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Michelle Gilmartin
David Learmonth
Peter McGregor
Kim Swales
University of Strathclyde

Karen Turner
Stirling Management School

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Michelle Gilmartin[a,b], David Learmonth[a], Peter McGregor[b],
Kim Swales[a,b], Karen Turner[c].

[a.] Fraser of Allander Institute, University of Strathclyde

[b.] Department of Economics, University of Strathclyde

[c.] Stirling Management School, Division of Economics

Abstract

UK regional policy has been advocated as a means of reducing regional disparities and stimulating national growth. However, there is limited understanding of the interregional and national effects of such a policy. This paper uses an interregional computable general equilibrium model to identify the national impact of a policy-induced regional demand shock under alternative labour market closures. Our simulation results suggest that regional policy operating solely on the demand side has significant national impacts. Furthermore, the effects on the non-target region are particularly sensitive to the treatment of the regional labour market.

JEL classification: C68, D58, R58.

Key words: regional CGE modelling, migration, regional development policy.

1. Introduction

UK regional policy has been promoted as a means of increasing national growth and reducing interregional economic imbalances (DTI, 1998). Despite this shift towards decentralised decision-making and responsibility, few researchers have evaluated the impact of local development policy outwith its immediate target area. A substantial body of literature considers the effect of regional policy on the recipient regions (Taylor, 2002; Wren, 2003). However, studies that consider the effect of regional policies on other regions or the national economy are rare.

In fact, until recently, the official Government view was that local development policy had no net effect on the national economy (HM Treasury, 1997). Regional policy was traditionally viewed as a 'zero sum game', such that any employment gains in one area would be exactly offset by losses elsewhere, thus ruling out the possibility that regional policy could have welfare-enhancing effects at the national level. This suggests that regional policy was viewed as being of limited use: it could have a redistributive contribution to make, but could play no role in enhancing overall economic performance. This may have been a factor in discouraging comprehensive research into the national effects of regional policy.

More recently, the Treasury has moved away from the assumption of full crowding out, though only with regard to supply-side policies (HM Treasury, 2003)[1]. The Treasury's shift in perspective - albeit only a partial one - acknowledges the potential for regional policy to provide national economic gains. Furthermore, it makes the policy-making process more complex: the impact of local development policies on both the target and

[1] These most recent guidelines for the appraisal and evaluation of Government policy still do not explicitly acknowledge that demand disturbances can have a national impact.

non-target region ought to be considered, and both equity and aggregate effects become potentially significant.

This change in emphasis strengthens the need for an examination of the spillover effects of local development initiatives on other regions and for identifying and measuring their impact on the UK economy. As Taylor (2002, p.204) states: "the "big" question is whether regional policy yields economic benefits for the economy as a whole. We need to know, for example, whether the non-assisted areas benefit from regional policy and, if so, to what extent". This study aims to address the issue by providing a more comprehensive evaluation of regional policy, focusing on both the regional and national implications of a policy shock.

We consider the system-wide effects on the Scottish and rest of UK (RUK) economies of a policy-induced export shock in the target (Scottish) economy. Policy simulations are carried out in a two-region computable general equilibrium (CGE) framework of the Scottish and RUK economies (AMOSRUK). The analysis incorporates alternative wage-setting and migration assumptions, according to popular views of how regional labour markets work.

A number of variants of the AMOS[2] and AMOSRUK[3] frameworks have been used in earlier research on this broad policy issue (Gillespie *et al* 2001a and 2001b, McGregor *et al* 1999). Our extensions to previous work include (i) using an updated (1999) base year dataset (ii) examining period-by-period results rather than long-run equilibria outcomes only (iii) incorporating a larger variety of labour market scenarios and (iv) considering a longer, fifty-year, post-shock time horizon.

[2] AMOS is an acronym for A Macro-Micro Model of Scotland. Harrigan *et al* (1991) gives a full description of early versions of the AMOS framework.
[3] A Macro-Micro Model of Scotland and the Rest of the UK. Gillespie *et al* (2002) describes the interregional model AMOSRUK.

