, and the consumer price index increases. This results in the fall in real take home consumption wage, given the fixed nominal wage. Initially, when capital stocks are fixed in period one, capital rental rates increase by 19.93%. Later, when capital stocks are fully adjusted, capital stocks increase by 8.70% by period 35, while capital rental rates, approaches the initial equilibrium rates. Exports in the long-run approach the 10% increase, as prices return to their original levels. In the long-run the results approach (augmented) input-output results with equi-proportionate increase in capital stocks, total employment and value added in all three sectors, namely manufacturing, non-manufacturing traded and sheltered sectors. Again these results reflect the fact that, at least over a range, the national bargaining closure effectively assumes an infinitely elastic supply of labour at the prevailing nominal wage. The unemployment rate decreases by 20.83% in period 1, and falls all the way throughout the adjustment period, falling by 38.60% by period 35. Hence unemployment rate is permanently reduced, and there is no NAIRU in this case. The increase in export demand increases total employment and hence reduces the unemployment rate. With zero mobility the increase in the number of jobs can only be filled by local labour joining the workforce. This helps to reduce the unemployment rate further.

Figure 6.21 shows the dynamics of the adjustment Process. Total employment and GDP increase gradually throughout, while the real take home consumption wage initially falls as prices increase due to the increased demand. Later, the real take home consumption wage returns to its initial level as prices return to their original levels. Notice that the unemployment rate falls from period one onwards and never returns to the original rate, hence no NAIRU is established. We again have a unique solution, where unemployment rate is permanently affected, although real wage and prices remains unchanged in the long-run. The fact that nominal wages are determined outwith the region implies that this wage remains unchanged in the medium and long-runs, although the real wage falls in the short-run due to the increase in demand caused by the export shock. The increase in employment implies that the unemployment rate falls and in this case there is no migration to add to the workforce, hence the regional unemployment rate is permanently reduced. The economy shifts to a higher level of output (than before the export shock is imposed) and a lower unemployment rate (than before). While real take home consumption wages and prices remain unchanged in the long-run..

6.6 Conclusions.

The results above suggest that, with the flow-adjustment (FA) model, a 10% demand stimulus in the export sector generates a 10% rise in exports to RUK in the long-run. Employment, value added and capital stock within each sector all increase equi-proportionately. The results therefore parallel those of an Input-Output system (augmented to accommodate migration) in the long-run, for a demand disturbance. If the Layard *et al* (1991) flow-adjustment model is correct, then the demand shock will stimulate output and employment significantly. However, due to the impact of migration, the unemployment rate remains unchanged and the real wage settles at the old equilibrium wage. This suggests that our results conform to the notion of a NAIRU or the "natural rate" theory. The bargained real wage (BRW), or regional bargaining, closure implies that the real wage has to rise to stimulate employment in the short-run. However, the increased real wage has an adverse competitiveness effect that leads to a crowding out effect on the other two sectors in our simulations. Eventually the crowding out effect is reduced and ultimately eliminated as the real consumption wage falls back to the old equilibrium. In the sensitivity analysis we find that our steady-state, or long-run equilibrium, results do not change as we vary the parameters of the net migration function: only the adjustment speed of the system varies.

In the stock–adjustment model, the system does not converge on input-output results, and exports to RUK (and ROW) do not expand by the full 10% impact from the demand stimulus, in the long-run. This can be explained as follows. The increase in the manufacturing export demand causes the demand for labour to increase thus increasing the real wage. However this increase in the real wage never falls back to its original level as it does in the FA model. The increase in the real take home consumption wage and the increase in prices are permanent in the SA model. The (manufacturing) export sector therefore does not receive the full (I-O) impact of the export demand stimulus since induced price rises choke off some export demand. The other two sectors export less than than they did initially, because of the impact of the adverse competitiveness effects. Referring to the LNJSA results again, the non-manufacturing trading exports fall (by 2.42% from base) and the sheltered sector exports fall by more (3.29% from base). However, employment and value added actually increase in the non-manufacturing traded sector. The increased demand in the manufacturing sector (due to the export demand stimulus) causes demand for intermediate goods to rise. Also the increased demand for consumption and intermediate goods generated ultimately by migrants and the indigenous population expands the other sectors.

As mentioned earlier the fall in unemployment that comes from the demand stimulus is good for a small economy such as Scotland relative to RUK. The increase in the CPI (by 0.68% from base) is quite small relative to the increase in employment. The increased real consumption wage helps to increase demand in other sectors[11] hence encouraging GDP increase (by about 1.70%) within the region but less than the increase in GDP when the FA model is employed. In practice this trade-off is immaterial because policy maker cannot choose which model is applicable.

In the SA model the steady state solution changes when we change the migration parameters, in contrast to the results of the flow adjustment model of migration. This is a key difference between the two migration models we employ in our studies. In the stock-adjustment model the steady state solution changes when we change the migration parameters, but this is not true of the Layard *et al* (1991) flow-adjustment model. The test results suggest that the impact of the demand stimulus is very sensitive to changes in the unemployment elasticity but not so sensitive to the real wage elasticity.

[11] But note also the adverse supply effect of increase wage.

With zero labour mobility, the expansion in employment is fully absorbed by the local Scottish population because no in-migration occurs. The increase in demand causes the real wage rate to rise, and this encourages employment in the regional bargaining closure, but since there is no migration to counteract the increased wages, the real take home consumption wage does not return to the original equilibrium and so nor does the unemployment rate. Hence with zero mobility there is no NAIRU established. Our findings thus far suggest that migration is fundamentally important in terms of its influence on the system-wide impact of the demand disturbance on a regional economy, both in terms of differences in the qualitative results and in the striking differences apparent in the quantitative impact.

We also explored the impact that a national wage bargaining system would have on our results, given the emphasis that this hypothesis had received in the earlier literature on regional macroeconomies. The fixity of the nominal wage under this closure tends to enhance the impact of a demand stimulus in the short-run, since the increase in prices actually induces a ***fall*** in real wages in these circumstances. However, in the long-run the results of this closure converge on exactly the same input-output results that prevail under regional bargaining over the same interval under the flow adjustment model: the distinction between the systems does not matter across equilibria where prices do not change. Interestingly, while the NAIRU result no longer characterises long-run equilibria under stock-adjustment processes, input-output results still hold: the fixed nominal wage implies an infinitely elastic supply of labour at that wage (over some relevant range).

In the next chapter we discuss the results when we impose a supply shock to the system.

Tables.

Table 6.2.1.The impact of the 10% change in exports on key economic variables at different time horizons with the flow adjustment migration model.

	short-run	**medium-run**	**long-run**
GDP (@ income measure)	0.68	1.22	4.04
Consumption	1.80	1.88	4.04
Nominal take home wage	1.68	0.41	0.00
Real T-H consumption wage	0.98	0.00	0.00
Value-added:			
Manu	3.46	4.25	8.79
N Manu Tr	-0.18	0.45	3.45
N Manu N Tr	-0.13	0.19	1.92
Total Employment (000's):	0.84	1.53	4.10
Manu:	4.22	5.21	8.79
Non-Manu tr:	-0.24	0.61	3.45
Sheltered:	-0.15	0.22	1.92
Unemployment rate	-8.29	0.00	0.00
Population (000's)	0.00	1.53	4.10
Net in-migration (000's)	--	--	--
Price of value added:			
Manu	4.21	3.51	0.00
Non-Manu tr	1.47	0.95	0.00
Sheltered	1.62	0.51	0.00
Capital rental rates:			
Manu	16.72	18.93	0.00
Non-Manu tr	0.86	2.47	0.00
Sheltered	1.18	1.14	0.00
Consumer price index	0.70	0.41	0.00
Capital stocks:			
Manu	0.00	0.00	8.79
N Manu Tr	0.00	0.00	3.45
N Manu N Tr	0.00	0.00	1.92
Exports to RUK:			
Manu	5.48	6.21	10.00
N Manu Tr	-2.15	-1.40	0.00
Sheltered	-2.90	-0.94	0.00
Exports to ROW:			
Manu	5.48	6.21	10.00
N Manu Tr	-2.15	-1.40	0.00
Sheltered	-2.9	-0.94	0.00
Real income (CPI deflator):			
Households disposable	1.79	1.88	4.04

Firms disposable	3.10	4.14	4.12

Table 6.2.2. Impact of 10% increase in manufacturing export on key economic variables using the LNJ (flow) migration model.

	1	5	10	20	30	40	60	80	85	90
GDP (@ income measure)	0.68	1.69	2.53	3.41	3.77	3.93	4.02	4.03	4.04	4.04
Consumption	1.8	2.46	3.02	3.61	3.86	3.97	4.03	4.04	4.04	4.04
Nominal take home wage	1.68	1.25	0.83	0.36	0.15	0.06	0.01	0.00	0.00	0.00
Real T-H consumption wage	0.98	0.64	0.40	0.17	0.07	0.03	0.01	0.00	0.00	0.00
Value-added:										
Manu	3.46	5.73	7.08	8.15	8.53	8.68	8.77	8.78	8.78	8.79
N Manu Tr	-0.18	0.61	1.50	2.61	3.10	3.31	3.42	3.45	3.45	3.45
N Manu N Tr	-0.13	0.37	0.88	1.47	1.73	1.84	1.90	1.91	1.91	1.92
Total Employment (000's):	0.84	1.83	2.64	3.49	3.85	3.99	4.08	4.10	4.10	4.10
Manu:	4.22	6.05	7.21	8.18	8.54	8.68	8.77	8.78	8.78	8.79
Non-Manu tr:	-0.24	0.69	1.60	2.66	3.12	3.31	3.43	3.45	3.45	3.45
Sheltered:	-0.15	0.39	0.89	1.48	1.73	1.84	1.90	1.91	1.91	1.92
Unemployment rate	-8.29	-5.54	-3.49	-1.45	-0.61	-0.26	0.04	-0.01	-0.00	0.00
Population (000's)	0.00	1.26	2.28	3.34	3.78	3.97	4.08	4.10	4.10	4.10
Net in-migration (000's)	--	- -	--	--	--	--	- -	--	--	- -
Price of value added:										
Manu	4.21	2.30	1.23	0.44	0.18	0.07	0.01	0.00	0.00	0.00
Non-Manu tr	1.47	1.52	1.16	0.53	0.22	0.09	0.02	0.00	0.00	0.00
Sheltered	1.62	1.28	0.89	0.39	0.16	0.07	0.01	0.00	0.00	0.00
Capital rental rates:										
Manu	16.72	7.43	3.16	0.88	0.33	0.14	0.02	0.01	0.00	0.00
Non-Manu tr	0.86	2.28	2.09	1.02	0.43	0.18	0.03	0.01	0.00	0.00
Sheltered	1.18	1.52	1.25	0.60	0.25	0.11	0.02	0.01	0.00	0.00
Consumer price index	0.70	0.60	0.43	0.19	0.08	0.03	0.01	0.00	0.00	0.00
Capital stocks:										
Manu	0.00	4.19	6.48	8.01	8.48	8.66	8.77	8.78	8.78	8.79
N Manu Tr	0.00	0.38	1.23	2.46	3.03	3.28	3.43	3.45	3.45	3.45
N Manu N Tr	0.00	0.30	0.77	1.41	1.70	1.83	1.90	1.91	1.91	1.92
Exports to RUK:										
Manu	5.48	7.49	8.65	9.51	9.80	9.92	9.99	10.00	10.00	10.00
N Manu Tr	-2.15	-2.22	-1.71	-0.78	-0.33	-0.14	-0.02	0.00	0.00	0.00
Sheltered	-2.9	-2.32	-1.61	-0.71	-0.30	-0.13	-0.02	0.00	0.00	0.00
Exports to ROW:										
Manu	5.48	7.49	8.65	9.51	9.80	9.92	9.99	10.00	10.00	10.00
N Manu Tr	-2.15	-2.22	-1.71	-0.78	-0.33	-0.14	-0.02	0.00	0.00	0.00
Sheltered	-2.9	-2.32	-1.61	-0.71	-0.30	-0.13	-0.02	0.00	0.00	0.00

Real income (CPI deflator):									
Households disposable	1.79	2.45	3.01	3.61	3.86	3.97	4.03	4.04	4.04	4.04
Firms disposable	3.1	3.41	3.65	3.92	4.03	4.08	4.11	4.12	4.12	4.12

Table 6.2.3: Sensitivity of NPVGDP to demand stimulus with variations in migration parameter wrt real wage elasticity α_1 and unemployment elasticity α_2.

α_1 / α_2	0.01	0.03	0.05	0.06 (default)	0.07	0.09	0.12	0.13	0.15	0.20	
-0.03	124130	126170	128080	128990	129870	131540	133880	134610	136020	139200	1
-0.05	138410	139600	140750	141300	141820	142860	144310	144770	145660	147730	1
-0.08(default)	150460	151120	151750	152100	152360	152930	153770	154050	154570	155810	1
-0.10	155490	155970	156430	156660	156880	157310	157930	158130	158530	159460	1
-0.13	160750	161070	161380	161530	161680	161980	162410	162540	162810	163460	1
-0.15	163300	163550	163800	163920	164040	164280	164620	164740	164950	165490	1
-0.18	166230	166420	166610	166690	166780	166960	167220	167300	167470	167870	1
-0.20	167770	167920	168080	168150	168230	168380	168590	168670	168810	169150	1
-0.40	175330	175370	175400	175440	175460	175510	175570	175590	175630	175740	1

Table.6.3.1. The steady-state impact of the 10% change in manufacturing export on key economic variables using the LNJ (Flow) and SA models

	"short- run"		"long- run"	
	LNJ	SA	LNJ	SA
GDP (@ income measure)	0.68	0.68	4.04	1.66
Consumption	1.80	1.80	4.04	2.55
Nominal take home wage	1.68	1.68	0.00	2.03
Real T-H consumption wage	0.98	0.98	0.00	1.34
Value-added:				
Manu	3.46	3.46	8.79	6.29
N Manu Tr	-0.18	-0.18	3.45	0.59
N Manu N Tr	-0.13	-0.13	1.92	-0.00
Total Employment (000's):	0.84	0.84	4.10	1.61
Manu:	4.22	4.22	8.79	6.21
Non-Manu tr:	-0.24	-0.24	3.45	0.48
Sheltered:	-0.15	-0.15	1.92	-0.06
Unemployment rate	-8.29	-8.29	0.00	-11.13
Population (000's)	0.00	0.00	4.10	0.48
Net in-migration (000's)	--	--	--	--
Price of value added:				
Manu	4.21	4.21	0.00	1.79
Non-Manu tr	1.47	1.47	0.00	1.66
Sheltered	1.62	1.62	0.00	1.84
Capital rental rates:				
Manu	16.72	16.72	0.00	0.61
Non-Manu tr	0.86	0.86	0.00	0.61
Sheltered	1.18	1.18	0.00	0.60
Consumer price index	0.70	0.70	0.00	0.68
Capital stocks:				
Manu	0.00	0.00	8.79	6.66
N Manu Tr	0.00	0.00	3.45	0.91
N Manu N Tr	0.00	0.00	1.92	0.37
Exports to RUK:				
Manu	5.48	5.48	10.00	8.04
N Manu Tr	-2.15	-2.15	0.00	-2.42
Sheltered	-2.90	-2.90	0.00	-3.29
Exports to ROW:				
Manu	5.48	5.48	10.00	8.04
N Manu Tr	-2.15	-2.15	0.00	-2.42
Sheltered	-2.9	-2.9	0.00	-3.29
Real income (CPI deflator):				
Households disposable	1.79	1.79	4.04	2.55

Firms disposable	3.10	3.10	4.12	2.18

Table.6.3.2. Impact of 10% change in manufacturing export on key economic variables using the stock adjustment migration model with LNJ default parameters.

	1	5	10	20	30
GDP (@ income measure)	0.68	1.26	1.51	1.64	1.66
Consumption	1.80	2.23	2.43	2.54	2.55
Nominal take home wage	1.68	1.83	1.97	2.03	2.03
Real T-H consumption wage	0.98	1.11	1.25	1.33	1.34
Value-added:					
Manu	3.46	5.27	5.99	6.26	6.29
N Manu Tr	-0.18	0.18	0.40	0.56	0.59
N Manu N Tr	-0.13	-0.03	-0.02	-0.01	-0.00
Total Employment (000's):	0.84	1.32	1.50	1.60	1.61
Manu:	4.22	5.52	6.01	6.19	6.21
Non-Manu tr:	-0.24	0.15	0.34	0.46	0.48
Sheltered:	-0.15	-0.06	-0.07	-0.06	-0.06
Unemployment rate	-8.29	-9.30	-10.44	-11.04	-11.13
Population (000's)	0.00	0.38	0.44	0.48	0.48
Net in-migration (000's)	--	--	--	--	--
Price of value added:					
Manu	4.21	2.64	2.03	1.81	1.79
Non-Manu tr	1.47	1.72	1.74	1.68	1.66
Sheltered	1.62	1.70	1.80	1.83	1.84
Capital rental rates:					
Manu	16.72	6.62	2.36	0.76	0.61
Non-Manu tr	0.86	1.43	1.11	0.70	0.61
Sheltered	1.18	0.89	0.70	0.61	0.60
Capital stocks:					
Manu	0.00	4.07	5.88	6.60	6.66
N Manu Tr	0.00	0.27	0.59	0.86	0.91
N Manu N Tr	0.00	0.21	0.30	0.36	0.37
Exports to RUK:					
Manu	5.48	7.13	7.77	8.02	8.04
N Manu Tr	-2.15	-2.51	-2.53	-2.44	-2.42
Sheltered	-2.90	-3.05	-3.22	-3.29	-3.29
Exports to ROW:					
Manu	5.48	7.13	7.77	8.02	8.04
N Manu Tr	-2.15	-2.51	-2.53	-2.44	-2.42
Sheltered	-2.90	-3.05	-3.22	-3.29	-3.29
Real income (CPI deflator):					
Households disposable	1.79	2.22	2.42	2.53	2.55
Firms disposable	3.10	2.67	2.35	2.20	2.18

Table.6.3.3. Impact of 10% increase in manufacturing exports on key economic variables using SA migration model with variation in the parameters.

	LNJSA	rw=0.01	rw=0.04	rw=0.06	rw=0.07	rw=0.09	rw=0.13
	default	ue=-0.05	ue=-0.08	ue=-0.12	ue=-0.15	ue=-0.20	ue=-0.25
GDP (@ income measure)	1.66	1.54	1.65	1.77	1.85	1.97	2.07
Consumpt+ion	2.55	2.48	2.55	2.62	2.67	2.75	2.81
Nominal take home wage	2.03	2.14	2.04	1.93	1.86	1.76	1.67
Real T-H consumption wage	1.34	1.41	1.35	1.27	1.23	1.16	1.10
Value-added:							
Manu	6.29	6.16	6.28	6.41	6.50	6.62	6.73
N Manu Tr	0.59	0.45	0.58	0.73	0.83	0.97	1.09
N Manu N Tr	-0.00	-0.10	-0.01	0.09	0.16	0.25	0.33
Total Employment (000's):	1.61	1.49	1.60	1.73	1.82	1.94	2.05
Manu:	6.21	6.08	6.21	6.34	6.43	6.56	6.67
Non-Manu tr:	0.48	0.33	0.47	0.63	0.73	0.872	1.00
Sheltered:	-0.06	-0.16	-0.07	0.04	0.10	0.20	0.29
Unemployment rate	-11.13	-11.67	-11.16	-10.61	-10.24	-9.70	-9.22
Population (000's)	0.48	0.302	0.469	0.654	0.773	0.949	1.103
Net in-migration (000's)	--	--	--	--	--	-1104.44	-145.83
Price of value added:							
Manu	1.79	1.88	1.79	1.70	1.64	1.55	1.47
Non-Manu tr	1.66	1.74	1.66	1.58	1.52	1.44	1.37
Sheltered	1.84	1.93	1.84	1.75	1.68	1.59	1.51
Capital rental rates:							
Manu	0.61	0.63	0.61	0.59	0.56	0.54	0.52
Non-Manu tr	0.61	0.63	0.61	0.58	0.57	0.54	0.52
Sheltered	0.60	0.62	0.60	0.57	0.55	0.52	0.50
Capital stocks:							
Manu	6.66	6.56	6.66	6.77	6.84	6.94	7.03
N Manu Tr	0.91	0.78	0.90	1.03	1.11	1.24	1.35
N Manu N Tr	0.37	0.29	0.36	0.44	0.49	0.57	0.64
Exports to RUK:							
Manu	8.04	7.94	8.03	8.14	8.20	8.30	8.39
N Manu Tr	-2.42	-2.54	-2.42	-2.30	-2.22	-2.10	-2.00
Sheltered	-3.29	-3.46	-3.30	-3.13	-3.02	-2.86	-2.71
Exports to ROW:							
Manu	8.04	7.94	8.03	8.14	8.20	8.30	8.39
N Manu Tr	-2.42	-2.54	-2.42	-2.30	-2.22	-2.1	-2.00
Sheltered	-3.29	-3.46	-3.30	-3.13	-3.02	-2.86	-2.71
Real income (CPI deflator):							
Households disposable	2.55	2.47	2.54	2.62	2.67	2.74	2.81
Firms disposable	2.18	2.08	2.18	2.28	2.35	2.44	2.53

Table 6.4.1. The short-run and long-run impact of the 10% change in manufacturing export on key economic variables: the no-migration case.

	short-run	long-run
GDP (income measure)	0.68	1.33
Consumption	1.80	2.35
Nominal take home wage	1.68	2.32
Real T-H consumption wage	0.98	1.53
Value-added:		
Manufacturing	3.46	5.95
Non-Manu Traded	-0.18	0.21
Sheltered	-0.13	-0.26
Total Employment (000's):	0.84	1.28
Manufacturing:	4.22	5.86
Non-Manu traded:	-0.24	0.08
Sheltered:	-0.15	-0.33
Unemployment rate	-8.29	-12.60
Population (000's)	0.00	0.00
Net in-migration (000's)	--	--
Price of value added:		
Manufacturing	4.21	2.04
Non-Manu traded	1.47	1.89
Sheltered	1.62	2.10
Capital rental rates:		
Manufacturing	16.72	0.67
Non-Manu traded	0.86	0.67
Sheltered	1.18	0.67
Consumer price index	0.70	0.77
Capital stocks:		
Manufacturing	0.00	6.38
Non-Manu Traded	0.00	0.57
Sheltered	0.00	0.16
Exports to RUK:		
Manufacturing	5.48	7.77
Non-Manu Traded	-2.15	-2.74
Sheltered	-2.90	-3.74
Exports to ROW:		
Manufacturing	5.48	7.77
Non-Manu Traded	-2.15	-2.74
Sheltered	-2.90	-3.74
Real income (CPI deflator):		
Households disposable		
Firms disposable	1.79	2.35

		3.10	1.92

Table.6.5.1. Impact of 10% change in manufacturing export on key economic variables at various time periods with National Wage Bargaining closure, the Flow Adjustment case.