In particular, the analysis of the policy issue on both a multi-regional and period-by-period basis provides for a more comprehensive study of the topic than previous research has allowed. Firstly, this approach enables consideration of the adjustment paths of the economy under different policy options, rather than of long-run equilibria only. Thus we can evaluate whether the policy option that is 'best' in the long-run is similarly so in the short-run. Policy makers have a ten year time horizon for the evaluation of local development initiatives (HM Treasury, 1995), and so period-by-period analysis - over the duration of this evaluation period and beyond - helps to identify whether there are any significant adjustments that occur outwith policy makers' period of consideration. Secondly, taking account of the time component of the effects of regional policies allows us to examine any discrepancies in the relative speed of adjustment of the Scottish and RUK economies, which would likely be important in determining the most appropriate policy action.

The choice of policy change that we consider is closely in accord with current Government policy in the target region. Although regional development policy has previously focussed mainly on supply-side issues, demand-side policies have also become important in recent years. The Scottish 'Government Economic Strategy' (2007) sets out its objectives for improving Scottish international competitiveness and increasing Scottish exports, and one aim of Scottish Enterprise – Scotland's Economic Development Agency – is to improve global trade links and help exporters become more competitive suppliers to overseas markets, through its 'Global Connections' theme[4].

Although we do not explicitly focus on they types of policies that could potentially achieve this effect, we do note that recent policy emphasis by the Scottish Government on the Scottish renewable energy sector could generate an export shock of the type

[4] This comes ultimately from 'A Smart, Successful Scotland: Ambitions for the Enterprise Networks', The Scottish Executive, January 2001.

discussed here. Successful policies to develop an offshore energy transmission infrastructure, capital expenditure grants for emerging technologies and the promotion of partnerships between Scottish manufacturers and foreign investors could help to open up new export channels for the manufacture of both renewable energy devices/hardware and energy provision itself to overseas markets. The size of the renewable energy resource in Scotland, and provisional estimates of renewable energy capacity, suggest that the sector's potential is sufficiently large to warrant a sizeable export market in the longer term.

2. AMOSRUK: A Computable General Equilibrium Framework

AMOSRUK, the interregional version of the AMOS simulation framework, is a computable general equilibrium model of the UK economy[5]. It is a flexible model structure that offers a range of model closures corresponding to different time periods of analysis and labour market options. This paper focuses on the national population constraint, and its impact on regional wage determination. The way in which labour market closures are used to vary the operation and spatial impact of this constraint is given in greater detail in Section 3.

The model structure includes two endogenous regions - Scotland and the rest of the UK (RUK) - and one exogenous region - the rest of the world (ROW). There are three transactor groups in each region - households, firms and the government - and three commodities and activities - manufacturing, non-manufacturing and sheltered. There are four main components of final demand: household consumption, investment, government expenditure and exports to the ROW.

[5] Greenaway *et al* (1993) provides a general appraisal of CGE models and Partridge and Rickman (1998, 2010) review regional CGEs.

The basic data set for the model is an interregional Social Accounting Matrix (SAM) for 1999. This data set provides a ‘snapshot’ of the Scottish and RUK economies for that year, highlighting the relative size of the economies (Scottish GDP represents 8.05% of total UK output) and the linkages that exist between sectors and regions. The SAM is an augmented Input-Output table with transfer payments between economic agents and factors of production. It covers all intra-regional, interregional and international transactions in the economy that year. The structural data embedded in the SAM are used to ascribe actual values to some of the parameters of the functional forms in the model system (for example the relative size and import intensity of sectors). Other parameter values are determined exogenously (for example migration function parameters and elasticities of substitution), drawing from existing literature. A final set of parameter values are determined through calibration of the model. Where econometrically parameterised relationships have been imposed, these have been determined using annual data. Each ‘period’ in the model is therefore interpreted as a single year.

In production, local intermediate inputs are combined with imports from the other region and the rest of the world via an Armington link (Armington, 1969). This composite input is then combined with labour and capital (value added) to determine each sector’s gross output. Production functions at each level of the production hierarchy can be CES, Cobb-Douglas or Leontief. In this paper CES production functions are imposed throughout.