	1	2	10	20	50	80	90
GDP (@ income measure)	1.69	2.06	3.52	3.94	4.04	4.04	4.04
Consumption	1.98	2.32	3.58	3.96	4.04	4.04	4.04
Nominal take home wage	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real T-H consumption wage	-0.40	-0.37	-0.14	-0.03	0.00	0.00	0.00
Value-added:							
Manu	4.57	5.39	8.15	8.70	8.78	8.78	8.78
N Manu Tr	0.78	1.09	2.69	3.30	3.45	3.45	3.45
N Manu N Tr	0.88	1.04	1.67	1.87	1.92	1.92	1.92
Total Employment (000's):	2.11	2.43	3.67	4.02	4.10	4.10	4.10
Manu:	5.60	6.22	8.30	8.72	8.78	8.78	8.78
Non-Manu tr:	1.06	1.38	2.83	3.33	3.45	3.45	3.45
Sheltered:	1.03	1.16	1.71	1.88	1.92	1.92	1.92
Unemployment rate	-20.83	-14.96	-2.89	-0.54	-0.01	0.00	0.00
Population (000's)	0.00	0.90	3.37	3.97	4.10	4.10	4.10
Net in-migration (000's)	0.00	0.00	--	--	--	--	--
Price of value added:							
Manu	3.33	2.65	0.46	0.06	0.00	0.00	0.00
Non-Manu tr	0.93	0.95	0.47	0.11	0.00	0.00	0.00
Sheltered	0.47	0.40	0.11	0.02	0.00	0.00	0.00
Capital rental rates:							
Manu	19.93	15.76	2.67	0.35	0.00	0.00	0.00
Non-Manu tr	3.56	3.64	1.78	0.42	0.00	0.00	0.00
Sheltered	3.45	2.94	0.80	0.17	0.00	0.00	0.00
Consumer price index	0.40	0.37	0.14	0.03	0.00	0.00	0.00
Capital stocks:							
Manu	0.00	1.66	7.45	8.61	8.78	8.78	8.78
N Manu Tr	0.00	0.30	2.29	3.20	3.45	3.45	3.45
N Manu N Tr	0.00	0.29	1.46	1.83	1.92	1.92	1.92
Exports to RUK:							
Manu	6.40	7.12	9.50	9.94	10.00	10.00	10.00
N Manu Tr	-1.37	-1.40	-0.69	-0.16	0.00	0.00	0.00
Sheltered	-0.85	-0.73	-0.20	-0.04	0.00	0.00	0.00
Exports to ROW:							
Manu	6.40	7.12	9.50	9.94	10.00	10.00	10.00
N Manu Tr	-1.37	-1.40	-0.69	-0.16	0.00	0.00	0.00

Sheltered	-0.85	-0.73	-0.20	-0.04	0.00	0.00	0.00
Real income (CPI deflator):							
Households disposable	1.97	2.32	3.58	3.96	4.04	4.04	4.04
Firms disposable	5.24	5.10	4.40	4.17	4.12	4.12	4.12

Table.6.5.2. Impact of 10% change in manufacturing export on key economic variables at various time periods with National Wage Bargaining closure, the Stock Adjustment case.

	1	2	10	20	35
GDP (@ income measure)	1.69	2.06	3.44	3.82	3.89
Consumption	1.98	2.32	3.21	3.47	3.52
Nominal take home wage	0.00	0.00	0.00	0.00	0.00
Real T-H consumption wage	-0.40	-0.37	-0.13	-0.03	0.00
Value-added:					
Manu	4.57	5.39	8.12	8.65	8.73
N Manu Tr	0.78	1.09	2.57	3.12	3.24
N Manu N Tr	0.88	1.04	1.59	1.75	1.78
Total Employment (000's):	2.11	2.43	3.58	3.89	3.95
Manu:	5.60	6.22	8.27	8.67	8.73
Non-Manu tr:	1.06	1.38	2.71	3.15	3.24
Sheltered:	1.03	1.16	1.61	1.75	1.78
Unemployment rate	-20.83	-14.96	-23.77	-24.45	-23.15
Population (000's)	0.00	0.90	1.00	1.05	0.99
Net in-migration (000's)	--	--	--	--	--
Price of value added:					
Manu	3.33	2.65	0.45	0.05	0.00
Non-Manu tr	0.93	0.95	0.43	0.10	0.01
Sheltered	0.47	0.40	0.10	0.02	0.00
Capital rental rates:					
Manu	19.93	15.76	2.64	0.32	0.04
Non-Manu tr	3.56	3.64	1.64	0.37	0.03
Sheltered	3.45	2.94	0.70	0.13	0.01
Consumer price index	0.40	0.37	0.13	0.03	0.00
Capital stocks:					
Manu	0.00	1.66	7.43	8.56	8.72
N Manu Tr	0.00	0.30	2.21	3.04	3.23
N Manu N Tr	0.00	0.29	1.40	1.71	1.78
Exports to RUK:					
Manu	6.40	7.12	9.50	9.94	10.00
N Manu Tr	-1.37	-1.40	-0.64	-0.14	-0.01
Sheltered	-0.85	-0.73	-0.18	-0.03	0.00
Exports to ROW:					
Manu	6.40	7.12	9.50	9.94	10.00

N Manu Tr	-1.37	-1.40	-0.64	-0.14	-0.01
Sheltered	-0.85	-0.73	-0.18	-0.03	0.00
Real income (CPI deflator):					
Households disposable	1.97	2.32	3.21	3.47	3.52
Firms disposable	5.24	5.10	4.26	4.02	3.97

Table.6.5.3. Impact of 10% change in manufacturing export on key economic variables at various time periods with National Wage Bargaining closure, the zero migration case.

	1	2	10	20	35
GDP (@ income measure)	1.69	2.04	3.40	3.77	3.85
Consumption	1.98	2.18	3.05	3.30	3.36
Nominal take home wage	0.00	0.00	0.00	0.00	0.00
Real T-H consumption wage	-0.40	-0.36	-0.13	-0.03	0.00
Value-added:					
Manu	4.57	5.39	8.11	8.63	8.71
N Manu Tr	0.78	1.06	2.52	3.05	3.17
N Manu N Tr	0.88	1.02	1.55	1.70	1.74
Total Employment (000's):	2.11	2.40	3.54	3.85	3.91
Manu:	5.60	6.21	8.25	8.65	8.71
Non-Manu tr:	1.06	1.34	2.65	3.08	3.18
Sheltered:	1.03	1.13	1.57	1.71	1.74
Unemployment rate	-20.83	-23.71	-34.97	-38.00	-38.60
Population (000's)	0.00	0.00	0.00	0.00	0.00
Net in-migration (000's)	--	--	--	--	--
Price of value added:					
Manu	3.33	2.64	0.45	0.06	0.00
Non-Manu tr	0.93	0.92	0.42	0.09	0.01
Sheltered	0.47	0.38	0.09	0.02	0.00
Capital rental rates:					
Manu	19.93	15.74	2.63	0.32	0.02
Non-Manu tr	3.56	3.52	1.60	0.36	0.03
Sheltered	3.45	2.85	0.68	0.13	0.01
Consumer price index	0.40	0.36	0.13	0.03	0.00
Capital stocks:					
Manu	0.00	1.66	7.42	8.55	8.70
N Manu Tr	0.00	0.30	2.16	2.97	3.17
N Manu N Tr	0.00	0.29	1.37	1.67	1.73
Exports to RUK:					
Manu	6.40	7.13	9.50	9.94	10.00
N Manu Tr	-1.37	-1.36	-0.62	-0.14	-0.01
Sheltered	-0.85	-0.70	-0.17	-0.03	0.00
Exports to ROW:					
Manu	6.40	7.13	9.50	9.94	10.00
N Manu Tr	-1.37	-1.36	-0.62	-0.14	-0.01

Sheltered	-0.85	-0.70	-0.17	-0.03	0.00
Real income (CPI deflator):					
Households disposable	1.97	2.18	3.05	3.30	3.36
Firms disposable	5.24	5.04	4.21	3.97	3.93

Figures

Figure 6.1:Impact of 10% increase in manufacturing export demand on GDP, total employment, real take home consumption wage and unemployment rate with LNJ (Flow) default parameters.

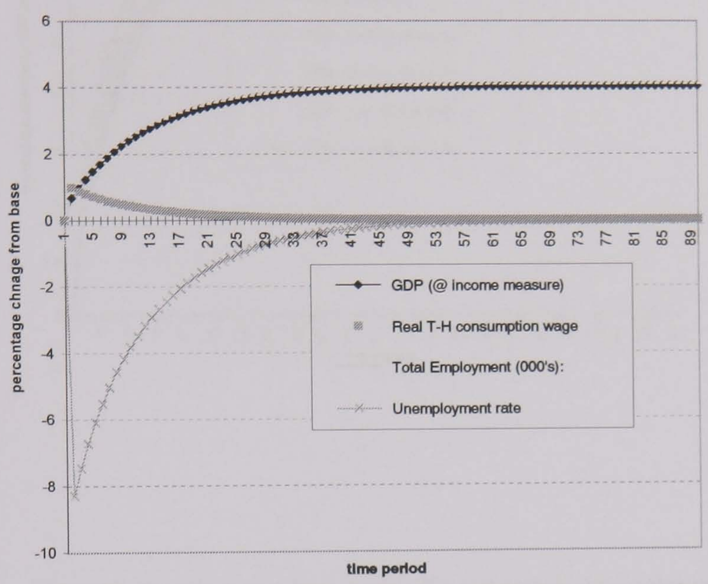


Figure 6.1a. Impact of 10% increase in manufacturing export on GDP, real THC wage, total employment and unemployment rate, with the default Flow migration parameters, with fixed capital stock.

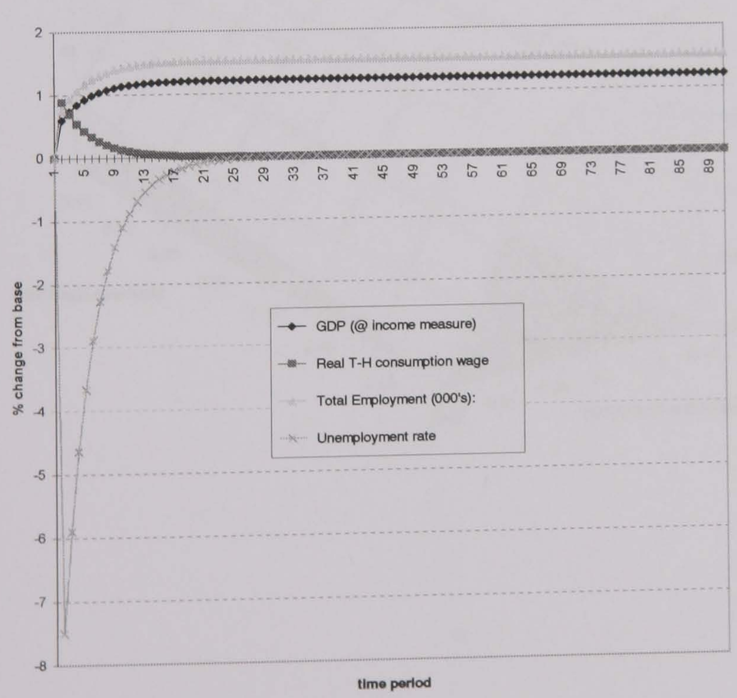


Figure 6.2. Impact of 10% increase in manufacturing export demand on GDP wrt variations in NMG parameters.

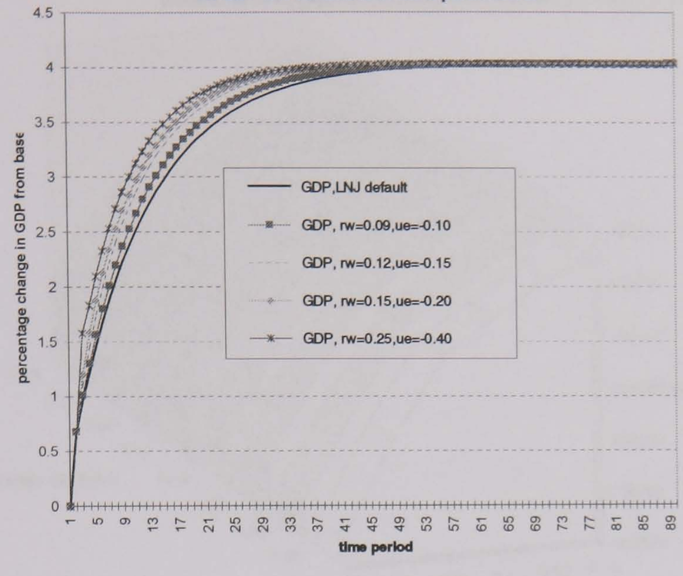


Figure 6.3. The steady state impact of a 10% increase in manufacturing export on GDP with variations in migration elasticity wrt unemployment and real wage.

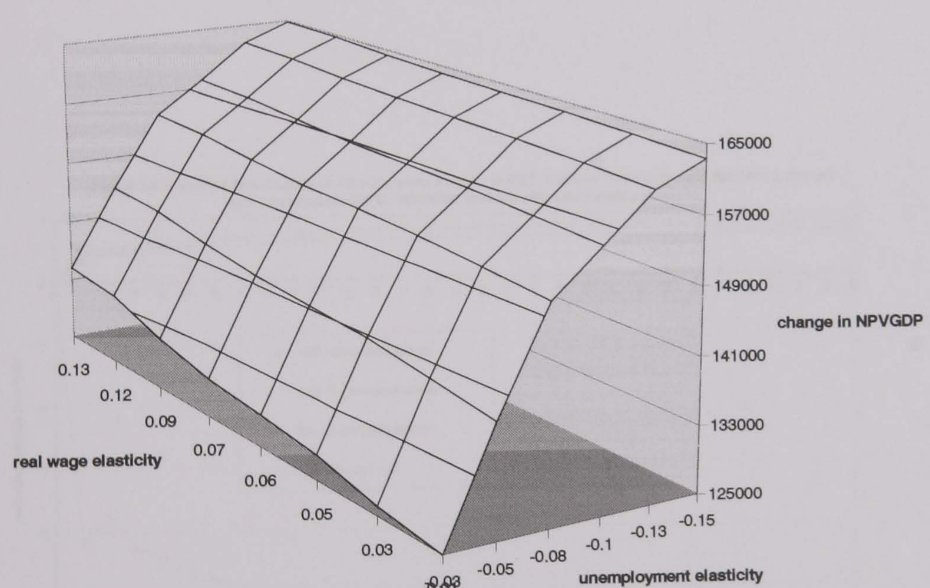


Figure 6.4. The steady state impact of a 10% increase in manufacturing export on GDP with variations in migration elasticity wrt unemployment and real wage.

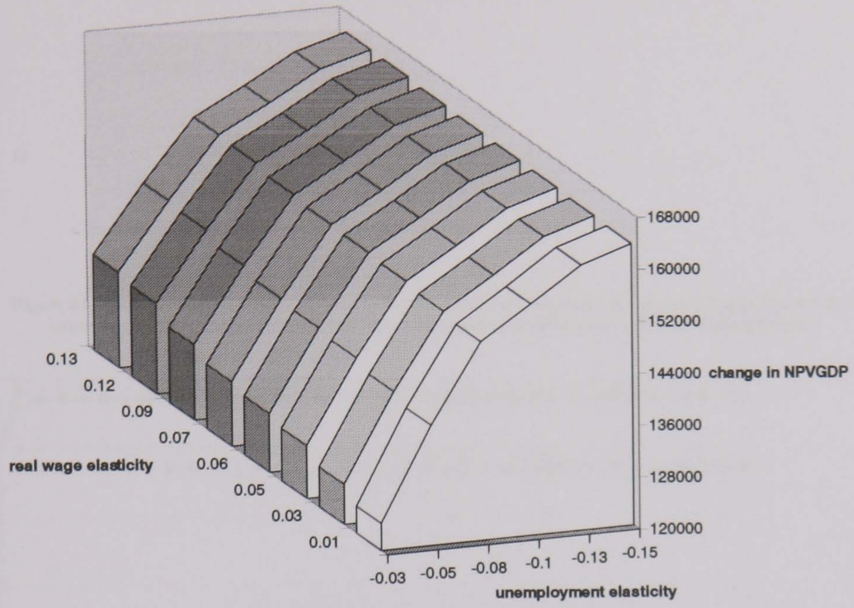


Figure 6.5. Impact of 10% increase in manufacturing exports on GDP, real take home wage, unemployment rate and total employment with SA migration function with LNJ default parameters

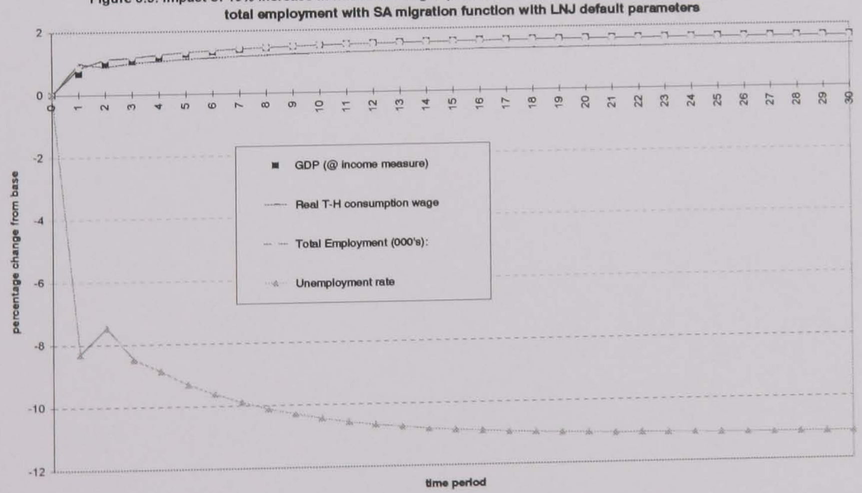


Figure 6.5a. Impact of 10% increase in manufacturing export on GDP, real THC wage, total employment and unemployment rate, with default stock adjustment migration parameter, with fixed capital stocks.

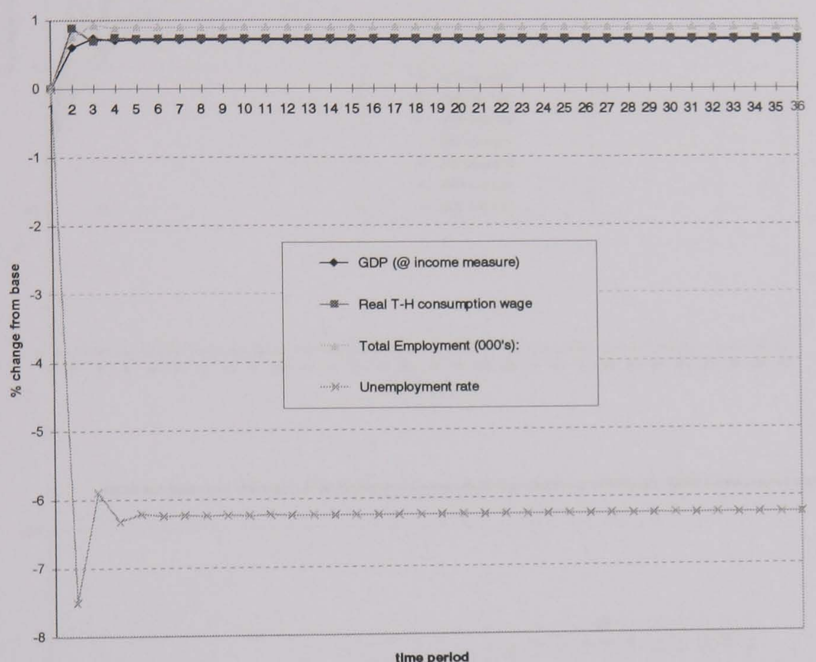


Figure 6.6. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMG SA parameters (rw=0.01)

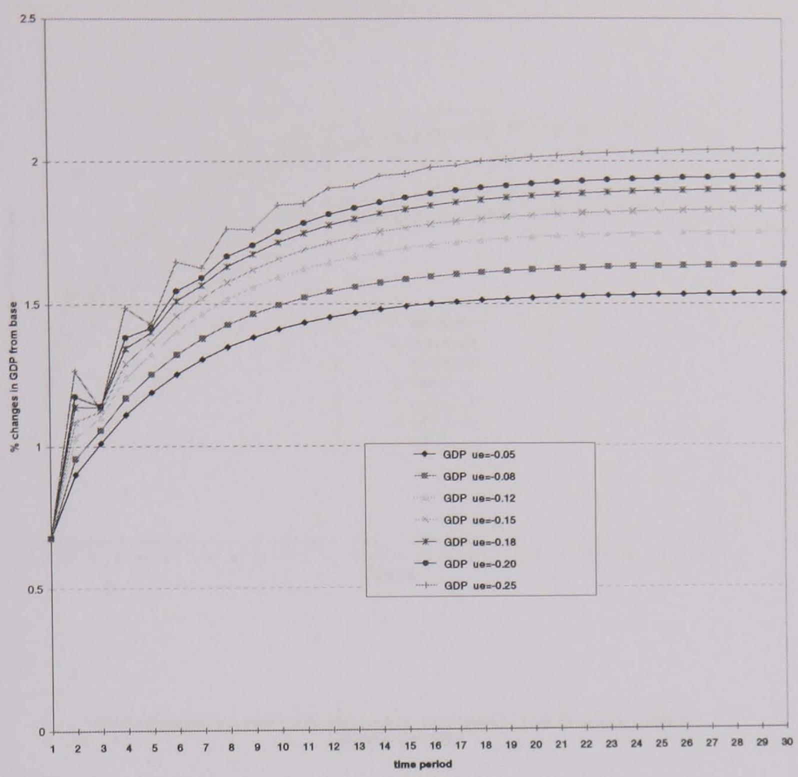


Figure 6.7: Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.04)

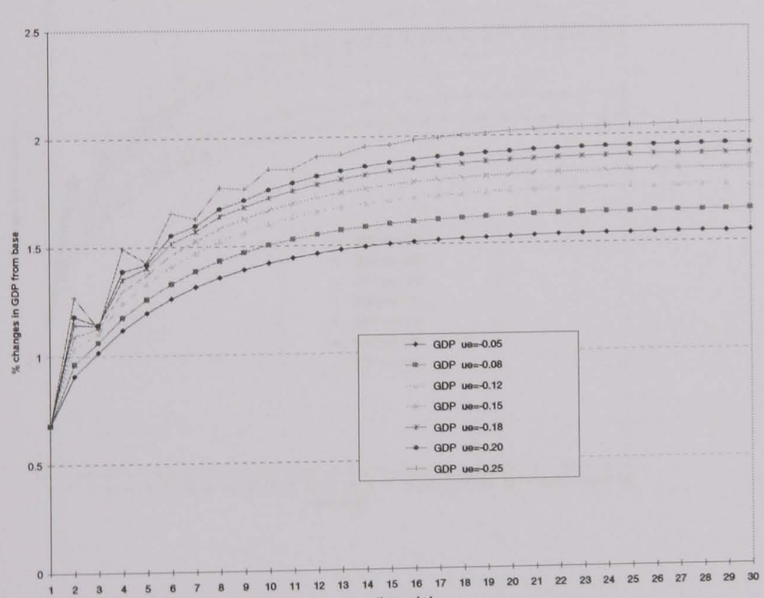


Figure 6.8: Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.06)

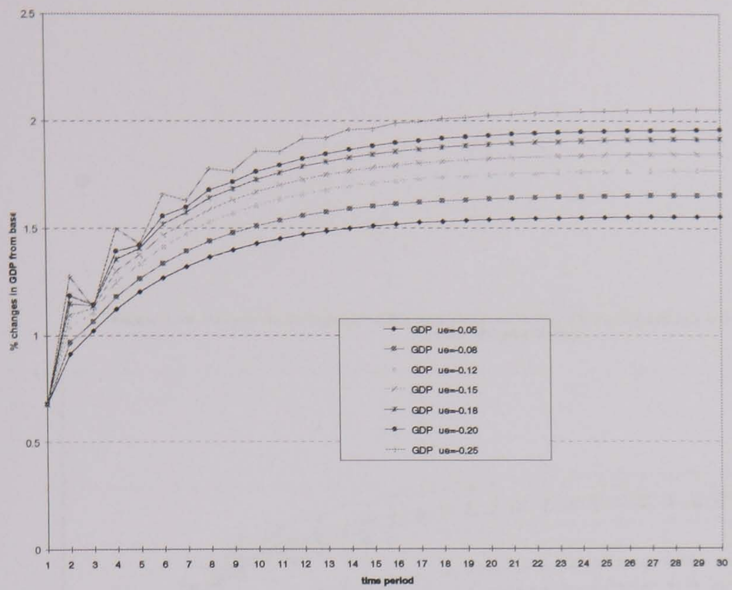


Figure 6.9. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.07)

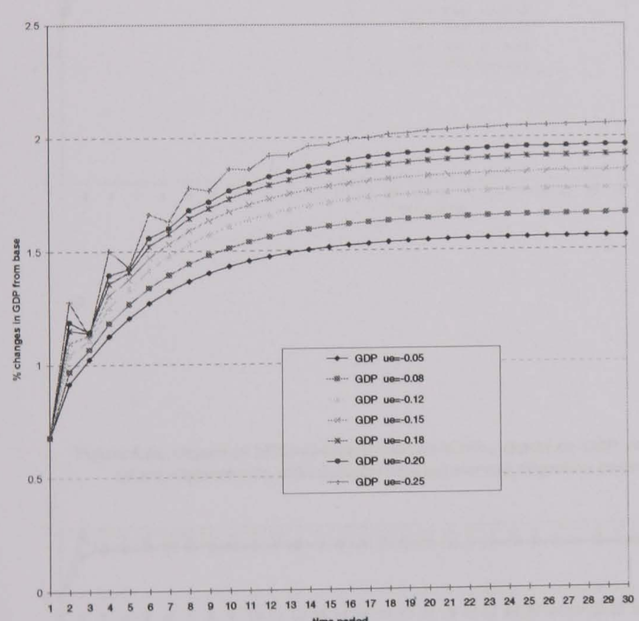


Figure 6.10. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters(rw=0.09)

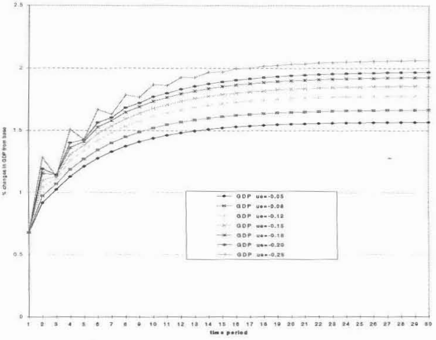


Figure 6.5a. Impact of 10% increase in manufacturing export on GDP, real THC wage, total employment and unemployment rate, with default stock adjustment migration parameter, with fixed capital stocks.