Consumption demand is linear in real income and homogenous of degree zero in all nominal variables. Real government demand is exogenous. Both interregional and international exports are price sensitive. However, while non-price determinants of export demand from the rest of the world are taken to be exogenous, export demand to the other UK region is fully endogenous, depending not only on relative prices, but also on the structure of all elements of intermediate and final demand in the other region.

A significant feature of the model is the between-period updating of capital stocks and the labour force. For the capital stock, gross investment is given by an explicit capital-stock adjustment mechanism: in each period investment demand from each sector is a proportion of the difference between actual and desired capital stock, where desired capital stock is a function of commodity output, the nominal wage and the user cost of capital. For the labour force, it is assumed that there is no natural population increase and that international migration can be ignored. Therefore, the only means of adjusting the regional labour forces is through interregional migration. This is explained in greater detail in the next section. In addition, the AMOSRUK model also provides the opportunity to impose constraints on the regional balance of payments and on public sector net transfers to the region. However, in this analysis, no macro constraints are imposed other than the labour market closures mentioned above.

For the simulations, the main parameter values are as follows: the elasticity of substitution in the CES production functions is set at 0.3 (Harris, 1989) and the Armington assumption is applied to both interregional and international trade with an elasticity of substitution of 2.0 (Gibson, 1990). The parameter determining the speed of adjustment from actual to desired capital stock is set at 0.5, following econometric work on the determination of investment in the Scottish economy.

3. Alternative Visions of the Labour Market

In evaluating the full spatial impact of a demand shock, this study focuses on a population constraint that can operate at the regional or national level. The main impact of the constraint feeds through to the economy via its effect on wage setting. For example, where the regional real wage is determined by a local bargaining process, a rise in employment leads to an increase in the regional real wage and a reduction in competitiveness. Interregional migration can, however, ease this labour market pressure, in this example by attracting net in-migration[6]. We consider five labour market scenarios - summarised in Table 1. Each of these is intended to represent a stylised version of conventional labour market configurations that are common in the labour market and regional macroeconomic literature.

Table 1: Simulation Set-Ups

	Population	**Regional Wage Setting**		**Effective Long-Run Population Constraint**	
		Scotland	**RUK**	**Regional Level**	**National Level**
Quasi IO	Fixed at the regional level	Fixed real wage	Fixed real wage	No	No
Regional Bargaining	Fixed at the regional level	Bargaining	Bargaining	Yes	Yes
Flow Migration	Fixed at the national level	Bargaining	Bargaining	No	Yes
Wage Spillover (1)	Fixed at the regional level	Adoption of RUK nominal wage	Bargaining	Yes (RUK) No (Scot)	Yes
Wage Spillover (2)	Fixed at the national level	Adoption of RUK nominal wage	Bargaining	Yes (RUK) No (Scot)	Yes

3.1 QUASI IO

The first scenario incorporates fixed real wages in both the Scottish and RUK economies. There is no interregional migration of the labour force, so that regional employment is determined solely by regional labour demand. This configuration involves no effective

[6] We define a region as having an effective long-run population constraint when an increase in regional employment leads to an increase in long-run regional real wages. Thus where an increase in employment is not directly associated with an increase in long-run real wages (for example due to the presence of fixed real wages or in-migration) no effective long-run population constraint exists.

population constraints at either the regional or the national level. Increased employment is met by increased regional labour market participation, with no change in real wages, so neither region suffers adverse competitiveness effects generated specifically through the labour market as export demand expands. The nominal wage might change but only in response to changes in the regional consumer price index (CPI). Capital fixity dictates supply restrictions, so that marginal costs and prices rise in the short-run as output expands. Over time, however, investment optimally adjusts capital stocks, relaxing capacity constraints, and ultimately the economy operates like an extended Input-Output (IO) system (McGregor *et al* 1996).

The Quasi IO closure is used here as a "benchmark" against which the other closures can be measured, and the results from this scenario offer important insights into the forces at work during the adjustment process of the regional economies. However, the lack of any national labour market constraint must be seen as unrealistic, though this assumption is central to the standard demand driven interregional IO analysis (Madden and Trigg, 1990, McGregor and Swales, 1999; Miller and Blair, 2009).

3.2 REGIONAL BARGAINING

The second simulation scenario involves a set-up where population is fixed in each region as before, but differs from the Quasi IO configuration in that wages are now determined by a bargaining process. The particular bargaining function adopted is the econometrically-parameterised relationship identified by Layard *et al* (1991):

$$\ln\left[\frac{w^I}{cpi^I}\right] = \beta^I - 1.113 \ln u^I \qquad (1)$$

where:

w is the nominal wage rate

cpi is the consumer price index

u is the unemployment rate

β is calibrated to ensure that the model replicates the base year data set, and

the I superscript indicates the region.

A population constraint operates in each region in this configuration. In both regions, real wages reflect the tightness of the regional labour market, measured as inversely related to the regional unemployment rate. This configuration is intended to reflect the notion of a conventional 'wage curve' operating at the level of the region[7].

3.3 FLOW MIGRATION

The third model scenario involves real wage bargaining at the regional level, as in the previous Bargaining set-up, but also introduces interregional migration to allow for population adjustment. Migration flows in one period serve to update the population stock in the next period. The Scottish rate of in-migration is positively related to the Scottish/RUK ratio of the real consumption wage and negatively related to the Scottish/RUK ratio of unemployment rates, in the spirit of Harris and Todaro (1970)[8]. The specific form of this equation is derived from the Layard *et al* (1991) econometrically parameterised interregional migration function:

$$\ln\left[\frac{m^S}{L^S}\right] = \delta - 0.08\left[\ln u^S - \ln u^R\right] + 0.06\left[\ln\left[\frac{w^S}{cpi^S}\right] - \ln\left[\frac{w^R}{cpi^R}\right]\right] \qquad (2)$$

[7] As in Blanchflower and Oswald (1990). More recently, they and others have found additional evidence of an inverse relationship between regional unemployment rates and wage rates – see Blanchflower and Oswald (1994, 2005) and Montuenga *et al* (2003).

[8] Harris and Todaro (1970) suggests that in-migration will occur to a local area if (among other factors): wages increase, unemployment decreases or job creation increases, thereby increasing expected income in that area. Treyz *et al* (1993) provides further analysis relating to internal migration.

where:

m is net-inmigration

L is population

δ is a calibrated parameter that ensures zero net migration (the equilibrium condition) for the base year data, and

S and R indicate Scotland and the rest of the UK respectively.

In this set-up, the presence of migration allows for a unified national labour market: an increase in regional demand lowers regional unemployment and increases the real wage, inducing migratory flows into that region. In long-run equilibrium, the presence of migration re-imposes the original ratio of regional wage and unemployment rates (see Appendix B). In this scenario, the population constraint works only at the national level; migration eases labour market pressures for one of the two regions.

3.4 WAGE SPILLOVER (1) AND (2)

In the Wage Spillover cases the RUK acts as the lead region and Scotland as the follower. Real wages in the RUK are determined by regional bargaining, as before, while the Scottish economy accepts the nominal wage that is set by the RUK. This labour market set-up is intended to incorporate an interregional variant of the traditional Keynesian macroeconomic vision of a region in which nominal wages are fixed. This has often been motivated in terms of a national bargaining system. In the present case, Scottish nominal wages are not fixed, but they are determined outwith the region. The set-up captures the scenario whereby unions negotiate at the national level, and the outcome of the bargaining process feeds through to the regions, who are nominal wage takers[9]. Wage

[9] This labour market configuration also incorporates the notion of inflationary wage spillovers, whereby inflationary wage pressures can differ across regions and wage pressures in one 'lead' region, such as the South East of England, can influence wages in other regions. A number of authors have considered the extent to which wages in one region are influenced by wages set in other regions, including Manning

Spillover (1) incorporates no interregional migration, whilst in Wage Spillover (2), interregional migration is allowed for, according to equation (2).

In the Scottish region, there is essentially no population constraint, since regional wages do not directly respond to regional labour market pressures. In the RUK region, however, there is an effective population constraint, since nominal national wages reflect the tightness of the labour market in the RUK. The UK economy as a whole is therefore population constrained.