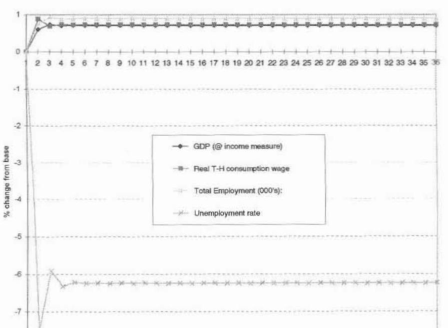


Figure 6.6. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMG SA parameters (rw=0.01)

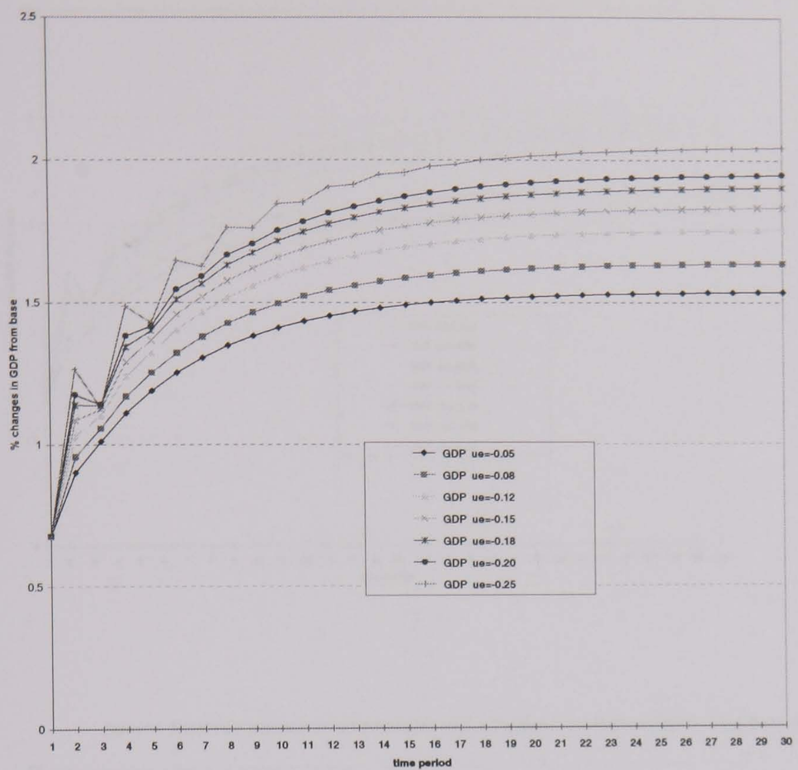


Figure 6.7: Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.04)

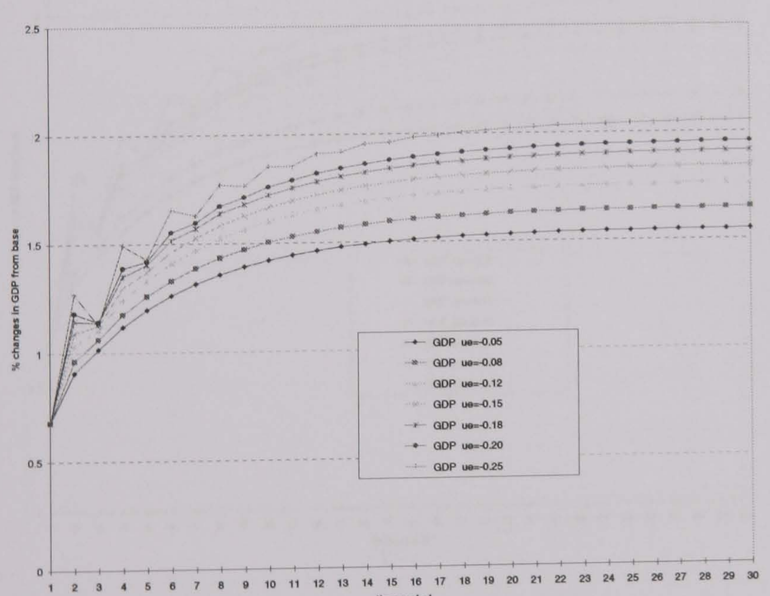
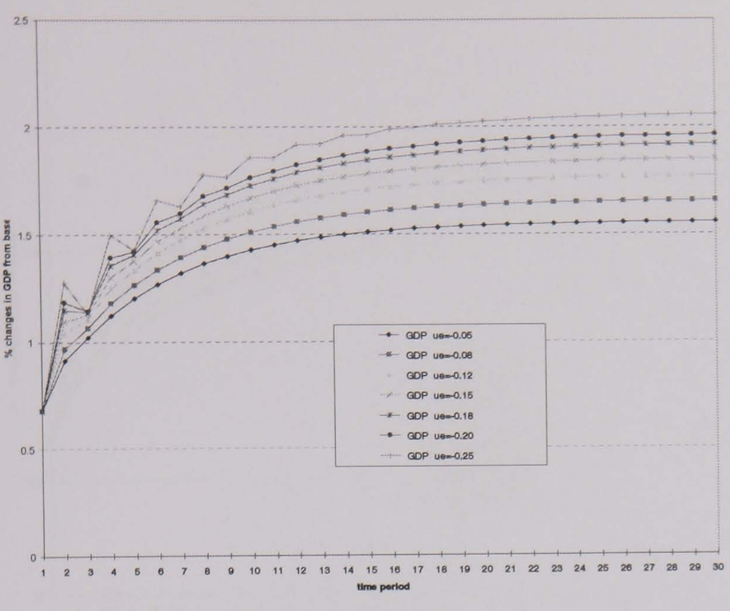


Figure 6.8: Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.06)



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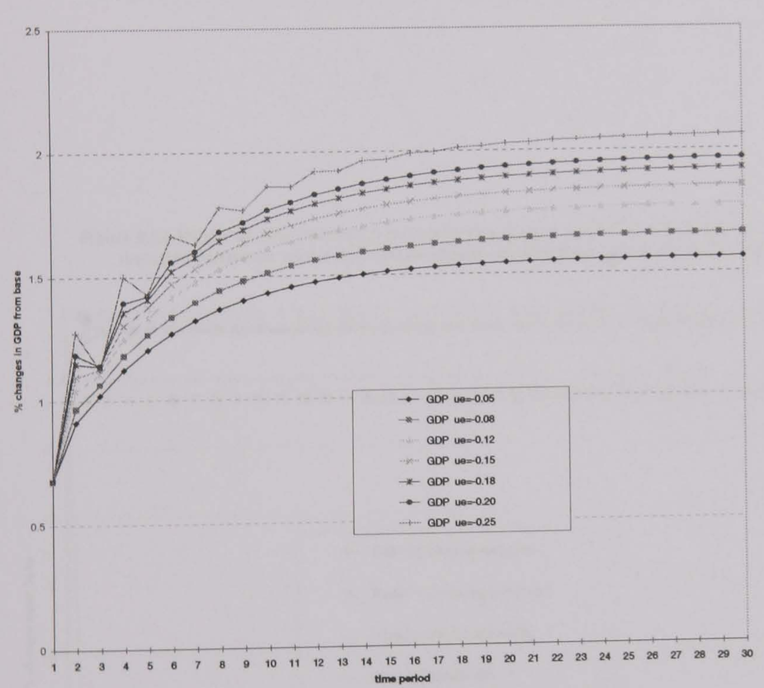


Figure 6.10. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters(rw=0.09)

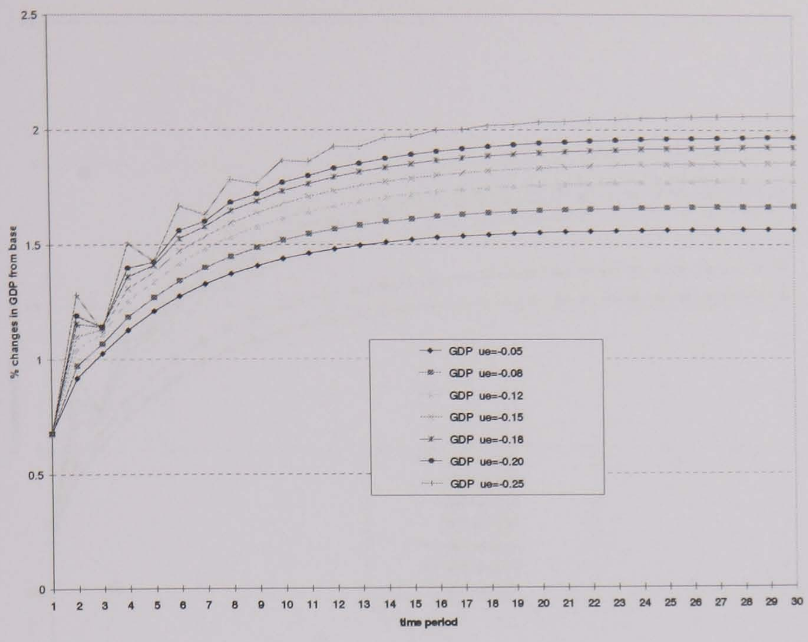


Figure 6.5a. Impact of 10% increase in manufacturing export on GDP, real THC wage, total employment and **unemployment rate, with default stock adjustment migration parameter, with fixed capital stocks.**

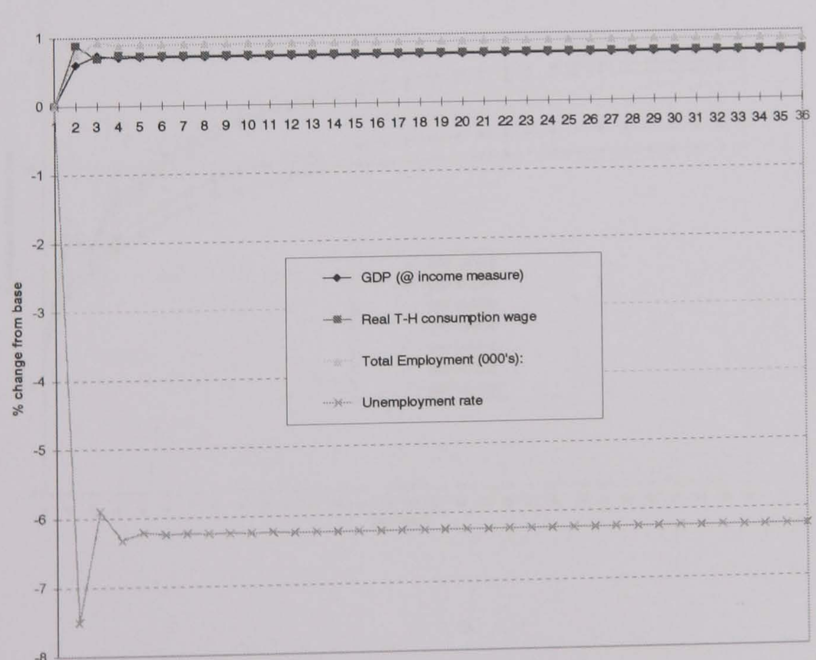


Figure 6.6. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMG SA parameters (rw=0.01)

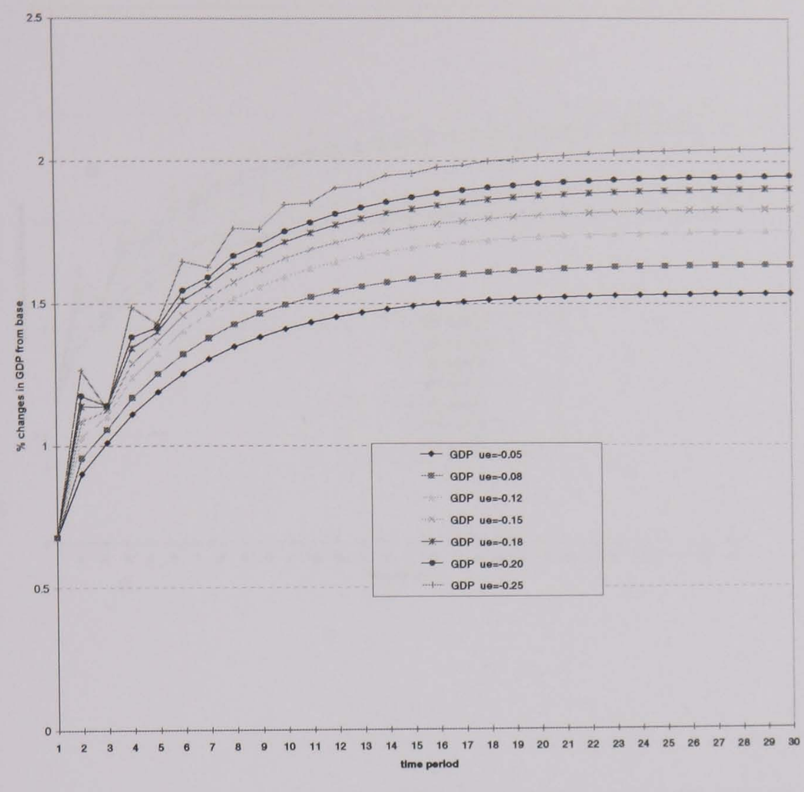


Figure 6.7: Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.04)

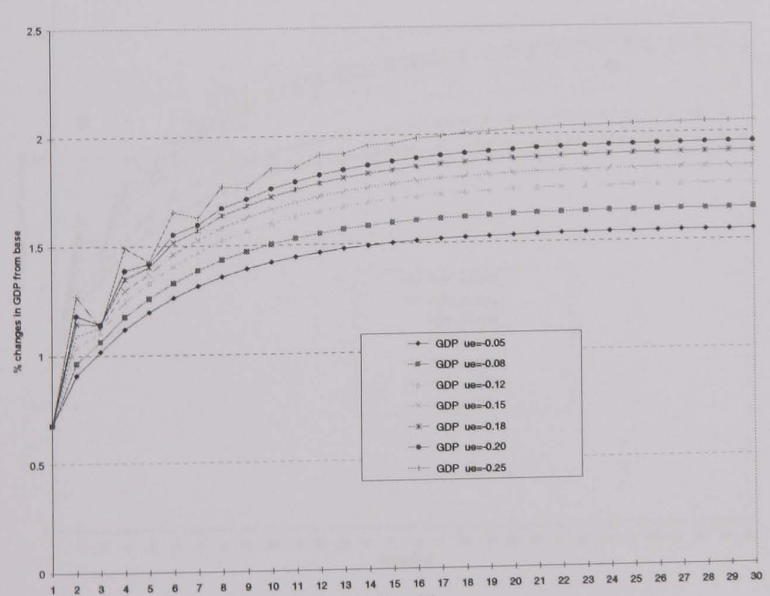


Figure 6.8: Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.06)

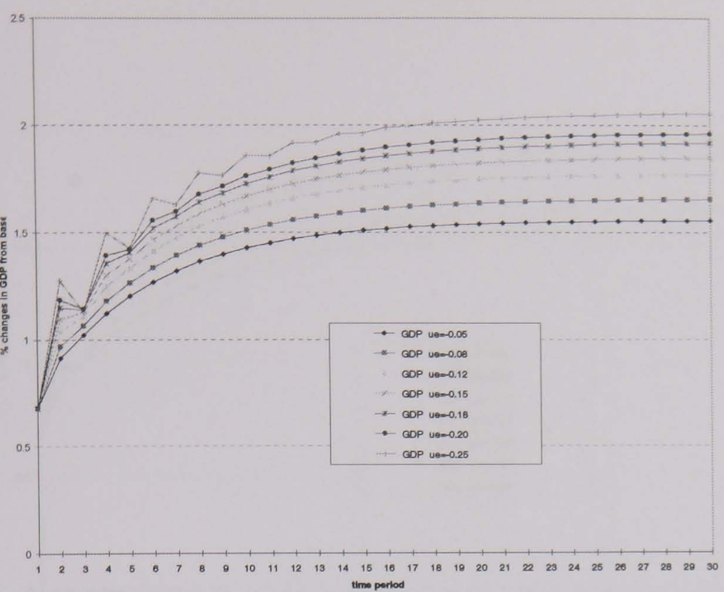


Figure 6.9. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.07)

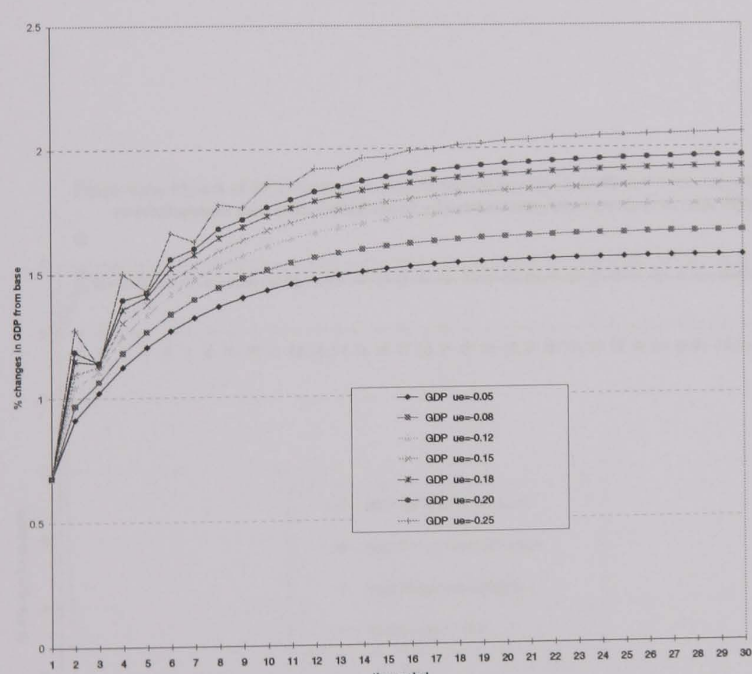


Figure 6.10. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters(rw=0.09)

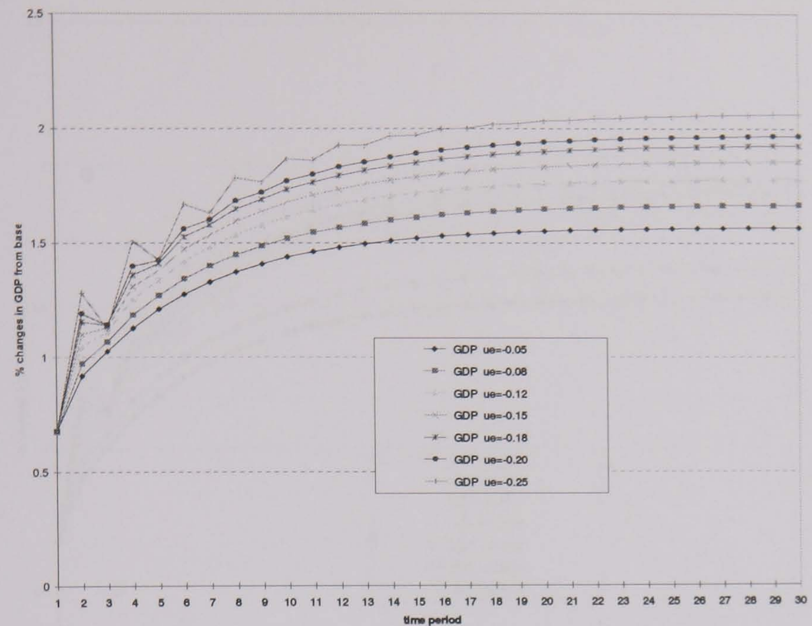


Figure 6.5a. Impact of 10% increase in manufacturing export on GDP, real THC wage, total employment and unemployment rate, with default stock adjustment migration parameter, with fixed capital stocks.