4. Simulation Results

This analysis considers the system-wide effects on Scotland and the RUK of a demand shock to the regional economy: an increase in Scottish exports to the rest of the world (ROW). Different types of demand stimuli are likely to lead to different outcomes due to, for example, different terms of trade effects, and the reason for choosing an export-led demand shock is partly conceptual. The effects of a demand disturbance within a conventional, purely demand-driven single and multi-regional IO model are already well understood[10]. Thus, comparison of CGE-based results relative to that of an IO framework provides significant insight into the combined effects of the sectoral linkages and national constraints. The choice of an export-led shock, in particular, is appropriate since it is a good example of a straightforward demand disturbance, and one that is often considered in the regional policy literature. Furthermore, the effects of an export shock are of interest due to this type of stimulus being closely related to current policy concerns

(1994) and Molho (1982). Armstrong and Taylor (2000) suggest that nationally bargained wages, and the corresponding wage rigidity that this introduces to regional labour markets, could be one explanation, amongst others, for regional unemployment differentials across the EU (pp170-171).

[10] McGregor *et al* (1996), and McGregor *et al* (1999).

in the target area. For simplicity, we do not invoke an offsetting impact elsewhere in the economy[11].

The simulation method involves a 5% step increase in ROW exports from the Scottish traded sectors (i.e. the manufacturing and non-manufacturing traded sectors). This involves an outward movement of the ROW demand schedule for Scottish manufactured goods and services, by 5%. The model is run forward for 50 periods with the values of all other exogenous variables held constant, and the changes from the initial base-period value are reported for the key variables. In all cases, capital stock is updated between periods, and in the 'Flow Migration' model configuration the regional populations are adjusted in a similar manner. In the other scenarios, the regional populations remain constant.

The model calibration process takes the economy to be initially in long-run equilibrium. This means that if the model is run forward with unchanged exogenous variables and parameters, the endogenous variables continuously take their initial values. Introducing a step change drives the economy towards a new long-run equilibrium and it is the paths to these new comparative static equilibria that are reported here. The different model configurations generate both different long-run equilibria and different adjustment paths.

The simulation results are discussed for each model configuration in turn. The long- run versus short-run impacts are discussed, along with the relative effects in each region[12]. Figures 1-16 show the trajectories for the change in key variables relative to base for the

[11] Thus the policy is assumed to be costless, for example representing an improvement in the effectiveness of existing policy.

[12] For the purposes of this paper, we use the terms 'short-run' and 'long-run' more flexibly than that suggested by an accurate analytical definition. We refer to the 'short-run' as being a period of 0 to 5 years after the policy shock, and to the 'long-run' as a period of around 50 years post-shock. We also make use of the term 'evaluation period' which refers to the period 0 to 10 years following the shock, which is the time period considered by HM Treasury for the purposes of evaluating local development policies (HM Treasury, 1995).

five model configurations: Figures 1-7 relate to the Scottish economy; Figures 8-14 to the RUK economy; Figures 15-16 to the national economy. Tables 2-7 summarise the results for key variables. Aggregate variables are reported in both absolute and percentage terms; the remaining key variables are reported in percentage terms. Some variables (such as capital rental rates and commodity output prices) do vary across the three sectors, but in some instances, to aid clarity, a weighted average of the change across all sectors is presented[13]. Each variable is expressed in terms of its change (absolute or percentage) relative to base.

4.1 QUASI IO: SCOTTISH ECONOMY EFFECTS

Figure 1 shows the change in Scottish GDP relative to base for the five model configurations. In all cases, Scottish GDP increases over time towards a new, stable, equilibrium. The increase relative to base is greatest for the Quasi IO configuration, with GDP 1.41% above its base value by period 50 (Table 2). The results from this configuration are used as a benchmark against which the other scenario results can be compared.