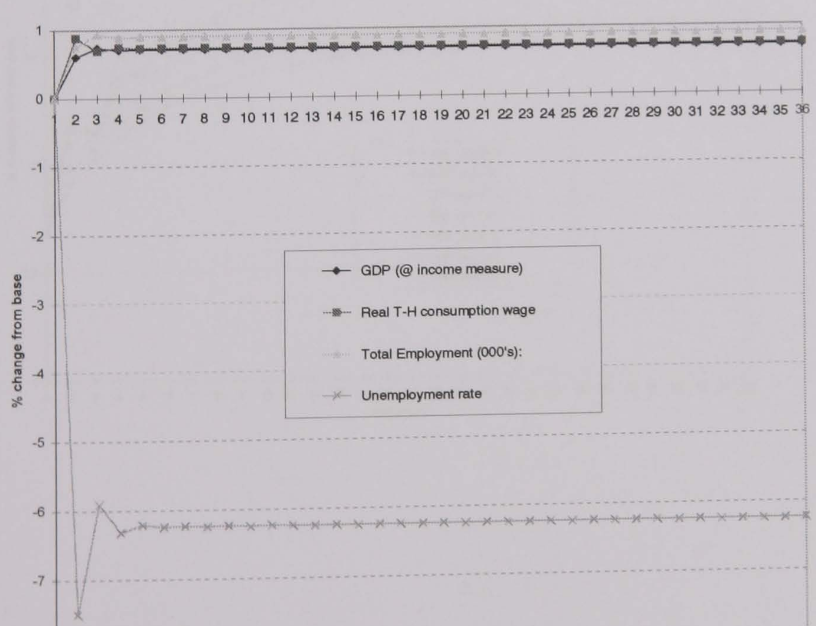


Figure 6.6. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMG SA parameters (rw=0.01)

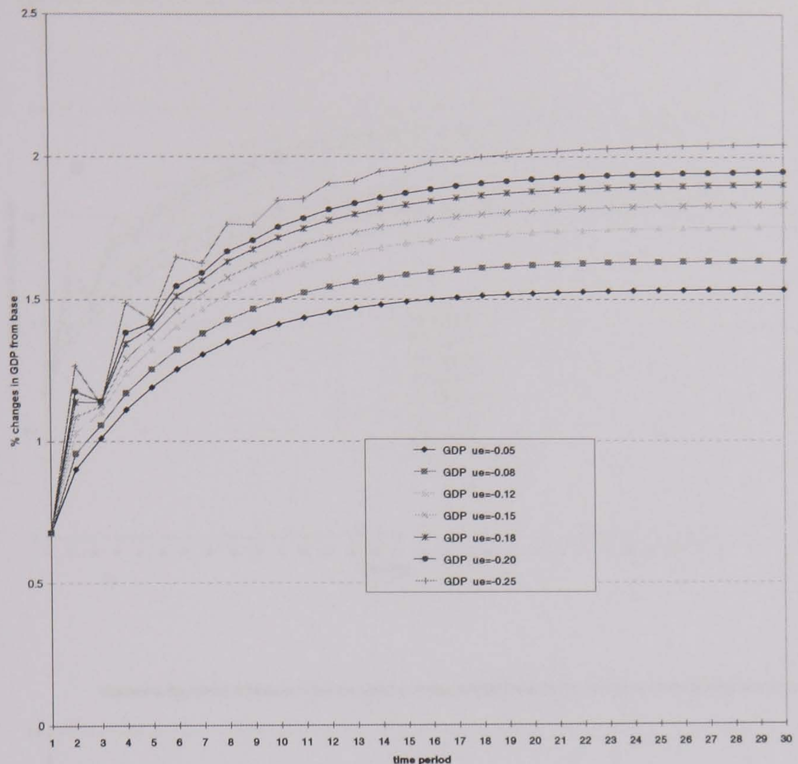


Figure 6.7: Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.04)

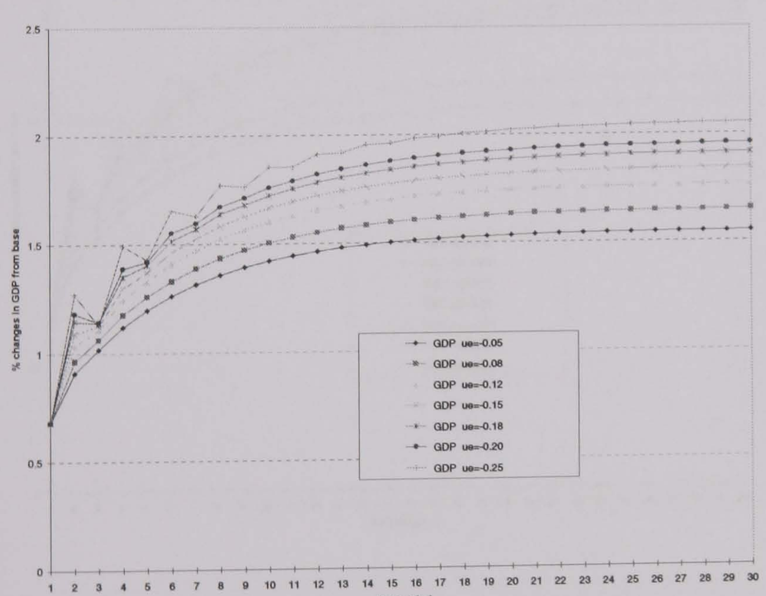


Figure 6.8: Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.06)

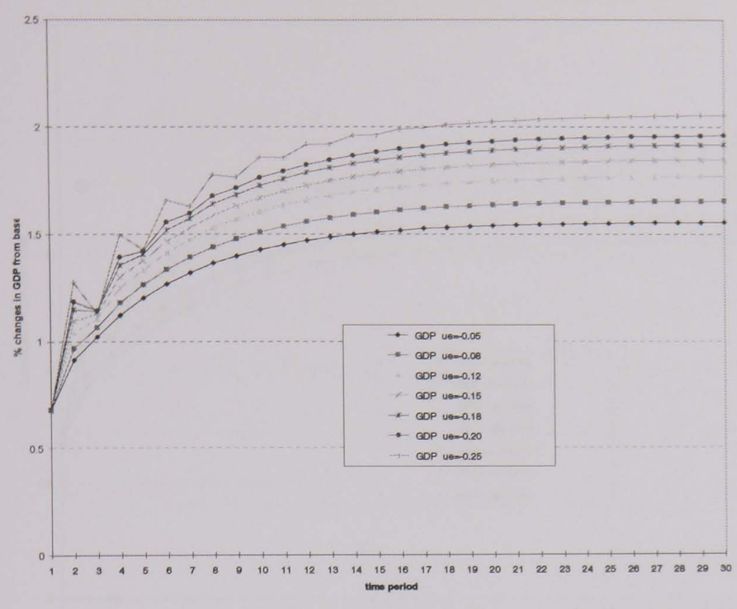


Figure 6.9. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters (rw=0.07)

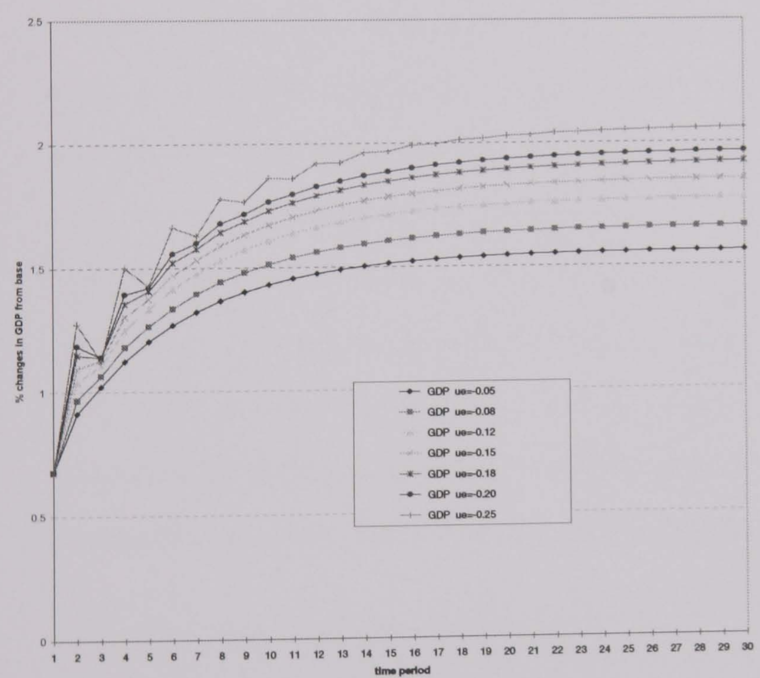
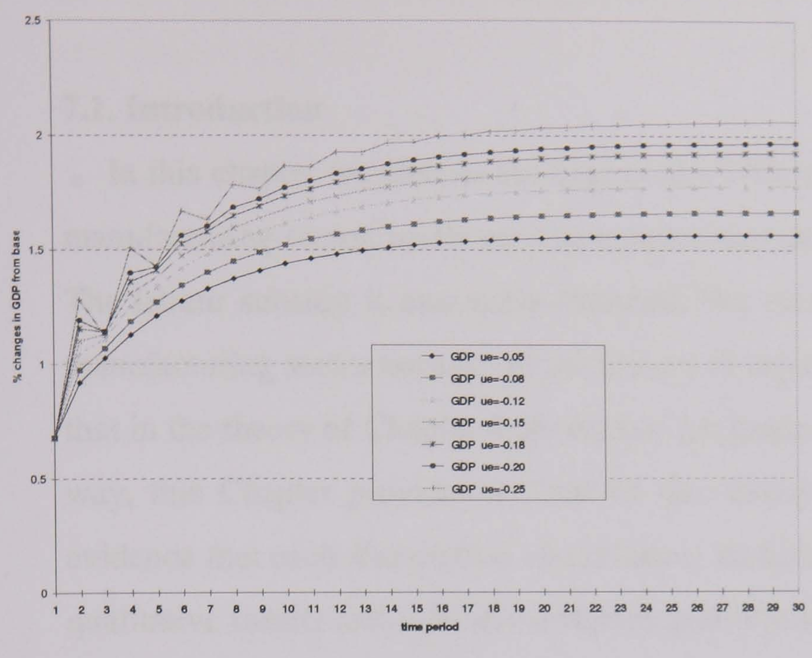


Figure 6.10. Sensitivity of impacts of the 10% increase in manufacturing exports wrt variations in NMGSA parameters(rw=0.09)



Chapter 7. Simulating Supply Disturbances.

7.1. Introduction

In this chapter we discuss the impact of a 10% increase in a labour subsidy to the manufacturing sector, under various assumptions about the degree of labour mobility. The labour subsidy is externally financed. We choose to impose the subsidy to the manufacturing sector because of the history of regional labour subsidies, though note that in the theory of Chapter 4 we discuss the general impact of a labour subsidy. In a way, this Chapter provides a "test" of that theory in a limited sense. We provide evidence that each assumption about labour mobility that we employ yields different qualitative results and radically different quantitative results in the long-run. We also show that the manufacturing sector, where the subsidy is targeted, receives the largest impact, while the other two sectors expand because of increased demands and spillover effects. For each of the migration cases we discuss the sensitivity of the results to variations in the key parameters of the net migration function. We consider the results of the flow-adjustment model of net migration in Section 7.2, and the stock-adjustment model in 7.3. In Section 7.4 we discuss the case of zero labour mobility. In Section 7.5 we explore the impact on our results of assuming that the regional labour market is characterised by national bargaining, rather than the regional bargaining structure that is assumed up to this point in the chapter. We provide some brief conclusions in Section 7.6.

7.2. The Flow-Adjustment Model.

7.2.1. Simulations with the default migration parameters.

In Table 7.2.1 we report the changes in key economic variables as a result of simulating a 10% labour subsidy, which is financed outside the region, on labour costs in the manufacturing sector. The simulations here are performed using the AMOS model, which we explained in Chapter 5, with the bargained real wage (BRW) closure. The elasticity of migration with respect to the real wage and the unemployment rate is 0.06 and -0.08 respectively. We begin by considering the short-run, medium-run and long-run equilibria. In column 1 of Table 7.2.1 we present the short-run results. According to our theory in chapter 4, the labour subsidy reduces the real wage to the firm, but initially the real consumption wage does not change hence creating a labour shortage which pushes up the real wage to the producer a little. Simultaneously the increase in government expenditure implied by the externally financed labour subsidy increases the general equilibrium demand for labour. The real take home consumption wage increases by 1.25 per cent and employment increases by 1.05 per cent. Due to the labour subsidy the real producer wage falls in the manufacturing sector. It rises in other sectors because the real consumption wage increases overall, and these sectors do not benefit directly from a labour subsidy. The CPI increases by 0.47 per cent but the nominal takes home wage increases by more (1.73%) which increases the real take home consumption wage by 1.25 per cent. Simultaneously the unemployment rate falls by 10.40 per cent[1]. GDP increases by only 0.78 per cent. In the manufacturing sector, the price of value added falls by 3.58 per cent. The labour subsidy provides a stimulus to the manufacturing sector by reducing labour costs and therefore prices. As a result Scottish manufacturing goods become more competitive than goods produced elsewhere. Thus exports increase by 3.31 per cent.

In general, the results depend on the wage elasticity of the general equilibrium demand for labour, which is governed by Hicks' laws of derived demand. According to these the wage elasticity of labour demand is positively related to: the elasticity of substitution of capital for labour; the price elasticity of the demand for good being produced; the elasticity of supply of capital and the share of labour in value-added. The labour subsidy has two impacts on the non-manufacturing sectors. First demand increases due to the fiscal stimulus and to the expansion in manufacturing. Secondly, the increase in the consumption wages implies an adverse supply shock to these other sectors which dominates the demand effect in short-run, when value added and employment fall. The real product wage falls in the manufacturing sector, while in other two sectors it increases. The producer cost of labour in the manufacturing

[1] This massive fall in unemployment rate implies the policy maker could have achieve the intended target of reducing unemployment rate almost immediately. Since in the short-run the Scottish

sector falls by 4.09 percent, while in the other sectors it increases by 0.10 percent and 0.17 percent respectively. This reflects the fact that subsidy is to the manufacturing sector only, while the general demand stimulus increase wages across the board. Price falls in the manufacturing sector, which causes exports from this sector to increase, by 3.31 percent. On the other hand, the non-manufacturing traded and sheltered sectors experience price increases which crowd out exports in these two sectors by -2.33 percent and -2.78 percent respectively. In the non-manufacturing traded sector exports fall due to the increase in wages and prices. Obviously with fixed capital, the capital stock cannot change. In fact, capital rental rates increase in all three sectors, reflecting increased demand for capital in each sector. In the manufacturing sector, where the labour subsidy is targeted, capital rental rates increase by 9.37 per cent. In the other traded and in the sheltered sectors capital rental rates increase by 1.42 percent and 0.66 percent respectively, reflecting the general stimulus to demand and the tendency for substitution in favour of capital. In the short-run, while the labour subsidy reduces the real product wage labour and the increase in labour demand pushes up the real consumption wage to increase labour supply, there is no migration. Hence the results we get for the impact period will be identical throughout our study regardless the assumed degree of labour mobility. This result parallels our theory on the impact interval effects where the economy is in temporary equilibrium with a lower real wage to producer and therefore higher employment rate than the initial equilibrium values, as shown by Figure 4.4 of Chapter 4.

In the medium-run, over which capital is fixed but population is optimally adjusted across space, there is no change in the real take home consumption wage as shown by the results, both the nominal wage and the consumer price index increase by the same 0.26 percent from the base. The fact that real take home wage and unemployment rates return to the initial equilibrium values implies NAIRU results which confirms our theory in Chapter 4. As migrants come into Scotland from RUK, attracted by the higher wages and lower unemployment rate relative to elsewhere established in the short-run, the increase in total employment matches the increase in

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population has not changed, the fall in unemployment implies that the jobs created by the labour population at 2.08 percent. This implies that it is 'as if' the extra jobs created by the labour subsidy are fully absorbed by the in-migrants into Scotland, thus leaving the unemployment rate unchanged. The price of value added continues to fall in the manufacturing sector (by 4.15%, more than in the short-run) while in the other two sectors the increase in the price of value added is less than in the short-run (here it rise by 1.31% and 0.63% respectively as compared to 1.63% and 1.55%) given that the wage increase is offset through in-migration. As a consequence, the exports to RUK (and ROW) from the Scottish manufacturing sector increase further (by 3.85% as compared to 3.31% in the short-run). Less export crowding out occurs in the other two sectors (by -1.89% and -1.13%) relative to the short-run results. By the medium-run, the expansion in the manufacturing sector has extended to the non-manufacturing traded and the sheltered sectors, again because net in-migration reverses the rise in the real consumption wage. In the medium-run GDP increases by more than in the short-run. This increase in GDP (of 1.52% from base) is due to the greater impact of the fiscal stimulus as the short-run rise in wages is moderated and ultimately completely offset, reinforced by the increased demand generated by the fiscal expansion and by the increase in intermediate demands due to expansions in all sectors, especially manufacturing.

Finally, in the long-run, with capital optimally adjusted as well as population, the real take home consumption wage remains unchanged as in the medium-run. Capital stocks increase (by 6.21%, 3.82% and 1.96%) in all three sectors. Total employment and population increase by 4.41% from the base, thus implying zero change in the unemployment rate, establishing the NAIRU results as discussed in our theory chapter. The unemployment rate returns to the initial equilibrium level because of in-migration which also causes the real consumption wage to return to the initial equilibrium level. Hence the NAIRU results that occur during the medium-run, now extend into the long-run interval. In all three sectors employment increases by more than the increases in capital stocks implying substitution in favour of labour away from capital. Employment in the manufacturing sector increase by 9.33%, while in the non-manufacturing traded and sheltered sectors, employment increases by 3.86%

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subsidy is mostly absorbed by the local people.

and 2.00% respectively. The price of value added falls (by 7.28%, 0.34% and 0.36% from base) in all the three sectors. Our long-run results are consistent with the finding that the labour subsidy improves the regional "efficiency wage" hence increases Scotland's competitiveness. Regional prices fall (relative to RUK), hence there is a stimulus to traded sectors from increased exports and import substitutes. As shown by Table 7.2.1, as a result of falling prices exports in all the three sectors increase by 6.94%, 0.50% and 0.66% from their base values respectively in the manufacturing, non-manufacturing traded and sheltered sectors. Thus, in the long-run, expansion in employment and exports occur in all the three sectors. Together with the expansion in demands, they generate a 4.20 percent increase in GDP.

Figure 7.1 and Table 7.2.2 show the dynamics of the adjustment. There is a gradual increase in GDP and total employment; both reaching about 95 percent of the long-run steady state value around period 30. The real take home consumption wage rises the most in period one. This is a response to the initial increased labour demand with a fixed population. After period 1 the real take home consumption wage falls gradually towards its original equilibrium value. Simultaneously the unemployment rate initially falls and then gradually increases towards the old equilibrium rate. In period 1 the unemployment rate falls by the greatest percentage (-10.40% from the base value). From period two onwards the unemployment rate rises (although it remains below its base value) and moves gradually towards its original level. During the adjustment period, initially when population and capital are fixed, the supply stimulus in terms of labour subsidy causes labour costs to firms to fall hence encouraging producers to produce more at any given price level. Employment in the target sector rises, which initially reduces the unemployment rate. Initially the increase in the real wage and falling unemployment rate attracts migrants into Scotland from RUK and this creates a further stimulus to demand (intermediate and consumption) and therefore employment. Simultaneously there is an even greater stimulus to labour supply. These imply employment rises, but by less than the labour supply so that the employment rate falls, and hence, under the bargained real wage closure, the real wage falls.

GDP rises to 1.06 percent above base and employment increases by more (1.36 %) in period 2. Population adjustment begins in period 2 where it increases by 0.46 percent from the base value. Note that the increase in population is less than the increase in total employment from period 2 to period 50 implying that the jobs created by the labour subsidy are in part taken by local people. Here, substitution in favour of labour away from capital occurs because in all sectors, especially manufacturing, employment increases by more than the increase in capital stocks. Next, in period 10 through period 80, GDP keeps increasing until it reaches 4.20 percentage points higher than the base. Total employment increases by 4.41% and reaches the long-run steady state value by period 80. The unemployment rate increases to its original value.[2] Table 7.2.2 shows that most of the variables reach the long-run steady state value by period 80. Finally in period 90 total employment increases by 4.41 percent relative to base, with the greatest impact on the targeted manufacturing sector where employment rises by 9.33 percent from the base value. Expansions occurring in the other two sectors are mainly due to the spillover effects from the expansion in the target manufacturing sector. The increased wages increase spending which generate further income both in the manufacturing and non-manufacturing traded sectors. Other things being equal, the adverse supply effects of increase wages dominate demand effects. Initially, here it is the fiscal stimulus which causes effect to be greater than zero. The sheltered sector mainly absorbs the spillover effect from the manufacturing and non-manufacturing traded sectors. Since the price of value added (and output) falls in the manufacturing sector and this is an intermediate purchased by other sectors, in the long-run their prices fall too.

The long-run steady state results do not converge to (augmented) input-output (I-O) results as is the case for the demand stimulus. This is because the prices are permanently affected and there is no equi-proportionate expansion in employment, capital and value added in the three sectors: the labour subsidy creates a permanent incentive to substitute labour for capital. The impact of the 10 percent labour subsidy on the system is thus greater in magnitude in the medium-run and long-run as compared to the short-run case. Next we conduct a sensitivity test to see how the

[2] Only -0.01% less than the base. Note that we are dealing with percentage changes in percentage

impact of the labour subsidy impact varies with the absolute values of the migration elasticities with respect to the real wage and unemployment rates.

7.2.2. Sensitivity analysis.

We report the results in terms of the induced changes in GDP, the real take home consumption wage and the unemployment rate. We use the Layard *et al* (1991) migration model with the same default parameters (real wage elasticity, α_1=0.06, and unemployment rate elasticity α_2=-0.08) as our basis of comparisons. The supply shock that we use is, of course, the same 10% labour subsidy to the manufacturing sector. In our simulations we find that the steady state value of each of the endogenous variables is insensitive to the choice of key parameters of the migration function. This is expected because our theory implies that, with the present flow-adjustment specification of the migration function, wage and unemployment rates should converge to the old equilibrium values of the real take home wage and unemployment rates. We established an identical property with respect to the demand shock, with the flow adjustment model of migration: only the speed of adjustment is sensitive to these parameters. This is reflected in the differences in the net present value of the change in GDP associated with different values of the key migration function parameters.

Figure 7.2 confirms the theory that changes in the degree of mobility have no effects on the final equilibrium level of GDP in the flow model. Notice the larger the absolute magnitude of the parameters (α_1 and α_2) means the more accessible Scotland's labour market is and the larger the short-run impact is. However when a very small absolute value of elasticities is used (see curve A in Figure 7.2), the impact is initially very small and takes more than 90 periods before converging to the long-run steady-state value.

To facilitate interpretation of the sensitivity tests we proceed, as we did in our corresponding sensitivity analysis relating to the demand shock, by first calculating the net present value (NPV) of GDP because this varies directly with the speed of adjustment. (The formula for calculating the net present value is as given in the flow model sensitivity test when the 10% demand shock is analysed.) The results in Table

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unemployment rate here.

7.2.3[3] suggest that the impact of the supply stimulus on NPVGDP is more sensitive to variations in unemployment elasticity than to variations in real wage elasticity. Moving from left to right in a row indicates NPVGDP is not so sensitive to the changes in the elasticity of migration with respect to real wage, α_1; but moving down a column shows it is very sensitive with respect to unemployment rate elasticity, α_2. Fixing the real wage elasticity α_1 at 0.01 and increasing unemployment elasticity α_2 from 0.01 to 0,08 causes NPVGDP to increase by £50,730 thousand from the base value (that is about £51 million). Whereas, when we fix α_2 at 0.01 and increase α_1 from 0.01 to 0.08, this causes NPVGDP to increase by only £12,920 thousand which is about £13 million. Also notice that as we move the real wage elasticity away from the default value, the supply stimulus has more impact on steady-state NPVGDP. The NPVGDP increases by the most, about £116 million (from the base value) when α_1 is 0.11 and α_2 is -0.14. The larger [4]the absolute magnitude of the parameters (α_1 and α_2) the more accessible Scotland's labour market is and the larger the impact is the impact of the labour subsidy. The supply shock causes suppliers to increase the demand for labour as it is cheaper to hire labour than before the labour subsidy is introduced. Simultaneously the unemployment rate falls and the real wage rises. Because of these changes.in-migration into Scotland from RUK increases and so Scotland's population increases.

We summarise sensitivity with respect to to α_1 and α_2 of the impact of the supply shock on NPVGDP in Figures 7.3. Clearly, the impact of the 10% labour subsidy on the NPVGDP is sensitive to changes in the migration parameters with respect to real wage and unemployment. In fact, the impact of the demand stimulus on NPVGDP is more sensitive to variation in α_2 than to variation in α_1. Above the default α_2 (in absolute terms) the impact of the 10% labour subsidy on NPVGDP is less sensitive to changes in α_1. As α_1, the (absolute) real wage elasticity moves closer to zero, the migration parameter with respect to unemployment becomes more important in

[3] We make the elasticities values different because we want to incorporate the maximum value possible for α_1 and α_2. It so happen that absolute α_1 can be extended to 0.11 and α_2 can be extended to 0.14: higher than these absolute values produces erratic simulation results.

[4] There is a limit to how large the absolute parameters can be. We find that increasing the absolute parameters to more than 0.14 causes the results to be erratic hence we choose to stop at reporting the results upto unemployment elasticity of absolute 0.14.

influencing net migration behaviour, relative to the real wage influence. Hence at α_1 = 0.01 the change in NPVGDP as we vary α_2 is greater than when α_1=0.11.

Next, as we move α_2 towards zero, for example at α_2 = -0.01, the impact of the export demand stimulus on NPVGDP becomes very sensitive to changes in α_1. This is so because α_2 is very small relative to α_1 (very close to being zero) and hence the influence of the real wage now dominates. To highlight this effect let us consider the change in NPVGDP when we vary each elasticity. To show the relative dominance of α_2 we evaluate its effect when α_1= 0.11 (since the increase in NPVGDP is smallest at this level of α_1) and compare this with the increase in NPVGDP when α_2= -0.01 where the change in NPVGDP as we vary α_1 is at its greatest. As we move α_1 from 0.01 to 0.11 (α_2=0.01) the NPVGDP increases by £17,290 thousand whereas changing α_2 from -0.01 to -0.12 when α_1= 0.11 results in an increase in NPVGDP of £42,920 thousand.

Where the value of NPVGDP is greater than its value in the default case, this implies that the speed of adjustment is faster (since GDP levels once final equilibrium is attained are equal irrespective of elasticities) and of course were equal prior to the (labour subsidy, supply) shock. Recall that the Layard *et al* (1991) net migration function suggests that migration is more sensitive to unemployment differential than to real wage differential between Scotland and RUK. We limit the increase in real wage elasticity to 0.11 because above that our simulation procedure begins to give erratic results and later breaks down. As for the unemployment elasticity we limit the increase to 0.14 after which the simulation generates erratic results. Also above elasticities: α_1 = 0.11 and α_2= -0.14 the sensitivity of the results does not change much.

7.3. The Stock Adjustment (SA) Model

To capture the importance of the migration specifications in influencing both the qualitative and quantitative results we compare the simulation results generated by the stock adjustment (SA) migration model to those associated with the flow migration model that we reported and discussed above above. We begin by using the

Layard *et al* (1991) default parameter values to emphasise the differences that are due simply to the alternative stock-adjustment (SA) formulation of the net migration function.

7.3.1. Simulations with the default migration parameters.

In Table 7.3.1 we compare the changes in key economic variables as a result of introducing the 10% labour subsidy to manufacturing between the flow-adjustment and stock-adjustment specification of net migration. As before, the simulations are performed the bargained real wage closure. Here we impose the default values of the elasticities of migration with respect to the real wage and unemployment rates, namely 0.06 and -0.08 respectively. We concentrate on the short-run and long-run equilibria. The short-run results of the flow model (which we discussed in the preceding section) are identical to the short-run results of the stock adjustment model since migration only begins to have an impact once population can adjust. The long-run results of the FA and SA models differ qualitatively and quantitatively. The magnitude of the results is very much greater with the flow-adjustment model than with the stock adjustment model. This is expected because with the flow model the in-migration flows continue until the original equilibrium wage and unemployment rates are restored.

The 10 per cent labour subsidy in the long-run reduces the producer cost of labour by 2.33 per cent in the manufacturing sector in the flow model, while in the other sectors the cost of labour is reduced by less than 0.05 per cent. Conversely, with the stock adjustment model the producer cost of labour falls by 1.94 per cent in the manufacturing sector while in the other sectors the cost increases by 0.49 per cent in the non-manufacturing traded sector and by 0.24 per cent in the sheltered sector (reflecting the impact of increased demand on the bargained wage). Total employment rises in all three sectors with the manufacturing sector gaining the most (9.33%) in the flow model, but with the stock-adjustment model employment in the sheltered sector actually decreases by about 1.00 per cent. As mentioned in the theory chapter, the unemployment rate returns to its NAIRU within the flow model, but under the stock adjustment model the unemployment rate ultimately decreases by 12.65 per cent. The long-run equilibrium results with the stock adjustment migration model under the bargain real wage closure fail to produce Input-Output results because of the long-run increase in the bargained real wage. As a result the long-run equilibrium prices of all factors and commodities rises in the other sectors. Likewise in the flow model no I-O result is established but the real wage returns to the initial equilibrium level and so does the unemployment rate. The long-run impacts on value added, employment and capital stocks within the sectors are not equi-proportionate. In the manufacturing sector there is substitution of labour for capital, given the fall in the cost of labour to firms. While in the other two sectors substitution now works the other way; capital is substituted for labour.

The results in Table 7.3.1 thus provide the evidence that, with the flow model, the old equilibrium levels of the real wage and unemployment rates are established (hence establishing a NAIRU), but with the stock adjustment model the labour market settles at a wage higher than the initial equilibrium real wage (1.54% more) and at lower unemployment rate than in the initial equilibrium. Thus as our theory suggest, there is no NAIRU result with the stock adjustment specification of the migration function. In Table 7.3.1a we show the results of the short-run, medium-run and long-run impact of the 10% labour subsidy to manufacturing with the stock adjustment model of migration. (Here the "medium-run" solution is obtained simply from a multi-period solution to running the model forwards with capital stocks fixed.) The short-run result shows much smaller macroeconomic impacts than the short-run result of the multi-period simulation because in the latter case both capital stock and population are endogenous, whereas in the multiperiod medium-run model investment is exogenous. Hence there less expansionary impact in the medium-run model. Notice that in this model, in the medium-run the real wage and unemployment rates do not return to their inital equilibrium values: the real take home wage increase by 0.96%, while the unemployment rate is permanently reduced by 8.14%. Population increases by 0.35% in the medium-run due to in-migration into Scotland, however this is not enough to push real wages down to their initial levels, in contrast to the flow-adjustment model. We next discussed the multi-period results.

In Table 7.3.2 we provide the results of the impact of the 10 per cent labour subsidy to manufacturing at periods 1, 5, 10, 20, 30 and 35 with the stock adjustment model of migration, employing the default parameters. Notice that the real take home wage, employment rate, consumer price index and population reach the long-run steady state results by period 30. More than 90 per cent of the adjustment occurs by period 10 for most of the variables. The 10 per cent labour subsidy to manufacturing reduces the producer cost of labour of that sector by 4.09 per cent in period 1. This parallels our theory that as a result of the labour subsidy, in the impact period the real wage to the firm falls markedly. But in the other two sectors the producer cost of labour has actually increased throughout the simulation period. This is due to the fact that the fall in the product wage of labour to the manufacturing sector, on which the subsidy is targeted, causes a general increase in the demand for labour. This occurs as a result of increase in intermediate and consumption demand and because of the fiscal stimulus. This stimulus to labour demand pushes up the market clearing bargained real wage. Value added increases only in the manufacturing sector in period one, and likewise employment initially expands only in the manufacturing sector. By period 5 employment in the non-manufacturing traded sector also expands as the increased demand from the fiscal stimulus also increases demand from this sector, and wage increase to other sectors are now moderated as immigration occurs. Note as capital adjusts, this increase the wage elasticity of labour demand. Also, capital stock increases imply greater responsiveness to the initial change and greater intermediate demands by manufacturing sector. Employment in the sheltered sector, however, actually shrinks throughout the simulation period. Since capital stocks are fixed initially, capital rental rates increase by the most in period 1 (by 9.37%) relative to other periods. By period 5 capital stock expands by 2.41% in the manufacturing sector, while in the other sectors it expands by 0.44% and 0.16%. Correspondingly the returns to capital decrease in the manufacturing sector although they are still higher than in the base period, by 4.22%. In the other two sectors capital rental rates remain high relative to period one. Exports from manufacturing sector have increased by 4.45% during this period, while in the other two sectors exports fall by 2.36% and 2.79% respectively.

Exports from the manufacturing sector increase to their long-run equilibrium values by period 35, while in the other two sectors exports remain below their base values. The labour subsidy thus makes the manufacturing sector more competitive than the other sectors as reflected in the fall in the price of value added and output in the manufacturing sector, hence expanding export demand for this sector's output. In the other two sectors, the price of value added has increased, reflecting the wage rise generated by the stimulus to labour demand. In Figure 7.4 we show the heavy concentration of the long-run employment impact in manufacturing: almost all of the employment increase is concentrated in this sector. The long-run impacts are reached more quickly than under the flow adjustment model.

Figure 7.5 shows the dynamics of the response to the 10% labour subsidy to manufacturing in terms of changes in GDP, the real take home consumption wage, total employment and the unemployment rate. Long-run adjustment occurs faster in the stock adjustment than in the flow adjustment model. The long-run result is obtained at period 90 in the flow model whereas with the stock model the long-run result is obtained by period 35. Notice that the real take home wage increases the most in period one relative to the base. More than 90 percent of the adjustment is reached by period 5. The increase in the real take home wage is permanent as are price increases; the increase in demand caused by the fiscal stimulus pushes price up permanently. This increase in the demand for labour is responsible for the increase in the real take home consumption wage as workers demand a higher wage rate in the bargained real wage closure. The increase in wage rates relative to the previous period attracts migrants into Scotland. The increased wages mean increases in employment, and simultaneously unemployment falls. Like the real wage, the unemployment rate does not return to its initial equilibrium level. Hence with the stock adjustment migration specification, real wage and employment rates are permanently expanded, while the unemployment rate is permanently reduced. These effects are entirely in line with our theoretical analysis.

7.3.2. Sensitivity Analysis.

In this section we change the elasticity of migration with respect to the real wage and unemployment rate differentials in order to explore the sensitivity of the impact of the labour subsidy to such changes. Notice that the values of the key migration parameters change the steady-state solutions, unlike the flow model where the long-run equilibrium solutions are entirely unaffected by changes in these elasticities. In Table 7.3.3 we show how the impact of the 10 per cent labour subsidy to manufacturing, assuming the stock adjustment model of migration, varies with the values of the key parameters of the net migration function. The first column shows the result when default migration parameters are used. Moving from left to right, beginning from column two the results show that as we increase the migration elasticity with respect to real wage (α_1) and unemployment rate (α_2) the impact on the main macroeconomic variables increases gradually. However as we increase the absolute value of α_1 to 0.11 and α_2 to 0.14[5] our results become erratic for the earlier time periods, although finally the long-run results are established. Figure 7.6 shows the sensitivity of impact of the 10 per cent labour subsidy to manufacturing on GDP as we vary the migration elasticities. Notice as we increase the absolute elasticities away from the default the impact on GDP increases.

Clearly, Figure 7.7 implies that GDP is more sensitive to changes in the unemployment elasticity than to changes in the real wage elasticity. At a fixed value of α_1, GDP rises sharply as we increase the absolute α_2 to 0.07 and after that GDP rises but at a declining rate. At α_1=0.01 for example, increasing the absolute α_2 from 0.01 to 0.08 causes GDP to increase by about £9 million. Alternatively at α_2=0.01, increasing the $\alpha 1$ from 0.01 to 0.08 causes GDP to increase by only about £1.2 million (see Table 7.3.4).

7.4. The impact of a 10% labour subsidy with zero labour mobility.

In Table 7.4.1 we present the short-run and long-run impact of the 10 percent labour subsidy when no migration is allowed into the region. The simulation is conducted exactly as before, but with the net migration function eliminated from the model. The short-run result is identical to that of Table 7.3.1, because in the short-run migration has no impact on population. There is no conceptual medium-run interval

[5] We choose 0.11 as the maximum value of the real wage elasticity in our simulation because that is the furthest $\alpha 1$ can be stretched and yet getting the long-run steady state results. The unemployment

in this case because there is no migration. In the long-run with no migration allowed, and with capital endogeneity, the real take home consumption wage increases by 1.78 per cent, and the unemployment rate falls by 14.42 per cent. Unlike the flow-adjustment migration case, here the real wage and unemployment rate do not return to their initial equilibrium values. The labour subsidy causes the real wage to the firm to fall and this increases the employment rate (thus lowering the unemployment rate), but since no migration is allowed, with the bargained real wage closure, the higher employment implies higher wage rates. The employment increase is greatest in the manufacturing (by 6.37%), but employment also increases in the non-manufacturing traded sector increases, although only by 0.33 per cent, while in the sheltered sector employment actually falls by 0.40 per cent. Capital stock increases by 3.92 per cent in the manufacturing sector, which implies labour is still substituted for capital, but in the non-manufacturing traded and sheltered sectors substitution in favour of capital away from labour occurs as reflected in capital increases that are more than double the proportionate increase in employment in the non-manufacturing traded sector. In these sectors the general push on wages implies there is substitution of capital for labour. In the sheltered sector, the capital stock increases (by 0.49%), while employment falls by 0.40 per cent. Consequently, capital rental rates in all three sectors fall relative to short-run period, although they are still higher than the base. Hence, without migration, the labour subsidy expands employment in the targeted sector quite considerably while it shrinks employment in the sheltered sector. In the long-run, labour is transferred from the sheltered to the manufacturing sector. Exports from the manufacturing sector increase by 4.92 per cent but in the other two sectors, exports shrink by 2.42 and 3.52 percent respectively.

In Table 7.4.2 we report the multi-period results for periods, 1, 2, 10, 20 and 35. The period one results are as discussed above. Capital stocks begin increasing from period 2, and the increase is very substantial in the manufacturing sector, where it reaches more than 80% of the adjustment by period 10. From period 2 capital stocks increase by less than 1% throughout, in the other sectors, which shows there is not much expansion in the other sectors relative to the manufacturing sector. The labour

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rate elasticity can be expanded even further; we extend it to -0.14 beyond this value our simulation subsidy targeted on the manufacturing sector has made the manufacturing sector more competitive relative to the non-manufacturing traded and sheltered sectors. Value added increases steadily in the manufacturing sector and reaches 96% of the adjustment at period 10, and reaches more than 70% of the adjustment at period 2. Exports from the manufacturing sector increase, from period one (by 3.31%) and achieve more than 70% of the adjustment by period 2, and more than 95% of the adjustment occurs by period 10.

Figure 7.8 illustrates the dynamics of the adjustment process. There is a modest increase in GDP and total employment; both reach about 95 per cent of the long-run steady state value by period 5. The real take home consumption wage rises gradually from period one and reaches the maximum at period 35. The real take home wage achieves more than 90% of full adjustment by period 10 and more than 60% adjustment by period 2. This is the major difference between the no migration case and the flow-adjustment model. The steady state value is obtained faster when there is no migration because the fall in the real wage to the firm causes employment to increase, this quickly absorbs the available labour supply within the region, thus reducing the unemployment rate significantly. There is no long-run expansion in the labour force in this case because no migration is allowed. Hence the unemployment rate is permanently reduced while the real wage remains higher than the original equilibrium level. As more employment is created, labour gets scarce, there is upward pressure on wages and it is more likely that the expansion will cause substitution in favour of capital and away from labour. Table 7.4.2 shows that most of variables complete more than 95 percent of the adjustment by period 20.

7.5. National Wage Bargaining

Recall that, in this case, wages are determined within an integrated national bargaining system, which implies that the nominal wage is exogenous to small open regional economies such as Scotland. This implies that regional influences do not have a direct impact on regional wages: in particular, the regional unemployment rate does not influence the regional wage rate. The impact of the supply shock in the form of a 10% labour subsidy on quantities is likely greater, but on prices is likely to be

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results get erratic and finally the simulation breaks down.

less at least in the short-run, since nominal wages do not respond by rising to the general stimulus to demand. The impact on GDP and other economic variables should be higher as prices are less affected. When migration is included, there maybe be a smaller migration effect since the real wage does not increase so as to attract migration into Scotland. But the impact on the unemployment rate is bigger. According to the theory the increase in demand which increases employment will be the main attraction for migrants to come into Scotland.

7.5.1. The Flow Adjustment Model.

Table 7.5.1 shows the impact of 10% labour subsidy to manufacturing on key economic variables at various time periods with the national bargaining wage closure, with the flow-adjustment migration model. The period one[6] increase in GDP is more than double the period one increase in GDP under the bargained real wage (BRW) closure. There is an increase in the demand for labour as a result of the subsidy but the nominal wage remains unchanged and, since prices increase initially, the real take home consumption wage actually falls in period 1 and period 2. The unemployment rate falls most in period 1 (by 21.61%), after which it falls but at a decreasing rate. However by period 50 onwards it increases by about 0.19%. Since there is no increase in the real wage to attract migrants into Scotland, the only incentive to migrate into Scotland is the increase in employment rate that resulted from the increase in consumption and intermediate demand. Capital rental rates increase the most in period one for each of the three sectors because capital stock is fixed. In the manufacturing sector, where the shock occurs the capital rental rate increases by 11.64 %, while in the non-manufacturing and sheltered sectors it increases by 3.57% and 2.60% respectively. By period 50, capital stocks are fully adjusted. In general, substitution in favour of labour away from capital occurs, stimulated by changes in relative factor prices. Initially, all move in favour of labour. Eventually, this is not true of the non-manufacturing sectors. After period 50, substitution in favour of capital away from labour occurs, in the non-manufacturing traded and sheltered sectors and capital stocks now increase by more than the

[6]The period one results are identical no matter what migration model is used because at period 1 migration effect has not occured.

increase in employment. However, these effects are not observed in the BRW closure as discussed above (where the real wage is greatly affected by the shock initially but gradually falls back to the initial rate).

The producer cost of labour decreases throughout the simulation period in the manufacturing sector, which reflects the fact that this is where the subsidy is targeted. However, unlike with the BRW closure, where the general demand stimulus increase wages across the board, with the national bargaining closure there is no change in nominal wages, and the real wage actually falls initially. Although complete adjustment occurs by period 90, for most variables more than 90 percent of the adjustment occurs by period 10.

Figure 7.10 provides the plot of the adjustments when national wage bargaining is used. Notice that real wage falls initially and then bounces back to its initial level. From period 4 onwards there is almost no change in the real wage. The increase in the subsidy implies that it is cheaper for the producer to hire more workers, hence total employment increases and simultaneously the unemployment rate falls. Regional real wages are not much affected under this national wage closure after their initial fall. Figure 7.10a summarises the impact of a 10% increase in labour subsidy on GDP, real take home wage, total employment and unemployment rate with the flow migration model, under the same national wage bargaining closure, but with fixed capital stock. With a fixed capital stock, the long-run adjustments occur faster than when the capital stock is not fixed and the impact on the economic variables is lesser in magnitude than the impact when the capital stock varies. Comparing Figures 7.10 and 7.10a, in period 1, the unemployment rate is reduced by about 22% in the former, but in the latter, the unemployment rate falls by about 19%. About 90% of the total adjustment in the unemployment rate occurs by period 10 in Figure 7.10, but in Figure 7.10a the same adjustment occurs faster (by period 5).

7.5.2. The Stock Adjustment Model

In Table 7.5.2 we provide the results of the impact of 10 per cent labour subsidy to manufacturing at periods 1, 2, 10, 20 and 35, with the stock-adjustment model of migration under the national wage bargaining closure. As with the BRW closure, the long-run equilibrium results are achieved faster than with the flow adjustment model.

Throughout the simulation period, GDP increases by more than double the increase in GDP when the BRW closure is used. With the BRW closure, the nominal take home wage increases throughout in response to the stimulus, but with the national wage bargaining closure the nominal take home wage is fixed. Wages in this case are determined externally, so that regional factors have no influence on wages. In the first few periods the increase in the consumer price index causes the real take home wage to fall, given that nominal wage is unchanged. But from period 10 onwards the fall in cpi causes real wage to increase, although not as much as the increase in real take home wage under the BRW closure. Notice that, with the BRW closure, the real wage increases because workers demand more wages, but with national wage bargaining, the real wage only increases because cpi falls. Here total employment increases by more than capital stocks throughout the entire period in all sectors (except in period 35 of the sheltered sector), which implies that substitution in favour of labour away from capital occurs. Exports from the manufacturing sector, to RUK and ROW, increase by more than the increase in exports under the BRW closure because price falls (after period 2), thus Scottish goods are more competitive than goods from elsewhere. There is no NAIRU result here because the unemployment rate does not return to the original value, nor does the real wage.

7.5.3. Zero Labour Mobility.

In Table 7.5.3 we report the results of the impact of 10 per cent labour subsidy to manufacturing at various time periods namely periods 1, 2, 10, 20 and 35 with zero labour mobility under the national wage bargaining closure. Since the nominal wage remains unchanged throughout the entire simulation period, changes in the real take home consumption wage depend on changes in the consumer price index (cpi). During the initial period when the cpi increases as a result of the increase demand, the real take home consumption wage falls, but later the real take home consumption wage increases as cpi falls. Capital stock increases from period 2, especially in the manufacturing sector where it increases by 5.78% by period 35. Unlike with the BRW closure, where crowding out of employment occurs in the non-manufacturing traded and sheltered sectors, there is no crowding-out in these two sectors under the national wage bargaining closure. Employment increases in all three sectors with the target manufacturing sector exhibiting the greatest impact. Total employment in the manufacturing sector in the long-run increases by 8.81% as compare to the 6.37% increase under the BRW closure. The unemployment rate decreases markedly under the national wage bargaining relative to the BRW closure. In the long-run the unemployment rate falls by 37.42% under the national wage bargaining closure, while under the BRW closure it falls by 14.42%. Thus it seems that the magnitude of the impact on real economic variables is greater when the national wage bargaining closure is appropriate as compared to the BRW closure. This is because under the national wage bargaining, the nominal wage is determined externally, hence any changes in the regional labour market do not affect local nominal wages. With the BRW closure, in contrast, wages are determined regionally by workers bargaining. Hence any changes in the regional market, reflected in unemployment rate changes, affect wages which then affect the response of other variables.

7.6. Conclusion.

The results that we report above suggest that, when migration is incorporated endogenously in the system, with the flow-adjustment model, a 10% supply stimulus in the export sector generates a 9.33% rise in employment in the target manufacturing sector, in the long-run under the bargained real wage closure. Employment, value added and capital stocks within each sector increase but not equi-proportionately for both the flow-adjustment (FA) and stock-adjustment (SA) models. This implies that the results do not parallel those of the Input-Output[7] system in the long-run. In the long- run prices fall, and labour for capital substitution occurs as reflected in the fact that the proportionate changes in labour are greater than the corresponding changes in capital stocks. This is due to the fall in the price of labour to firm. If the Layard *et al* (1991) flow migration model is correct, then the supply shock will stimulate employment and output significantly, especially in the target manufacturing sector, while in the other two sectors the expansions are mainly due to the spill over effects.

In the medium-run output growth in the manufacturing sector spills over into the peripheral sectors. However, due to the impact of migration, the unemployment rate ultimately remains unchanged and the real wage settles at the old equilibrium

[7] Note that with the supply shock none of the simulations exhibit I-O results in the long-run.

wage. These suggest that our results conform to the notion of a NAIRU or the "natural rate" results. Indeed NAIRU here is insensitive even to a supply-side policy. In the sensitivity test we find that as we increase the parameters away from the LNJ default parameters, the impact cause by the supply disturbance is increased. This reflects the increased in the speed of adjustment. The assumed relationship of real wage and unemployment, implies that the real wage has to fall as unemployment rises. The bargained real wage closure means the real wage has to rise to promote employment in the expanding sector. However, the increased real wage has a crowding out effect on the other two sectors. Later on in the adjustment process the crowding out effect is reduced, and eventually eliminated, as the real consumption wage falls back to the old equilibrium.

Our results thus far suggest that the impact of the 10 percent labour subsidy varies both in magnitude and speed of adjustment, depending on the type of migration model we employ. The flow-adjustment model generates larger impacts than the stock adjustment migration model. For example GDP ultimately increases by 4.20% in the former (SA model), but by only 1.77% in the latter (FA model). However, the respective long-run equilibrium results are obtained faster with the stock adjustment model than with the flow model. The long-run results are different in the two models: the flow model exhibits a NAIRU result, where the unemployment rate returns to the original level, but this is not a characteristic of the stock adjustment model. This confirms our earlier suggestion in the introductory chapter: the existence of a regional "natural rate" of unemployment may depend on the nature of the net migration function. The steady-state solution is sensitive to variations in the migration parameters under the stock adjustment migration specification, but not with the flow adjustment migration model. Note also that with the flow model equilibrium is achieved at a new zero-net-migration schedule (unlike the results with the demand stimulus using the flow adjustment migration model where equilibrium satisfying the original zero-net-migration condition is re-established). In the stock adjustment model the zero-net-migration equilibrium condition, as conventionally interpreted, is not applicable.