The positive demand shock boosts commodity outputs in the traded sectors, and also in the wider economy via increased demand for intermediate inputs, though the effects are less significant in these sectors. In the long-run, in each sector, all inputs rise by the same proportionate amount, which equals the growth of output in that sector, so that constant technical coefficients are maintained, and all prices return towards their base-period equilibrium in this set-up (Figure 2). This confirms previous long-run simulation results

[13] A weighted average of the change in exports across all three sectors is provided in the summary tables. For the simulations, a 5% ROW export demand shock is imposed on the Scottish manufacturing and non-manufacturing traded sectors, but not on the sheltered sector. In this model, the sheltered sector includes industries in which there is relatively little external trade, though the level of exports is still positive. Imposing a 5% export shock on the traded sector increases total exports by approximately 4.8%, assuming there is no exogenous change in sheltered sector exports.

for similar model configurations in a single region context: a small region with fixed wages and no migration will encounter demand-invariant prices, which motivates fixed production and consumption coefficients (McGregor *et al*, 1999). This paper extends the existing research to a two-region CGE analysis, but the absence of population and supply-side constraints makes the framework IO-like, and the long-run equilibrium exhibits the IO characteristics of constant technical coefficients and constant prices.

In the shorter-run, during the adjustment process, capital fixity imposes supply restrictions. As output expands, prices rise in the short-run. Capital rental rates increase on average across all sectors by 1.41% and 1.30% relative to base in periods 2 and 3 respectively. There is upward pressure on the price of commodity outputs and value added in the traded sectors, and also on the overall CPI. Sheltered sector prices rise because of the general increase in consumption demand, and also because intermediate inputs from this sector are required in the traded sector production process, but the effects are less significant than in the traded sectors.

In line with the output expansion, the positive demand shock increases the derived demand for labour across all sectors. The long-run employment effects are strongest in this scenario out of all the labour market configurations (Figure 3), with total employment 25,138 (1.33%) above base by period 50. The Scottish real wage rate is held constant throughout the adjustment period (Figure 4). So in this scenario, the Scottish economy does not suffer adverse competitiveness effects generated specifically through the labour market as export demand expands. As output increases, nominal wages do rise (Figure 5), in response to the increase in the regional CPI in the shorter-run (Figure 2), and this has implications for the region's competitiveness. In the long-run, however, prices and nominal wages return to their base values in the Quasi IO scenario, and this labour market configuration results in the highest increase in ROW exports over base (Figure 6).

Table 2: Quasi IO Summary Results

		Period 3		Period 10		Period 50	
		Scotland	RUK	Scotland	RUK	Scotland	RUK
GDP		£275.43m	£44.43m	£549.08m	£200.5m	£880.37m	£694.63m
		0.44%	0.01%	0.88%	0.03%	1.41%	0.10%
Total employment		9,913	1,442	16,611	5,965	25,138	19,220
		0.52%	0.01%	0.88%	0.03%	1.33%	0.09%
Traded sector employment		0.68%	0.01%	1.13%	0.04%	1.69%	0.11%
Sheltered sector employment		0.18%	0.00%	0.34%	0.01%	0.53%	0.05%
CPI		0.31%	0.08%	0.21%	0.06%	0.01%	0.01%
Commodity output prices		0.47%	0.08%	0.29%	0.06%	0.02%	0.01%
Price of value added		0.69%	0.08%	0.40%	0.07%	0.02%	0.01%
Nominal wage		0.32%	0.08%	0.21%	0.06%	0.01%	0.01%
Real wage		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Exports to the other region		-0.93%	1.25%	-0.47%	1.42%	0.06%	1.56%
Exports to ROW		3.67%	-0.15%	4.33%	-0.12%	4.87%	-0.02%

4.2 QUASI IO: RUK ECONOMY EFFECTS

In the Quasi IO case and for the RUK economy, the regional export shock in Scotland also results in an increase in both short-run and long-run GDP, and the results under this scenario are significantly stronger than for the other four scenarios, and always expansionary (Figure 8). This reflects the absence of RUK population constraints in this model set-up. As is apparent from Table 2, in this scenario the long-run impact on the RUK in terms of the absolute change in GDP is almost as large as the impact on Scotland itself, reflecting the high trade linkages between the two economies. The size of the impact as a percentage of GDP is, as expected, less significant for the RUK economy relative to Scotland, owing to the direct effect of the shock on the Scottish economy.