With zero labour mobility, the long-run steady state results are achieved faster: effectively by period 35. A 10% supply stimulus in the export sector generates a 6.37% rise in employment in the target manufacturing sector, in the long-run. Capital stocks increase in all sectors, but employment and value added increase only in the manufacturing and non-manufacturing traded sectors. In the sheltered sector employment and value added fall by 0.41% and 0.31% respectively. Thus input-output results are not achieved in the long-run because prices increase in the non-manufacturing traded and sheltered sectors and, in the manufacturing sector, substitution away from capital for labour occurs as reflected in the change in labour (6.37%) which is greater than the change in value added (5.77%) which in turn is greater than the change in capital (3.92%). But in the non-manufacturing traded sector and the sheltered sector substitution for capital away from labour occurs as reflected in the change in employment being smaller than the change in value added, which is, in turn, smaller than the change in capital stock. The unemployment rate does not return to its original level, nor does the real wage, so our results with zero migration are not consistent with the existence of a NAIRU at the regional level. Table 7.5.1 provide the long-run unemployment results for various degree of labour mobility.

Table 7.6.1. The long-run impact of labour subsidy on unemployment rates.

	Long-run impact on unemployment rates (% increase from base) BRW	Long-run impact on unemployment rates (% increase from base) National Bargaining
Flow adjustment	0.00	0.19
Stock adjustment	-12.65	-26.28
Zero mobility	-14.42	-37.42

With fixed nominal wage unemployment rates fall initially by 21.61 percent and in the long-run it fell by 37.42 percent. As nominal wage is fixed consumer price index fell by 0.25 percent. Capital rental rates increase the most in period one for each of the three sectors because capital stock is fixed. In the manufacturing sector, where the shock occurs the capital rental rate increases by 11.64 %, while in the non-manufacturing and sheltered sectors it increases by 3.57% and 2.60% respectively. By period 35, capital stocks are fully adjusted.

Our findings thus far suggest that, as our theory implies, the system-wide impact of a 10% labour subsidy depends both qualitatively and quantitatively on the precise specification of the migration function.

Tables.

Table 7.2.1. The short-run, medium-run and long-run impact of 10% labour subsidy to manufacturing with default parameter values of migration

	short-run	med-run	long-run
GDP (income measure)	0.78	1.52	4.20
Consumption	1.21	1.62	3.40
Nominal take home wage	1.73	0.26	-0.38
Real T-H consumption wage	1.25	0.00	0.00
Producer cost of labour:			
Manufacturing	-4.09	-4.91	-2.33
Non-Manu traded	0.10	-1.04	-0.04
Sheltered	0.17	-0.37	-0.02
Value-added:			
Manufacturing	3.85	4.61	8.56
Non-Manu Traded	-0.06	0.64	3.85
Sheltered	-0.26	0.57	1.99
Total Employment (000's):	1.05	2.08	4.41
Manufacturing:	5.16	6.20	9.33
Non-Manu traded:	-0.09	0.96	3.86
Sheltered:	-0.31	0.68	2.00
Unemployment rate	-10.40	0.00	0.00
Population (000's)	0.00	2.08	4.41
Net in-migration (000's)	-	-	-
Price of value added:			
Manufacturing	-3.58	-4.15	-7.28
Non-Manu traded	1.63	1.31	-0.34
Sheltered	1.55	0.63	-0.36
Capital rental rates:			
Manufacturing	9.37	11.37	-0.25
Non-Manu traded	1.42	3.49	-0.26
Sheltered	0.66	2.54	-0.26
Consumer price index	0.47	0.26	-0.38
Capital stocks:			
Manufacturing	0	0	6.21
Non-Manu Traded	0	0	3.82
Sheltered	0	0	1.96
Exports to RUK:			
Manufacturing	3.31	3.85	6.94
Non-Manu Traded	-2.33	-1.89	0.50
Sheltered	-2.78	-1.13	0.66
Exports to ROW:			
Manufacturing	3.31	3.85	6.94
Non-Manu Traded	-2.33	-1.89	0.50
Sheltered	-2.78	-1.13	0.66
Real income			
Households disposable	1.69	1.88	3.00
Labour income	0.50	0.05	1.59
Capital income	3.07	5.07	3.61

Table 7.2.2. Impact of 10% labour subsidy to manufacturing on key economic variables at various time periods using the LNJ (flow) migration model

	1	2	10	20	50	80	90
GDP (income measure)	0.78	1.06	2.61	3.52	4.15	4.20	4.20
Consumption	1.21	1.38	2.35	2.95	3.36	3.40	3.398
Nominal take home wage	1.73	1.49	0.51	0.01	-0.35	-0.38	-0.381
Real T-H consumption wage	1.25	1.05	0.40	0.17	0.01	0.00	0.00
Value-added:							
Manufacturing	3.85	4.42	6.87	7.89	8.50	8.55	8.56
Non-Manu Traded	-0.06	0.17	1.77	2.92	3.77	3.84	3.84
Sheltered	-0.26	-0.08	0.90	1.51	1.95	1.99	1.99
Total Employment (000's):	1.05	1.36	2.90	3.76	4.36	4.41	4.41
Manufacturing:	5.16	5.65	7.77	8.70	9.28	9.32	9.33
Non-Manu traded:	-0.09	0.21	1.91	3.00	3.79	3.85	3.86
Sheltered:	-0.31	-0.11	0.92	1.53	1.96	2.00	2.00
Unemployment rate	-10.40	-8.80	-3.49	-1.48	-0.12	-0.01	-0.01
Population (000's)	0	0.46	2.53	3.60	4.35	4.41	4.41
Net in-migration (000's)	--	--	--	--	--	--	--
Price of value added:							
Manufacturing	-3.58	-4.06	-6.05	-6.81	-7.24	-7.27	-7.27
Non-Manu traded	1.63	1.61	0.97	0.27	-0.29	-0.34	-0.34
Sheltered	1.55	1.42	0.60	0.07	-0.33	-0.36	-0.36
Capital rental rates:							
Manufacturing	9.37	7.99	2.36	0.60	-0.19	-0.25	-0.25
Non-Manu traded	1.42	1.88	1.93	0.81	-0.17	-0.25	-0.25
Sheltered	0.66	1.05	1.06	0.36	-0.20	-0.26	-0.26
Consumer price index	0.472	0.434	0.106	-0.161	-0.364	-0.381	-0.38
Capital stocks:							
Manufacturing	0	0.78	4.16	5.44	6.15	6.20	6.20
Non-Manu Traded	0	0.09	1.48	2.75	3.73	3.81	3.82
Sheltered	0	0.02	0.76	1.42	1.92	1.96	1.96
Exports to RUK:							
Manufacturing	3.31	3.77	5.71	6.47	6.91	6.94	6.94
Non-Manu Traded	-2.33	-2.31	-1.41	-0.39	0.43	0.49	0.50
Sheltered	-2.78	-2.53	-1.08	-0.12	0.60	0.66	0.66
Exports to ROW:							
Manufacturing	3.31	3.77	5.71	6.47	6.91	6.94	6.94
Non-Manu Traded	-2.33	-2.31	-1.41	-0.39	0.43	0.49	0.50
Sheltered	-2.78	-2.53	-1.08	-0.12	0.60	0.66	0.66
Nominal income:							
Households disposable	1.69	1.82	2.46	2.78	2.99	3.00	3.00
Labour income	0.50	0.56	1.06	1.37	1.57	1.59	1.59
Capital income	3.07	3.33	3.74	3.68	3.61	3.61	3.61

Table. 7.2.3. Sensitivity of NPVGDP to supply stimulus with variations in migration parameter wrt real wage elasticity α_1 and unemployment elasticity α_2. The unit of NPVGDP is in thousand £.

rwage elasticity, α_1 / unemploy elasticity, α_2	0.01	0.03	0.05	0.06	0.08	0.09	0.11
-0.01	97300	101460	105230	106970	110220	111740	114590
-0.03	123570	125510	127300	128160	129780	130560	132040
-0.05	136960	138070	139130	139630	140600	141070	141970
-0.07	145070	145790	146470	146810	147460	147770	148380
-0.08	148030	148630	149200	149480	150030	150290	150800
-0.10	152610	153040	153450	153660	154050	154250	154620
-0.12	155980	156300	156610	156770	157070	157220	157510
-0.14	158550	158810	159050	159170	159410	159530	159760

Table 7.3.1. The short-run and long-run impact of 10% labour subsidy to manufacturing with default parameter values of migration

	flow adjustment		stock adjustment	
	short-run	long-run	short-run	long-run
GDP (income measure)	0.78	4.20	0.78	1.77
Consumption	1.21	3.40	1.21	1.91
Nominal take home wage	1.73	-0.38	1.73	1.92
Real T-H consumption wage	1.25	0.00	1.25	1.54
Producer cost of labour:				
Manufacturing	-4.09	-2.33	-4.09	-1.94
Non-Manu traded	0.10	-0.04	0.10	0.49
Sheltered	0.17	-0.02	0.17	0.24
Value-added:				
Manufacturing	3.85	8.56	3.85	6.13
Non-Manu Traded	-0.06	3.85	-0.06	0.93
Sheltered	-0.26	1.99	-0.26	-0.02
Total Employment (000's):	1.05	4.41	1.05	1.84
Manufacturing:	5.16	9.33	5.16	6.75
Non-Manu traded:	-0.09	3.86	-0.09	0.78
Sheltered:	-0.31	2.00	-0.31	-0.09
Unemployment rate	-10.40	0.00	-10.40	-12.65
Population (000's)	0.00	4.41	0.00	0.55
Net in-migration (000's)	-	-	--	--
Price of value added:				
Manufacturing	-3.58	-7.28	-3.58	-5.52
Non-Manu traded	1.63	-0.34	1.63	1.43
Sheltered	1.55	-0.36	1.55	1.67
Capital rental rates:				
Manufacturing	9.37	-0.25	9.37	0.41
Non-Manu traded	1.42	-0.26	1.42	0.41
Sheltered	0.66	-0.26	0.66	0.40
Consumer price index	0.47	-0.38	0.47	0.37
Capital stocks:				
Manufacturing	0.00	6.21	0.00	4.21
Non-Manu Traded	0.00	3.82	0.00	1.23
Sheltered	0.00	1.96	0.00	0.36
Exports to RUK:				
Manufacturing	3.31	6.94	3.31	5.19
Non-Manu Traded	-2.33	0.50	-2.33	-2.05
Sheltered	-2.78	0.66	-2.78	-2.98
Exports to ROW:				
Manufacturing	3.31	6.94	3.31	5.19
Non-Manu Traded	-2.33	0.50	-2.33	-2.05
Sheltered	-2.78	0.66	-2.78	-2.98
Households disposable	1.69	3.00	1.69	2.29
Labour income	0.50	1.59	0.50	1.43
Capital income	3.07	3.61	3.07	2.10

Table 7.3.1a. The short-run, medium-run and long-run impact of 10% labour subsidy to manufacturing with the BRW closure: the stock adjustment migration model with LNJ default parameters

Time period	short-run	medium-run	long-run
GDP (income measure)	0.78	0.86	1.77
Consumption	1.21	1.15	1.91
Nominal take home wage	1.73	1.34	1.92
Real T-H consumption wage	1.25	0.96	1.54
Producer cost of labour:			
Manufacturing	-4.09	-4.28	-1.94
Non-Manu traded	0.10	-0.11	0.49
Sheltered	0.17	0.18	0.24
Value-added:			
Manufacturing	3.85	4.03	6.13
Non-Manu Traded	-0.06	0.07	0.93
Sheltered	-0.26	-0.28	-0.02
Total Employment (000's):	1.05	1.17	1.84
Manufacturing:	5.16	5.40	6.75
Non-Manu traded:	-0.09	0.10	0.78
Sheltered:	-0.31	-0.33	-0.09
Unemployment rate	-10.40	-8.14	-12.65
Population (000's)	0.00	0.35	0.55
Net in-migration (000's)	--	--	--
Price of value added:			
Manufacturing	-3.58	-3.76	-5.52
Non-Manu traded	1.63	1.44	1.43
Sheltered	1.55	1.16	1.67
Capital rental rates:			
Manufacturing	9.37	9.77	0.41
Non-Manu traded	1.42	1.66	0.41
Sheltered	0.66	0.23	0.40
Consumer price index	0.47	0.37	0.37
Capital stocks:			
Manufacturing	0.00	0.00	4.21
Non-Manu Traded	0.00	0.00	1.23
Sheltered	0.00	0.00	0.36
Exports to RUK:			
Manufacturing	3.31	3.48	5.19
Non-Manu Traded	-2.33	-2.07	-2.05
Sheltered	-2.78	-2.08	-2.98
Exports to ROW:			
Manufacturing	3.31	3.48	5.19
Non-Manu Traded	-2.33	-2.07	-2.05
Sheltered	-2.78	-2.08	-2.98
Nominal income:			
Households disposable	1.69	1.52	2.29
Labour income	0.50	0.22	1.43
Capital income	3.07	3.16	2.10

Table 7.3.2. Impact of 10% labour subsidy to manufacturing on key economic variables at various time periods with the BRW closure: the stock adjustment migration model with LNJ default parameters

Time period	1	5	10	20	30	35
GDP (income measure)	0.78	1.33	1.58	1.74	1.76	1.77
Consumption	1.21	1.58	1.77	1.89	1.91	1.91
Nominal take home wage	1.73	1.73	1.85	1.91	1.92	1.92
Real T-H consumption wage	1.25	1.28	1.43	1.52	1.54	1.54
Producer cost of labour:						
Manufacturing	-4.09	-2.90	-2.26	-1.97	-1.94	-1.94
Non-Manu traded	0.10	0.08	0.27	0.44	0.48	0.49
Sheltered	0.17	0.16	0.21	0.24	0.24	0.24
Value-added:						
Manufacturing	3.85	5.22	5.82	6.09	6.12	6.13
Non-Manu Traded	-0.06	0.40	0.67	0.88	0.92	0.93
Sheltered	-0.26	-0.10	-0.06	-0.03	-0.02	-0.02
Total Employment (000's):	1.05	1.52	1.71	1.82	1.84	1.84
Manufacturing:	5.16	6.15	6.55	6.73	6.75	6.75
Non-Manu traded:	-0.09	0.37	0.59	0.75	0.78	0.78
Sheltered:	-0.31	-0.14	-0.12	-0.10	-0.09	-0.09
Unemployment rate	-10.40	-10.67	-11.81	-12.51	-12.64	-12.65
Population (000's)	0.00	0.44	0.50	0.54	0.55	0.55
Net in-migration (000's)	--	--	--	--	--	--
Price of value added:						
Manufacturing	-3.58	-4.76	-5.27	-5.49	-5.52	-5.52
Non-Manu traded	1.63	1.65	1.57	1.46	1.43	1.43
Sheltered	1.55	1.56	1.64	1.67	1.67	1.67
Capital rental rates:						
Manufacturing	9.37	4.22	1.69	0.55	0.41	0.41
Non-Manu traded	1.42	1.48	1.01	0.54	0.42	0.41
Sheltered	0.66	0.71	0.55	0.43	0.40	0.40
Consumer price index	0.47	0.44	0.41	0.38	0.37	0.37
Capital stocks:						
Manufacturing	0.00	2.41	3.59	4.14	4.20	4.21
Non-Manu Traded	0.00	0.44	0.84	1.16	1.22	1.23
Sheltered	0.00	0.16	0.26	0.34	0.36	0.36
Exports to RUK:						
Manufacturing	3.31	4.45	4.94	5.16	5.18	5.19
Non-Manu Traded	-2.33	-2.36	-2.26	-2.10	-2.05	-2.05
Sheltered	-2.78	-2.79	-2.92	-2.98	-2.98	-2.98
Exports to ROW:						
Manufacturing	3.31	4.45	4.94	5.16	5.18	5.19
Non-Manu Traded	-2.33	-2.36	-2.26	-2.10	-2.05	-2.05
Sheltered	-2.78	-2.79	-2.92	-2.98	-2.98	-2.98
Nominal income:						
Households disposable	1.69	2.02	2.19	2.27	2.29	2.29
Labour income	0.50	0.95	1.23	1.40	1.42	1.43
Capital income	3.07	2.77	2.39	2.15	2.11	2.10

Table 7.3.3. **Impact of 10% labour subsidy to manufacturing on key economic variables using SA migration model with variation in the parameters**

	α1=0.06 α2=-0.08	α1=0.01 α2=-0.03	α1=0.03 α2=-0.05	α1=0.05 α2=-0.07	α1=0.08 α2=-0.10	α1=0.09 α2=-0.12	α1=0.11 α2=-0.14
GDP (income measure)	1.77	1.55	1.64	1.73	1.84	1.90	1.9[illegible]
Consumption	1.91	1.78	1.84	1.89	1.95	1.99	2.0[illegible]
Nominal take home wage	1.92	2.13	2.04	1.96	1.85	1.78	1.7[illegible]
Real T-H consumption wage	1.54	1.68	1.62	1.57	1.49	1.45	1.4[illegible]
Producer cost of labour:							
Manufacturing	-1.94	-1.90	-1.92	-1.93	-1.95	-1.96	-1.9[illegible]
Non-Manu traded	0.49	0.54	0.51	0.50	0.47	0.45	0.4[illegible]
Sheltered	0.24	0.27	0.26	0.25	0.23	0.23	0.2[illegible]
Value-added:							
Manufacturing	6.13	5.91	6.01	6.09	6.20	6.27	6.3[illegible]
Non-Manu Traded	0.93	0.67	0.78	0.88	1.02	1.09	1.1[illegible]
Sheltered	-0.02	-0.19	-0.12	-0.05	0.04	0.10	0.1[illegible]
Total Employment (000's):	1.84	1.61	1.71	1.80	1.92	1.98	2.0[illegible]
Manufacturing:	6.75	6.52	6.62	6.71	6.83	6.90	6.9[illegible]
Non-Manu traded:	0.78	0.51	0.63	0.73	0.87	0.96	1.0[illegible]
Sheltered:	-0.09	-0.27	-0.20	-0.12	-0.03	0.03	0.0[illegible]
Unemployment rate	-12.65	-13.72	-13.27	-12.85	-12.29	-11.96	-11.6[illegible]
Population (000's)	0.55	0.22	0.36	0.49	0.66	0.76	0.8[illegible]
Net in-migration (000's)	--	--	--	--	--	--	--
Price of value added:							
Manufacturing	-5.52	-5.36	-5.43	-5.49	-5.57	-5.62	-5.6[illegible]
Non-Manu traded	1.43	1.58	1.52	1.45	1.37	1.32	1.2[illegible]
Sheltered	1.67	1.86	1.78	1.71	1.61	1.55	1.5[illegible]
Capital rental rates:							
Manufacturing	0.41	0.46	0.43	0.41	0.38	0.36	0.3[illegible]
Non-Manu traded	0.41	0.46	0.44	0.42	0.39	0.37	0.3[illegible]
Sheltered	0.40	0.45	0.43	0.41	0.38	0.36	0.3[illegible]
Consumer price index	0.37	0.44	0.41	0.38	0.35	0.33	0.3[illegible]
Commodity Output:							
Manufacturing	4.21	4.95	5.03	5.10	5.19	5.25	5.3[illegible]
Non-Manu Traded	1.23	0.80	0.91	1.00	1.13	1.20	1.2[illegible]
Sheltered	0.36	-0.15	-0.07	-0.01	0.09	0.14	0.1[illegible]
Capital stocks:							
Manufacturing	5.19	4.03	4.11	4.18	4.27	4.32	4.3[illegible]
Non-Manu Traded	-2.05	1.01	1.11	1.19	1.31	1.38	1.4[illegible]
Sheltered	-2.98	0.22	0.28	0.34	0.41	0.45	0.4[illegible]
Exports to RUK:							
Manufacturing	5.19	5.03	5.10	5.16	5.24	5.29	5.3[illegible]
Non-Manu Traded	-2.05	-2.27	-2.18	-2.09	-1.97	-1.90	-1.8[illegible]
Sheltered	-2.98	-3.30	-3.16	-3.04	-2.87	-2.77	-2.6[illegible]
Nominal income:							
Households disposable	2.29	2.23	2.25	2.28	2.31	2.33	2.3[illegible]
Labour income	1.43	1.41	1.42	1.42	1.43	1.43	1.4[illegible]
Capital income	2.10	1.97	2.03	2.08	2.15	2.19	2.2[illegible]

Table 7.3.4. Sensitivity of GDP to supply stimulus with variations in SA migration parameter wrt real wage elasticity $\alpha1$ and unemployment elasticity $\alpha2$. The unit of GDP is in thousand £.

$\alpha1$ / $\alpha2$	0.01	0.03	0.05	0.06	0.08	0.09	0.11
-0.01	48070	48400	48760	48920	49290	49450	49780
-0.03	51030	51320	51650	51820	52140	52280	52600
-0.05	53720	54020	54310	54440	54740	54900	55200
-0.07	56220	56480	56740	56910	57170	57300	57570
-0.08	57370	57630	57890	58030	58290	58420	58680
-0.10	59570	59830	60060	60190	60460	60560	60820
-0.12	61610	61840	62100	62200	62430	62560	62760
-0.14	63510	63740	63940	64070	64270	64370	64600

Table 7.4.1. The short-run, and long-run impact of 10% labour subsidy to manufacturing on key economic variables with the BRW closure, the no migration case.

	short-run	long-run
GDP (income measure)	0.78	1.41
Consumption	1.21	1.70
Nominal take home wage	1.73	2.27
Real T-H consumption wage	1.25	1.78
Producer cost of labour:		
Manufacturing	-4.09	-1.87
Non-Manu traded	0.10	0.57
Sheltered	0.17	0.28
Value-added:		
Manufacturing	3.85	5.77
Non-Manu Traded	-0.06	0.50
Sheltered	-0.26	-0.31
Total Employment (000's):	1.05	1.46
Manufacturing:	5.16	6.37
Non-Manu traded:	-0.09	0.33
Sheltered:	-0.31	-0.40
Unemployment rate	-10.40	-14.42
Population (000's)	0.00	0.00
Net in-migration (000's)	--	--
Price of value added:		
Manufacturing	-3.58	-5.25
Non-Manu traded	1.63	1.69
Sheltered	1.55	1.98
Capital rental rates:		
Manufacturing	9.37	0.50
Non-Manu traded	1.42	0.50
Sheltered	0.66	0.49
Consumer price index	0.47	0.48
Capital stocks:		
Manufacturing	0.00	3.92
Non-Manu Traded	0.00	0.86
Sheltered	0.00	0.13
Exports to RUK:		
Manufacturing	3.31	4.92
Non-Manu Traded	-2.33	-2.42
Sheltered	-2.78	-3.52
Exports to ROW:		
Manufacturing	3.31	4.92
Non-Manu Traded	-2.33	-2.42
Sheltered	-2.78	-3.52
Nominal income:		
Households disposable	1.69	2.19
Labour income	0.50	1.40
Capital income	3.07	1.88

Table 7.4.2. Impact of 10% labour subsidy to manufacturing on key economic variables at various time periods with the BRW closure, the no migration case.

	1	2	10	20	35
GDP (income measure)	0.78	0.89	1.29	1.39	1.41
Consumption	1.21	1.29	1.60	1.68	1.70
Nominal take home wage	1.73	1.83	2.19	2.26	2.27
Real T-H consumption wage	1.25	1.34	1.68	1.76	1.78
Producer cost of labour:					
Manufacturing	-4.09	-3.64	-2.17	-1.91	-1.87
Non-Manu traded	0.10	0.14	0.41	0.54	0.57
Sheltered	0.17	0.19	0.26	0.28	0.28
Value-added:					
Manufacturing	3.85	4.24	5.52	5.74	5.77
Non-Manu Traded	-0.06	0.00	0.35	0.47	0.50
Sheltered	-0.26	-0.28	-0.32	-0.31	-0.31
Total Employment (000's):	1.05	1.12	1.39	1.45	1.46
Manufacturing:	5.16	5.41	6.22	6.36	6.37
Non-Manu traded:	-0.09	-0.04	0.22	0.31	0.33
Sheltered:	-0.31	-0.33	-0.39	-0.40	-0.40
Unemployment rate	-10.40	-11.08	-13.67	-14.31	-14.42
Population (000's)	0.00	0.00	0.00	0.00	0.00
Net in-migration (000's)	--	--	--	--	--
Price of value added:					
Manufacturing	-3.58	-3.93	-5.05	-5.23	-5.25
Non-Manu traded	1.63	1.69	1.76	1.71	1.69
Sheltered	1.55	1.63	1.92	1.97	1.98
Capital rental rates:					
Manufacturing	9.37	7.53	1.63	0.62	0.50
Non-Manu traded	1.42	1.40	0.89	0.58	0.50
Sheltered	0.66	0.62	0.53	0.50	0.49
Consumer price index	0.47	0.48	0.50	0.49	0.48
Capital stocks:					
Manufacturing	0.00	0.78	3.39	3.86	3.92
Non-Manu Traded	0.00	0.09	0.61	0.81	0.86
Sheltered	0.00	0.02	0.10	0.12	0.13
Exports to RUK:					
Manufacturing	3.31	3.64	4.72	4.90	4.92
Non-Manu Traded	-2.33	-2.42	-2.52	-2.45	-2.42
Sheltered	-2.78	-2.91	-3.40	-3.50	-3.52
Exports to ROW:					
Manufacturing	3.31	3.64	4.72	4.90	4.92
Non-Manu Traded	-2.33	-2.42	-2.52	-2.45	-2.42
Sheltered	-2.78	-2.91	-3.40	-3.50	-3.52
Nominal income:					
Households disposable	1.69	1.78	2.11	2.18	2.19
Labour income	0.50	0.67	1.25	1.38	1.40
Capital income	3.07	2.87	2.10	1.91	1.88

Table 7.5.1. Impact of 10% labour subsidy to manufacturing on key economic variables at various time periods with the Keynesian closure, the Flow Adjustment case. National bargaining wage

	1	2	10	20	50	80	90
GDP (income measure)	1.63	1.93	3.23	3.67	3.80	3.80	3.80
Consumption	1.31	1.61	2.71	3.08	3.19	3.19	3.19
Nominal take home wage	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real T-H consumption wage	-0.19	-0.16	0.09	0.21	0.26	0.26	0.26
Producer cost of labour:							
Manufacturing	-5.04	-4.55	-2.76	-2.35	-2.27	-2.27	-2.27
Non-Manu traded	-1.15	-1.11	-0.50	-0.10	0.05	0.05	0.05
Sheltered	-0.42	-0.36	-0.10	-0.01	0.02	0.02	0.02
Value-added:							
Manufacturing	4.72	5.31	7.50	8.04	8.15	8.15	8.15
Non-Manu Traded	0.71	1.00	2.52	3.16	3.37	3.37	3.37
Sheltered	0.65	0.79	1.39	1.60	1.66	1.66	1.66
Total Employment (000's):	2.19	2.44	3.52	3.89	3.99	3.99	3.99
Manufacturing:	6.36	6.79	8.41	8.81	8.90	8.90	8.90
Non-Manu traded:	1.06	1.34	2.67	3.19	3.35	3.35	3.35
Sheltered:	0.78	0.90	1.42	1.60	1.65	1.66	1.66
Unemployment rate	-21.61	-14.68	-2.51	-0.41	0.19	0.19	0.19
Population (000's)	0.00	0.94	3.26	3.84	4.01	4.01	4.01
Net in-migration (000's)	-	-	-	-	-	-	-
Price of value added:							
Manufacturing	-4.27	-4.76	-6.51	-6.91	-6.98	-6.98	-6.98
Non-Manu traded	1.16	1.13	0.51	0.10	-0.05	-0.05	-0.05
Sheltered	0.42	0.37	0.10	0.01	-0.02	-0.02	-0.02
Capital rental rates:							
Manufacturing	11.64	9.49	1.90	0.19	-0.14	-0.14	-0.14
Non-Manu traded	3.57	3.46	1.55	0.31	-0.14	-0.14	-0.14
Sheltered	2.60	2.26	0.62	0.03	-0.15	-0.15	-0.15
Consumer price index	0.19	0.16	-0.09	-0.21	-0.26	-0.26	-0.26
Capital stocks:							
Manufacturing	0.00	1.00	4.76	5.68	5.87	5.87	5.87
Non-Manu Traded	0.00	0.31	2.20	3.10	3.40	3.40	3.40
Sheltered	0.00	0.22	1.23	1.59	1.70	1.70	1.70
Exports to RUK:							
Manufacturing	3.97	4.44	6.17	6.57	6.65	6.65	6.65
Non-Manu Traded	-1.67	-1.63	-0.73	-0.15	0.07	0.07	0.07
Sheltered	-0.76	-0.66	-0.18	-0.01	0.04	0.04	0.04
Exports to ROW:							
Manufacturing	3.97	4.44	6.17	6.57	6.65	6.65	6.65
Non-Manu Traded	-1.67	-1.63	-0.73	-0.15	0.07	0.07	0.07
Sheltered	-0.76	-0.66	-0.18	-0.01	0.04	0.04	0.04
Nominal income:							
Households disposable	1.50	1.77	2.62	2.86	2.92	2.92	2.92
Labour income	-0.10	0.14	1.15	1.48	1.57	1.57	1.57
Capital income	5.19	5.02	3.95	3.50	3.37	3.36	3.36

Table 7.5.2. Impact of 10% labour subsidy to manufacturing on key economic variables at various time periods with Keynesian closure: the Stock Adjustment migration model with LNJ default parameters. National Bargaining Wage

	1	2	10	20	35
GDP (income measure)	1.63	1.93	3.15	3.56	3.66
Consumption	1.31	1.61	2.34	2.62	2.69
Nominal take home wage	0.00	0.00	0.00	0.00	0.00
Real T-H consumption wage	-0.19	-0.16	0.10	0.22	0.25
Producer cost of labour:					
Manufacturing	-5.04	-4.55	-2.75	-2.34	-2.27
Non-Manu traded	-1.15	-1.11	-0.46	-0.09	0.03
Sheltered	-0.42	-0.36	-0.09	0.00	0.02
Value-added:					
Manufacturing	4.72	5.31	7.47	7.99	8.09
Non-Manu Traded	0.71	1.00	2.41	3.00	3.16
Sheltered	0.65	0.79	1.30	1.48	1.53
Total Employment (000's):	2.19	2.44	3.44	3.76	3.84
Manufacturing:	6.36	6.79	8.38	8.76	8.84
Non-Manu traded:	1.06	1.34	2.56	3.02	3.15
Sheltered:	0.78	0.90	1.33	1.48	1.52
Unemployment rate	-21.61	-14.68	-23.80	-25.80	-26.28
Population (000's)	0.00	0.94	1.00	1.12	1.15
Net in-migration (000's)	--	--	--	--	--
Price of value added:					
Manufacturing	-4.27	-4.76	-6.52	-6.91	-6.98
Non-Manu traded	1.16	1.13	0.46	0.09	-0.03
Sheltered	0.42	0.37	0.09	0.00	-0.02
Capital rental rates:					
Manufacturing	11.64	9.49	1.86	0.17	-0.12
Non-Manu traded	3.57	3.46	1.42	0.26	-0.10
Sheltered	2.60	2.26	0.54	0.01	-0.13
Consumer price index	0.19	0.16	-0.10	-0.22	-0.25
Capital stocks:					
Manufacturing	0.00	1.00	4.74	5.64	5.81
Non-Manu Traded	0.00	0.31	2.12	2.94	3.18
Sheltered	0.00	0.22	1.17	1.48	1.56
Exports to RUK:					
Manufacturing	3.97	4.44	6.18	6.57	6.64
Non-Manu Traded	-1.67	-1.63	-0.68	-0.12	0.05
Sheltered	-0.76	-0.66	-0.16	0.00	0.04
Exports to ROW:					
Manufacturing	3.97	4.44	6.18	6.57	6.64
Non-Manu Traded	-1.67	-1.63	-0.68	-0.12	0.05
Sheltered	-0.76	-0.66	-0.16	0.00	0.04
Nominal income:					
Households disposable	1.50	1.77	2.24	2.40	2.43
Labour income	-0.10	0.14	1.06	1.36	1.44
Capital income	5.19	5.02	3.79	3.35	3.23

Table 7.5.3. Impact of 10% labour subsidy to manufacturing on key economic variables at various time periods with the Keynesian closure, the no migration case.National Wage Bargaining.

	1	2	10	20	35
GDP (income measure)	1.63	1.91	3.11	3.51	3.60
Consumption	1.31	1.47	2.18	2.43	2.49
Nominal take home wage	0.00	0.00	0.00	0.00	0.00
Real T-H consumption wage	-0.19	-0.15	0.10	0.22	0.25
Producer cost of labour:					
Manufacturing	-5.04	-4.54	-2.75	-2.34	-2.27
Non-Manu traded	-1.15	-1.08	-0.45	-0.08	0.03
Sheltered	-0.42	-0.35	-0.08	0.00	0.02
Value-added:					
Manufacturing	4.72	5.31	7.46	7.97	8.07
Non-Manu Traded	0.71	0.98	2.36	2.92	3.08
Sheltered	0.65	0.76	1.26	1.43	1.48
Total Employment (000's):	2.19	2.42	3.40	3.71	3.79
Manufacturing:	6.36	6.79	8.36	8.74	8.81
Non-Manu traded:	1.06	1.31	2.50	2.95	3.07
Sheltered:	0.78	0.87	1.29	1.43	1.47
Unemployment rate	-21.61	-23.87	-33.55	-36.67	-37.42
Population (000's)	0.00	0.00	0.00	0.00	0.00
Net in-migration (000's)	--	--	--	--	--
Price of value added:					
Manufacturing	-4.27	-4.77	-6.52	-6.91	-6.98
Non-Manu traded	1.16	1.09	0.45	0.08	-0.03
Sheltered	0.42	0.35	0.08	0.00	-0.02
Capital rental rates:					
Manufacturing	11.64	9.46	1.85	0.17	-0.13
Non-Manu traded	3.57	3.35	1.38	0.24	-0.10
Sheltered	2.60	2.15	0.50	0.00	-0.13
Consumer price index	0.19	0.15	-0.10	-0.22	-0.25
Capital stocks:					
Manufacturing	0.00	1.00	4.73	5.62	5.78
Non-Manu Traded	0.00	0.31	2.08	2.87	3.10
Sheltered	0.00	0.22	1.13	1.43	1.51
Exports to RUK:					
Manufacturing	3.97	4.45	6.18	6.57	6.64
Non-Manu Traded	-1.67	-1.57	-0.66	-0.12	0.05
Sheltered	-0.76	-0.63	-0.15	0.00	0.04
Exports to ROW:					
Manufacturing	3.97	4.45	6.18	6.57	6.64
Non-Manu Traded	-1.67	-1.57	-0.66	-0.12	0.05
Sheltered	-0.76	-0.63	-0.15	0.00	0.04
Nominal income:					
Households disposable	1.50	1.61	2.07	2.21	2.23
Labour income	-0.10	0.12	1.02	1.31	1.38
Capital income	5.19	4.93	3.73	3.29	3.17

Chapter 8. Conclusions.

8.1. The Determinants of Migration.

In Part I we examine the theory of the determinants of migration and provide an econometric analysis which seeks to obtain the model that best describes the determinants of net Scottish rest-of-the-UK (RUK) migration flows for the 1970-1994 period. In Chapter 2 we discuss the many alternative approaches to analysing the determinants of migration. The human capital approach, first introduced by Sjaastad (1962), treats migration in the same way as any other investment in human capital. This investment involves costs and returns. A potential migrant weighs the costs and benefits across alternative locations before making the migration decision. Both monetary and non-monetary costs are considered; the monetary costs may include transportation costs and income forgone, while the non-money costs are the psychic costs of leaving familiar surroundings, including families and friends. Hart (1975) tested a very similar migration model to the one developed by Sjaastad (1961), where potential migrants consider all of the costs and benefits before deciding on a move. The human capital approach has subsequently been extended to accommodate a wider framework. Mincer (1978), for example, considers the situation where households, rather than individuals, are the relevant decision making units, while Davanzo (1983) considers the possibility of multiple moves.

In the search approach Lippman and McCall (1976) consider the simplest sequential model of job search where an unemployed individual (who is referred to as the searcher) is seeking a job. Each day this individual looks for a job, and only generates one job offer per day. He can accept the offer and thus abandon searching, or he can reject any offers that fall short of his expectations. The reservation wage is used as a basis to accept or reject an offer. It is chosen such that the expected marginal return from additional search is equal to the marginal cost of search.

Molho (1986) devises a migration decision making framework that includes the possibility of a speculative move. In the process of searching the potential migrant will receive an acceptable offer, an unacceptable offer or no offer at all. He/she may quit searching upon receiving an acceptable offer (and migrate to the region that provides the offer). If the offer is not acceptable he/she may either continue searching or abandon searching and thus become a stayer. When recall is allowed he/she can keep records of the offers received and compare to choose the best offer. A speculative migrant can exit and enter a new search field when the former does not seem promising.

The gravity model that is commonly used in a geographical context is also widely used in studies of migration. The use of gravity models in migration can be traced back to Ravenstein (1885). Later, Lowry (1966) propounded an "economic" gravity model that has profoundly influenced the econometric work on the migration process (Greenwood, 1975). Many studies use the gravity approach, for example, Greenwood and Sweetland (1972) analyse the determinants of migration in terms of metropolitan flows in the U.S. They found distance to be a serious deterrent to migration. They also suggest that out migration occurs: from low income to high income areas; to areas where local per capita government expenditures are relatively high, and to areas with temperate climates. Later, Smith and Clayton (1978) examine the U.S migration stream in terms of the transitivity characteristic of the gravity model. If the gravity model is given as

$$m_{ij} = A_i B_j f(D_{ij}) \qquad (8.1)$$

Where A_i, B_j are the origin and destination specific factors, pushing or pulling migrants to or from the corresponding regions, D is the distance between the two regions which affects migration according to some function. Then according to Smith and Clayton, as long as a symmetrical distance function is chosen, then the gravity model observes the transitivity property. As such if $m_{ij} > m_{ji}$ and $m_{jk} > m_{kj}$ then the model predicts $m_{ik} > m_{ki}$. That is, if more people migrate from region i to region j, than from region j to region i and if more people migrate from region j to region k than vice versa, then their model predicts that more people migrate from region i to region k than the other way round. Other variations of the gravity model are used by Goodchild and Smith (1980), Smith and Slater (1981) and Plane (1981). A brief account of their studies is as given in Chapter 2.

The Harris-Todaro model (1970) emphasises wages and unemployment rates (between regions) as important determinants of migration. Earlier, the Todaro (1969) migration model assumes that members of the labour force compare their expected incomes for a given time period in the urban sector, with current average rural incomes, and migrate if the former exceeds the latter.

The Ermisch (1995) model focuses on the relative real wage and relative employment rate, lagged one period, as the main determinants of migration, while Jackman and Savouri (1992) viewed migration as the consequence of successful job search rather than as a pre-condition for it. Accordingly, there is no reason for people to relocate in order to look for jobs, since existing technology makes job search a very convenient process. Layard *et. al.* (1991) include the real wage, unemployment and price differentials between the origin region and destination region in their model. However, they stress the importance of real wage differential and unemployment differential as the main determinants of migration in the UK. There is a huge array of models of migration in the literature, some of which are preferred to others by researchers for various reasons. For example Jackman and Savouri (1992) prefers to treat migration as a consequence of job search while they disagree with the human capital theory because that approach does not explain the time series behaviour of aggregate migration. The human capital approach predicts that people move from high unemployment to low unemployment region, whereas in actual fact it need not always be true.

Harvey and Taylor (1993) on the other hand stress the relevance of the human capital approach in migration while they disagree with the classical approach because of its many weaknesses. Among these weaknesses of the classical approach, according to Harvey and Taylor (1993):

> "A major weakness of the classical model is that it assumes a perfectly competitive environment with free movement of factors of production between regions. The existence of considerable impediments to the free working of the labour market, however, together with impediments to factor mobility such as poor information flows, means that the classical model has poor

explanatory and predictive powers. More success is achieved by the human capital approach. This has a similar starting point to the classical model in that it assumes that potential migrants aim to maximise their economic welfare. It has a distinct advantage over the simple classical approach, however, that, in principle it takes *all* factors affecting the costs and benefits of migration (to the migrant) into account explicitly."

In our case we prefer the Layard *et. al.* (1991) model because of the availability of data and their claim that their model has high explanatory ability for UK regions in general. In our stock adjustment migration model, we treat migrants as a heterogeneous group of individuals who respond differently to the determinants of migration. This is because people have different psychic transaction costs or have different values of amenities and so the expected net present value of a given migration differs, perhaps significantly, across individuals. Thus we assume that labour is not in infinitely elastic supply, even if we allow a sufficiently long period for all migration reactions to a particular change in incentives to have been completed. We focus on the change in the regional real wage and the unemployment rate differentials as the main determinants of net migration between Scotland and RUK.

In chapter 3 we conduct an econometric analysis of net Scottish-RUK migration flows. We choose several net migration models in view of their prominence in the literature. Our findings suggest that the Ermisch (1993) model, which focuses on the relative real wage and relative unemployment rate, lagged one period, is not a suitable model to explain the Scottish-RUK data. Likewise the Layard *et. al.* (1991) model, which employs the relative real wage, relative unemployment rate and relative prices between the two regions does not seem to explain the Scottish-RUK net migration data well. The relative real wage between Scotland and RUK is significant at the 5 per cent significance level but does not have the conventional sign. The relative unemployment rate however, does support the hypothesis that people move from high unemployment to low unemployment regions. Relative prices which are proxied by the relative house prices between Scotland and RUK, fail to be a significant regressor. The Jackman and Savouri (J&S) model (1992) does generate quite good results. The relative unemployment rate and relative vacancy rate are significant but the former does not have the conventional sign. The relative price variable is not a significant regressor. Later we augment the Ermisch, the Layard *et. al.* (1991) and the J&S (1992) models in an attempt to identify a suitable model to explain the Scottish-RUK data.

Using the stock adjustment version of the models, we find several interesting models. The change in the real wage variable is very close to being significant, while the price variable is significant but has a perverse sign. The change in the unemployment rate variable is insignificant, which parallels some other recent findings that unemployment rates are not an important determinant of migration between regions.

With the J&S model (1992), the stock adjustment specification implies that the change in the vacancy variable is not an important determinant of net out migration between Scotland and RUK. The change in unemployment rate and the change in prices between Scotland and RUK are significant but the latter maintains the perverse sign. Next we include the lagged dependent variable to see how previous migration affects current net out migration rate. The addition of the lagged dependent variable to the model reduces the explanatory power of the change in unemployment rate variable. While the price variable remains significant and has the perverse sign. Next we replace the lagged dependent variable with t, the time trend variable. The time trend variable is significant and has a negative sign which implies that over time the dependent variable "declines".

Due to the mixed results that we obtain with the three chosen model specifications we go on to test other model specifications with the hope of finding a model which can better explain Scottish-RUK data. We start by estimating the chosen variables in level forms individually. We find that the relative real wage is not significant but the unemployment rate in Scotland relative to that of RUK is significant and has the conventional sign. The higher the unemployment rate in Scotland relative to that of RUK, more out-migration occurs from Scotland into RUK. When regressed singly, the relative vacancy rate shows a significant negative impact on net out-migration behaviour between the two regions. Finally, the relative prices between the two regions are not statistically different from zero, when regressed on its own. We then proceed to specify the net out migration models by regressing different combinations of variables that we think might be important determinants of net out-migration from Scotland to RUK. Later we explore the possible impact of Northsea oil development, but we fail to find any support for the hypothesis that it may have stimulated additional net in-migration.

We then estimate our version of the stock adjustment models of migration; we start from the most general to the most specific form of the model. The change in real wage and the change in prices, are significant variables but the latter maintains the unconventional sign. Migration theory predicts that people move from high price region to low price regions but our result shows otherwise, a result that could reflect on the way that house price expectations are formed.

We also explore the possibility of correcting for the misspecification in the normally assumed net migration function. Rogers (1990) makes it clear that such models are misspecified because the ratio of home and other regions' populations are treated as a constant whereas in fact they cannot be. For this reason we specify the net migration function relative to the home population and later simplify it in the form of the "share" specification. We then estimate these migration specifications using the true population and then the adjusted population in which migration is the only source of population change. Our results with the population ratio and the "share" models do not provide very impressive findings but they do parallel recent findings. The unemployment rate variable, when included in the model is either not significant or when significant has an unconventional sign. Hughes and McCormick (1994) discuss similar findings. Later we omit the relative unemployment rate variable; the results show that all variables are significant. Our finding appears to offer support for recent (e.g. Hughes and McCormick, 1994) claims that the unemployment rate is not an important influence on migration behaviour.

When we explore the "share" model, our results with neither the flow and stock adjustment versions of the model produce conclusive results. We then estimate the flow specification with only lagged regressors. Our results are varied; in some cases the models fail the diagnostic tests, with evidence of first order serial correlation. The results improve when the lagged dependent variable is included in the model. Our "share" model seems to work better with the adjusted population, where migration is the only source of population change. We later test for structural breaks to see whether the relationship between the variables has been subjected to a change due to an external shock such as an institutional change. But our results do not indicate any obvious temporal break.

Part II, of this thesis concerns the system wide effect of such demand and supply stimulus under different assumptions about labour mobility. Our theory and simulation results of the impact of demand and supply disturbances are summarised in the following section.

8.2. The Consequences of Migration.

In Chapter 4 we provided a theoretical analysis of the impact of the migration process on the system-wide impact of both demand and supply disturbances. Subsequent chapters outlined the CGE model we employed to investigate these issues empirically (Chapter 5), and discussed the simulation results obtained for demand (Chapter 6) and then supply disturbances (Chapter 7). Here we attempt to provide an integrated summary and overview of these results and discuss their significance.

Tables 8.1 and 8.2 provide summaries of the long-run qualitative and the quantitative impact of the demand and supply stimulus under both regional and national bargaining under the three different characterisations of labour mobility namely: the flow-adjustment model of migration; the stock-adjustment model of migration and the zero mobility case. There are two major ways in which the results vary with alternative visions of regional labour mobility. First, there is an impact on the *qualitative* behaviour of the system, which varies with the specification of the net migration function. Secondly, there is a scale effect: the specification of the net migration function clearly can a dramatic effect on the *quantitative* impact of the regional macroeconomic impacts of both demand and supply disturbances. The migration elasticities with respect to real wage and unemployment rate that we use are those of our default specification (based on Layard et al (1991)).

Table 8.1. The system wide impact of the demand and supply stimulus.

	BRW	BRW	National Barg.	National Barg.
	Demand shock	Supply shock	Demand shock	Supply shock
Flow adjustment	NAIRU (Medium and long-runs) I-O Convergence	NAIRU (Medium and long-runs) Convergence	NAIRU (but only in long-run) I-O Convergence	No NAIRU Convergence
Stock adjustment	No NAIRU Non-convergence	No NAIRU Non-convergence	No NAIRU IO Non-convergence	No NAIRU Non-convergence
Zero mobility	No NAIRU	No NAIRU	No NAIRU IO	No NAIRU

8.2.1 Demand Disturbances

Throughout the demand stimulus consisted of a 10% stimulus to manufacturing exports.

Regional bargaining

The demand shock that we consider throughout is an expansion in (manufacturing) export demand. Irrespective of the model of migration, initially the general equilibrium labour demand curve shifts out responding to the increase in manufacturing demand. Consequently the real take home wage under the bargained real wage closure increases so as to expand the labour supply. The presence of a regional bargaining system implies that workers' bargaining power is directly related to economic activity (and inversely related to the unemployment rate.) Clarity of analysis is facilitated by use of three conceptual time intervals: a short-run or impact interval during which neither population nor capital stocks can change; a medium-run over which population is fully adjusted by migration flows; a long-run over which capital stocks, as well as population, is fully adjusted.

During the impact period migration has no impact, since up-dating of population stocks is assumed to occur at the end of the period, hence the impact period result is identical irrespective of the degree of labour mobility. The demand shock increases real wage rates and reduces the unemployment rate in the short-run, as activity is stimulated.

Flow adjustment model of migration

Over the medium- and long-run results do vary significantly across the alternative models of the migration process. As migrants come into Scotland from RUK, in the medium-run with the flow adjustment model, pressure on real take home wage will be reduced. This is because the employment to labour force ratio is now reduced. With the flow-adjustment model, in-migration continues until the original equilibrium real take home wage and original equilibrium unemployment rates are restored. With the flow model, it is implicitly assumed that labour is homogenous, and individuals react in pretty much the same way towards the increase in real wages and fall in unemployment rates. While wage and unemployment rates are restored to their original levels in this model, the implication is an even greater stimulus to the regional economy over the medium-run (as compared to the short-run) as in-migration moderates the adverse competitiveness effects of the induce rise in the real wage. The levels of economic activity are greater even than in the short-run, and this is despite the fact that the regional labour market still exhibits NAIRU type results, since the unemployment rate is ultimately unaffected by the demand stimulus.

In the long-run capital stocks adjust to the increases in rental rates apparent in the short- and medium runs. Ultimately, capital stocks expand until rental rates are again equated to user costs of capital. With flow migration the real wage is unaffected, and so across long-run equilibria prices do not change in response to the demand stimulus. Since the bargained real wage returns to its original level and prices are not affected in the long-run, the results parallel those of input-output (I-O), with equi-proportionate increases in output, value added, capital and labour within each sector. It is "as if" labour and capital are in infinitely elastic supply over the long-run. The NAIRU result is established as the unemployment rate returns to its initial level.

The regional economy eventually returns to the initial equilibrium level of real wage and unemployment rates, but at much higher levels of output and employment. Population has expanded due to in-migration into Scotland from RUK. Furthermore, while the adjustment path does depend on the values of the key parameters of the migration function, the medium and long-run solutions do not: all of the adjustment paths converge on a unique equilibrium, which we indicate by the label "convergence" in Table 8.1.

Stock-adjustment model and zero labour mobility

With the stock adjustment model, in the medium-run, the in-flow of migrants will also reduce the pressure on the real take home wage that is apparent in the short-run, but not to the extent that they do in the flow-adjustment model, because in-migration is not a continuous process here. In the stock-adjustment model we assume labour to be heterogenous, and potential migrants respond to changes in the real wage and unemployment rates in different ways. Although the real wage rate in Scotland increases and the unemployment rate falls, not all will perceive migration into Scotland to be advantageous. Thus, here, labour is not in unlimited supply, as it is effectively in the long-run under the flow-adjustment model. Hence as in-migration occurs into Scotland, the real take home wage falls, but the pressure is not sufficient to push the wage down to its initial equilibrium value. Likewise, the unemployment rate is permanently reduced by the demand expansion . In the long-run, the regional economy is in a new equilibrium, characterised by a permanently higher real wage rate and permanently lower unemployment rate.

With zero mobility, the qualitative results of the impact period analysis persist. In this case the short-run pressure on the real wage cannot be relieved to a degree by in-migration in this case. We would therefore expect the macroeconomic effects of the demand stimulus to be least under this configuration of migration.

It is clear that, at least for a demand disturbance under regional wage bargaining, assumptions about labour mobility prove critical for even the qualitative behaviour of the system: only under the flow adjustment model of migration does the system ultimately exhibit NAIRU properties, emulate an augmented IO system or converge on a unique equilibrium irrespective of the values of key parameters of the net migration function. Under either stock-adjustment or zero labour mobility assumptions ***none*** of these properties holds over any time period.

National Bargaining

Next we explore the impact of national wage bargaining for our analysis.. In the impact period, the impact on GDP under national bargaining is more than double that under regional bargaining. In the medium and long-run results are favourable relative to the regional bargaining (BRW) case because here the adverse competitiveness effects that arise through the hike of the real wage are not present in this case: indeed the real consumption wage actually falls as prices rise with the nominal wage fixed. Strictly, therefore, the overall impact on migration is ambiguous, but the major unemployment rate reduction dominates.

In the medium-run, NAIRU results no longer hold even under the flow-adjustment model of migration. The real consumption wage actually falls further as in-migration occurs and demand is further stimulated, and through the zero-net-migration condition the employment (unemployment) rate must rise (fall). In the long-run the real wage and unemployment rate exhibit NAIRU properties: the real wage is brought back to its original value through the absence of price changes, and the migration condition ensures that the same is true of the unemployment rate. In the long-run the system continues to emulate the behaviour of an augmented I-O model.

With the stock adjustment model, as with the regional bargaining closure, the long-run results are achieved more rapidly than with the flow adjustment model. However the main distinction here is that the long-run results with the stock-adjustment model, under the national wage bargaining closure, approach the input-output (I-O) results; there is equiproportionate expansion in capital stocks, total employment and value added in each of the three sectors. But the NAIRU result is not achieved with the stock adjustment migration model, when the national wage bargaining closure is assumed to hold. Although the real wage is ultimately restored to its original level (essentially because the consumer price index returns to its original level and the nominal wage is fixed), the same is not true of the unemployment rate: in the absence of flow migration this is not ultimately tied to its initial level. Accordingly, varying the elasticities of the migration function does result in a degree of non-convergence here in that the long-run equilibrium unemployment rate will vary.

With zero mobility, in the long-run (with full adjustment of capital stocks) the unemployment rate is permanently reduced, and there is also no NAIRU in this case. However, even with zero mobility, the long-run equilibrium of the model emulates an augmented input-output system, again reflecting the less binding nature of the employment constraint under national bargaining where, in effect, firms can get all the labour they wish (over the relevant range) at the prevailing nominal wage rate.

It is clear from our analysis that the degree of labour mobility does matter even for the qualitative behaviour of the system under national bargaining as well as under regional bargaining. However, because national bargaining effectively implies a much less severe labour supply constraint than regional bargaining, the mobility of labour typically matters less, at least for quantitative results. If firms have all the labour they wish within the region at the prevailing nominal wage rate, the ability to attract labour from outside the region is less critical. Notice here that NAIRU results now only hold in one case: long-run equilibrium under the flow adjustment model of my migration. However, notice also that I-O results characterise all of the long-run solutions (though not unique) under national bargaining, quite irrespective of the assumed degree of labour mobility, in stark contrast to the regional bargaining case. Again the reason is the absence of a tight regional labour market constraint under national bargaining.

8.2.2. Supply Disturbances.

Throughout, the supply shock we consider is an externally-financed labour subsidy to manufacturing. The introduction of, or increase in, a labour subsidy, causes the real wage to the firm to fall, thus making it cheaper to employ labour. The real wage to firm initially falls by the amount of the subsidy but the real take home wage to workers remain unchanged. But at that level of real wage to the firm, the demand for labour exceeds the supply, causing an increase in the real wage, even under the initial general equilibrium demand for labour curve. Since labour demand curve also shifts out due to the increased government spending implied by the fact that the subsidy is assumed to be externally financed, there will be further upward pressure on the real wage. This impact period analysis is identical for all models we discuss because migration has no impact in this interval.

Flow adjustment model of migration

In the medium-run, with the flow-adjustment model of migration, as migrants come into Scotland, the real take home wage falls, the labour demand curve, in employment *rate* – real wage rate space shifts in all the way to where the real wage to the firm falls by the amount of the subsidy, while the initial real take home wage is restored. The unemployment rate returns to its initial equilibrium level, hence establishing a NAIRU result. However, while wage and unemployment rates are restored, the level of activity increases further over the medium run as the short-run pressure on the real wage is relieved and adverse competitiveness pressures reduced. In the long-run with full adjustment of capital stocks (through investment) and population (through migration), the regional economy is in equilibrium with the initial real wage and unemployment rate restored. Population and employment has expanded because of in-migration. The long-run results do not, however, converge on input-output type results. The labour subsidy, with the real consumption wage ultimately tied down by migration, implies permanent price falls, and changes in the relative prices of inputs leading to substitution in favour of the subsidised factor.

Stock-adjustment model of migration and zero labour mobility

On the other hand with the stock adjustment migration model, in the medium-run, as migrants come into Scotland the real take home wage rate falls, but not to the initial equilibrium wage: the heterogeneity assumption implies a discrete response in migration to changes in real wage or unemployment rates. The general equilibrium labour demand curve in real wage-employment rate space shifts in, but not all the way to the initial position, as under the flow model: labour in this case remains regional specific, even in the long-run. In the long-run the regional economy is in equilibrium, with a permanent change in real wage and unemployment rates. Population and employment levels do expand due to in-migration, relative to the short-run equilibrium position, but not by as much as under the flow adjustment model of migration. Thus with the stock adjustment model there is no NAIRU result established in the medium or long-runs. In the long-run, the regional labour market settles at permanently higher real wage and lower unemployment rates. Price increases are not limited to zero and, of course, there is no approximation to IO results..

Furthermore, the long-run steady-state results change as we alter the migration parameters: here different adjustment paths are also associated with different equilibria, and there is "non-convergence". This is because, with the stock adjustment specification, real wage and unemployment rates do not return to the original values in the long-run. In the flow-adjustment model, in contrast, the migration elasticities affect only the speed of adjustment to equilibrium, not the long-run equilibrium itself.

The macroeconomic impacts of the labour subsidy are least under zero labour mobility. In this case, the short-run changes in real wages and unemployment rates cannot be even partially offset by net in-migration (as in the stock-adjustment model), let alone wholly offset (as under the flow-adjustment model). Of course, real consumption wage rates are permanently increased in this case, with the unemployment rate permanently reduced, so that NAIRU results do not hold.. With zero-labour mobility, the impact of the demand stimulus on the real wage will be greatest. The increase in real wage rates imposes additional costs on producers, and as a result the price of locally produced goods increase. Scottish exports will be less competitive relative to good produced elsewhere, and this “crowding out” effect will be greatest where labour mobility is not present to limit regional-specific changes in wage and unemployment rates.

It is clear that, for a supply disturbance under regional wage bargaining, assumptions about labour mobility again prove critical for even the qualitative behaviour of the system: only under the flow adjustment model of migration does the system ultimately exhibit NAIRU properties or converge on a unique equilibrium irrespective of the values of key parameters of the net migration function. Under either stock-adjustment or zero labour mobility assumptions ***neither*** of these properties holds over any time period. One significant difference from the case of the demand shock is that system equilibrium never converges on input-output type results, since the disturbance involves lasting relative price changes.

National bargaining

Next we consider the effects under national wage bargaining. Recall that, in this case, wages are determined within an integrated national bargaining system, which implies that the nominal wage is exogenous to small open regional economies such as Scotland. This implies that regional influences do not have a direct impact on regional wages: in particular, the regional unemployment rate does not influence the regional wage rate.

In the impact period, the increase in GDP is more than double the period one increase in GDP under the regional bargaining/ bargained real wage (BRW) closure. There is an increase in the demand for labour as a result of the subsidy but the nominal wage remains unchanged and, since prices increase initially, the real take home consumption wage actually falls.

Ultimately, prices fall in long-run equilibrium in response to the labour subsidy, and with a fixed nominal wage, this ensures a lower real wage, and with flow migration, a lower employment rate/ higher unemployment rate. So NAIRU results are not apparent, nor are IO results. In the long-run, capital stocks are fully adjusted and substitution in favour of labour away from capital occurs in the subsidised sector, stimulated by changes in relative factor prices. In fact in the non-subsidised sectors, substitution in favour of capital away from labour occurs, in the manufacturing traded and sheltered sectors and capital stocks now increase by more than the increase in employment. . However, these effects are not observed in the BRW closure as discussed above (where the real wage is greatly affected by the shock initially but gradually falls back to the initial rate).

With the stock adjustment model, throughout the simulation period, GDP increases by more than double the increase in GDP when the regional bargaining (BRW) closure is used. With the BRW closure, the nominal take home wage increases throughout in response to the stimulus, but with the national bargaining closure the nominal take home wage is fixed. Also notice that with the BRW closure, the real wage increases because workers demand more wages, but with national wage bargaining, the real wage only increases because the consumer price index falls. There is again no NAIRU result here because the unemployment rate is not forced to return to its original value, nor is the real wage. . As for the demand shock, with the stock adjustment migration specification there is no unique long-run equilibrium or steady-state result that holds irrespective of the key parameters of the migration function. The long-run equilibrium results change as we alter the migration elasticities. For example, GDP is very sensitive to changes in the migration parameters as reflected in the change in the long-run results that we discussed in Chapter 7.

Under zero labour mobility the results are rather different from the BRW closure. Unlike with the BRW closure, where crowding out of employment occurs in the non-manufacturing traded and sheltered sectors, there is no crowding-out in these two sectors under the national wage bargaining closure. Employment increases in all three sectors with the target manufacturing sector exhibiting the greatest impact.

Quantitative results: the demand and supply shocks

Table 8.4.2 reports the long-run impact on GDP as a result of the demand and supply disturbances. As mentioned earlier the migration parameters we use are taken from the Layard *et al* (1991) specification of the net migration function.

Table 8.2. Quantitative system wide impact of the demand and supply stimuli.

	Long-run impact on GDP (% increase from base): Regional Bargaining		Long-run impact on GDP (% from base): National Bargaining	
	demand shock	supply shock	demand shock	supply shock
Flow adjustment	4.04	4.20	4.04	3.80
Stock adjustment	1.66	1.77	3.89	3.66
Zero mobility	1.33	1.41	3.85	3.60

Referring to the first column of Table 8.2 (the demand shock), the greatest impact occurs when the flow adjustment model is employed; GDP increases by an estimated 4.04%, which is more than double of the increase in GDP in the stock adjustment model. With the stock adjustment migration model, GDP rises by only 1.66%. Our results also show that the impact on output is even smaller, a 1.33% increase, when there is zero labour mobility. Our results clearly demonstrate the fundamental importance of the specification of the migration process, especially in terms of the impact of a demand disturbance in the long-run under regional bargaining. Notice that national bargaining makes no difference to long-run equilibrium results for a demand shock (column 3 of Table 8.2): the models become equivalent in these circumstances. However, notice that the results of the national bargaining simulations are much less sensitive to migration assumptions. As already noted, this is because under national bargaining firms can get all the labour they wish at the prevailing nominal wage anyway, so the ability to attract in migrants is much less critical for production. Chapter 6 provides a thorough explanation of the impact of the 10 per cent increase in manufacturing export demand on the system

We next discuss the impact of the supply shock. With the flow adjustment migration specification GDP increases by 4.20% in the long-run, while real wage and unemployment rates return to their initial levels. With the stock adjustment model, GDP rises by 1.77%, while the real take home wage increases permanently (by 1.54%). However, the adverse competitiveness effects are even stronger in the zero mobility case since there is no inflow of migrants to even partially moderate the pressure on the regional labour market. With no migration, the 10% labour subsidy causes GDP to increase by only 1.41% in the long run, and the real take home wage increases by more (1.78%). When zero mobility is assumed, there NAIRU results do not arise, as the real wage and unemployment rates are permanently altered. Under the supply stimulus, with the flow adjustment migration model, the default Layard *et al* (1991) model shows that, in contrast to the demand stimulus, the long-run equilibrium results do not exhibit Input-Output properties. With the supply shock, prices are always lower in the new long-run equilibrium, even where NAIRU results are established. Under these circumstances there exist incentives for substitution effects to occur and input-output type results simply do not arise at all in the case of supply-side disturbances..

With the stock adjustment model the unemployment rate decreases by 12.65 per cent from the base. Our findings thus support our earlier suggestion that the existence of a regional "natural rate" of unemployment may, in general depend on the nature of the net migration function. Our results for the stock adjustment specification thus suggest that the labour subsidy impact does help to reduce long-run equilibrium unemployment rate and simultaneously increase GDP *per capita*. The 10 per cent labour subsidy reduces the unemployment rate (by 12.65%) permanently when the stock adjustment migration model is considered. Likewise with no migration, the unemployment rate is permanently reduced (by 14.42%, which is more than the fall in unemployment when the stock adjustment model is considered because there is no in-migration at all in this case). When we change the migration elasticities with respect to real wage and unemployment rate, with the flow adjustment model, the steady state values of the key economic variables converge to the same values but with the stock adjustment model, the long-run results change as we vary the migration elasticities. This is because, in the flow adjustment model, it is "as if" labour is ultimately in infinite elastic supply, while in the stock adjustment model labour remains a region-specific factor even in the long-run.

Notice that the long-run equilibrium results for national bargaining are quite different from those for regional bargaining, even in the long-run (despite their equivalence for a demand shock). In particular, the long-run impacts under national bargaining are less than under regional bargaining. The key to this result is that the change in the real wage in the long-run under the demand shock is precisely zero. The same is true of the supply shock under regional bargaining. However, since prices fall in the long-run in response to the supply stimulus, the nominal wage actually falls in the regional bargaining case. In the national bargaining case the change in the nominal wage is constrained to zero, so with price falls the real wage must rise in the long-run, and so the stimulus of the labour subsidy is less in the long-run than under regional bargaining. However, the reverse is true under stock-adjustment models of migration and under zero labour mobility. National bargaining systems generate I-O results irrespective of the assumed nature of labour mobility (though these are not identical). The fixity of the nominal wage in these cases precludes what would, under regional bargaining, be bigger increases in the real wage.

8.3. Suggestions For Future Research .

While the econometric results we obtain in our study of the migration behaviour between Scotland and the rest-of-the UK (RUK) are far from conclusive, the subsequent simulations certainly serve to demonstrate very emphatically the importance of migration flows in governing system-wide responses to both demand and supply side disturbances.

One set of suggestions for future research concern further development of the approach that we have adopted here. In terms of the econometric analysis, the use of pooled time-series and cross-section data seems a potentially productive way forward. If longer-time series and data from other countries and regions can be accessed we are likely to be able to improve the ability of our econometric models to discriminate among competing visions of regional labour mobility.

A further extension would involve the development of an explicitly interregional analysis, rather than restricting attention to the single region case. The determinants of migration between several regions in the UK could be addressed and migration role in the system-wide responses to demand and supply disturbances could be addressed for each of these regions in an integrated interregional model of the UK. Similarly, the proposed Malaysian application could be extended to allow for both major regions to be endogenous in the system-wide modelling component of the overall analysis.

Other policies could be investigated as sources of demand and supply stimuli. An example in the UK would be the move towards devolution (such as the establishment of the Scottish Parliament) and decentralisation (as e.g. with regional development in England). Similar studies could also be conducted using gross migration data. However, the Scottish office have been reluctant to make such data available. Efforts to improve the quality of regional migration data in Scotland would seem to be appropriate, and may again assist ultimately in discriminating among alternative perspectives on regional labour mobility.

A further important set of extensions of the present analysis would seek to capture some of the other potential effects of migration. In particular, the impact of population on the demand side of the system could be further explored, both econometrically and through model simulations. This could include, for example, the possibility of linking the demand side of the system more directly to the level, and ideally the composition, of population.

Furthermore, we have assumed homogenous labour throughout our analysis, but we know that in practice migration may be selective in both age and skills. Systematic exploration of these effects could surely form the subject of another thesis, in which skill dis-aggregation of labour markets might reveal quite distinct degrees of regional labour mobility by broad skill group. One interesting possibility, for example, would be where the highly skilled workers in effect conform to the flow adjustment model of migration, while the least skilled are completely immobile. The possible combinations of outcomes would, of course, be significantly increased by such an approach, but it may prove to be a very productive avenue for research.

The supply-side impacts of migrants are comparatively restricted in our framework. For example, in-migrants may be more entrepreneurial and ambitious than indigenous populations. In this case there may be additional beneficial supply-side effects operating through, for example, new firm formation and perhaps higher innovation rates that would spill over to other sectors in the economy in a kind of "virtuous circle". On the other hand, there may be circumstances in which negative effects occur, as for example, where migrants are geographically concentrated and add to an already existing problem of congestion. Again such investigation would seem to offer the potential for a wide range of new research, although again this could only be feasibly pursued if there exist migration databases of sufficient richness and accuracy.

Our framework can also be extended through additional applications to other regions and countries. One extension would be to apply the framework for example in the Malaysian setting. Over the years (except during the recent foreign exchange crisis) there has been massive population movement within Peninsula Malaysia, and between East and Peninsula Malaysia (also known as West Malaysia). While the availability of reliable data has yet to be confirmed it is my intention to embark on such research on my return home.

With regards to the influence of migration on system-wide behaviour in response to demand and supply disturbances, similar ideas can be apply to set up migration policies that could influence population movement within Malaysia. Previously the population resettlement program, conducted by the Population Department in conjunction with the Federal Land Development Authority (FELDA), has been successful in relocating families from poverty-stricken areas to FELDA schemes where cash crops such as rubber and oil palm are the major economic activities. However most of the FELDA schemes have become stagnant in terms of production and, in some cases, labour shortages are acute as children from these FELDA schemes becomes educated and then refuse to continue working in those plantations.

Some of the land owners are now too old to run the family plantation allocated for them, thus creating other problems as the land entitlement has been given permanently to these families. A study of what determines the net out-migration from these land schemes could help inform future land scheme plans to ensure that such areas remain attractive.

This study can also be extended to the analysis of international migration into Malaysia. The previous decade has seen Malaysia experience GDP growth in excess of 8%; due to labour shortages the Ministry of Home Affairs has been quite relaxed in allowing workers from countries such as Bangladesh, India, Indonesia and other neighbouring countries to come into Malaysia. However the recent currency turmoil and bleak economic outlook have caused deep concern among Malaysians because there is a perception that it is the locals who are losing out; these international migrant workers are willing to work at lower wages than the levels regarded as acceptable by the locals. There are plans to move migrant workers from simple production lines, into the rubber and oil palm plantations that are least attractive to the indigenous population. The idea is not about transferring migrant workers to a particular economic sector, which could create other social problems. Rather, the suggestion is that there should be a plan or regulation whereby migrants should willingly go home to their countries of origin once their work permit expires or when the economic situation in the host country, Malaysia, does not neccessitate their presence. However, this would naturally create problems within the countries from which migrants originate. The study of the consequences of international migration in Malaysia is important to see to what extent this migration impacts on the Malaysian economy.

The situation in Malaysia may differ from regional migration in the UK, where migrants aid regional economic growth in part through a stimulus to consumption and intermediate demands. International migrants in Malaysia are often argued not to help economic growth because they live in subsistence condition. Most of their earnings are transferred back to their countries of origin to support families back home or for their future investment, should they decide to return. Until recently the income of these migrant workers were un-taxed by the Malaysian government, eliminating another potential mechanism through which in-migrants could impact on the local economy. Often the income taxes of the expatriates are being paid by the local institution that brings them in. Certainly, it would seem very worthwhile further to investigate the impact of both interregional and international migration on the Malaysian economy, and on the indigenous and immigrant populations using an appropriately modified variant of the approach adopted here.

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