The source of the stimulus in the RUK economy is an increase in demand for RUK intermediate goods from the Scottish economy and, as activity expands in Scotland, for final consumption and investment goods. As with the Scottish economy, real wages remain fixed (Figure 11), so that, as output expands, the RUK economy does not experience negative competitiveness effects generated directly through the labour market. Nominal wages increase in response to a rise in CPI in the short-run, but both variables move back towards their base values over time (Figures 12 and 9 respectively).

In the short-run, as RUK commodity outputs increase across all sectors, prices increase relative to base (Figure 9). Therefore a negative external competitiveness effect does exist at this stage: exports to the ROW fall by 0.16% relative to base in the period immediately following the shock (Figure 13). Nevertheless, exports to Scotland increase by 1.16% relative to base in the same period (Figure 14), contributing to an overall relative GDP stimulus (Figure 8). Over time, capacity constraints relax, prices move back towards their base year values and the negative external competitiveness effect is removed.

Although the overall impact of the Scottish export shock is an increase in long-run GDP in both regions, the effects of the stimulus are much slower to materialise in the RUK compared with Scotland. In period 3, the relative increase in Scottish GDP is over 30% of its long run period 50 value. In contrast, RUK GDP in period 3 is just over 6% of its period 50 value (Table 2). This is partly explained by the differing composition of each region’s export market. Whilst exports to the RUK account for around 50% of Scotland’s total exports, exports to Scotland constitute only around 13% of the RUK’s total exports. The relatively small share of the RUK’s other-region exports means that the RUK has fairly limited exposure to the demand shock stimulus that feeds through from the Scottish economy[14].

Furthermore, the interregional transmission mechanism contributes to the delayed adjustment for the RUK economy. The initial shock felt by both economies, albeit originating from a pure demand disturbance in Scotland, embodies both a demand stimulus and an adverse supply shock. The Scottish economy receives an initial demand injection from an increase in ROW manufacturing exports. Capital fixity brings about an adverse supply reaction in the short-run, but the direct impact of the ROW demand stimulus is sufficient to dominate this, leading to an overall increase in Scottish GDP, even in the short-run (Figure 1)[15]. Over time, as capacity constraints relax, the full effects of the demand shock are transmitted to the wider economy. The RUK economy, in contrast, does not receive the immediate ROW demand stimulus. Rather, the demand boost for the RUK economy is generated indirectly from an increase in demand for intermediate and final goods from Scotland, and these effects take time to feed through. There is a limited short-run demand stimulus in the RUK, and a corresponding adverse supply reaction, and the demand effects do prevail to generate an increase in GDP in the periods following the shock (Figure 8)[16]. But the immediate effects of the shock are muted relative to the ultimate impact: only when capacity constraints are optimally adjusted in Scotland are the entire effects of the demand disturbance transmitted to the RUK via interregional trade linkages. This results in a protracted adjustment period for the RUK economy.

[14] Preliminary simulations of an equivalent ROW exports shock on the RUK economy support this suggestion. The analysis reveals that there is a delayed period of adjustment for the Scottish economy relative to that of the RUK in two of the labour market scenarios, but to a much lesser extent, and the delay is not apparent for the other labour market configurations.
[15] This is true for the Scottish economy across each of the labour market scenarios.
[16] This is true for the RUK economy across all the model scenarios, except those including migration. See Sections 4.6 and 4.8 for a discussion of the effects of migration in reducing RUK GDP relative to base in the short run.

The CGE results thus reveal more complex economic interactions and adjustment mechanisms compared with straightforward IO analysis, and this has direct implications for the non-target region effects. Whereas under IO analysis an increase in ROW exports for Scotland constitutes a pure demand shock, the active supply side response embodied in CGE analysis means that other region effects are both demand and supply orientated. This suggests that IO analysis would provide a poor approximation of the effects of the shock in the short run in the presence of a non-passive supply side.

4.3 REGIONAL BARGAINING: SCOTTISH ECONOMY EFFECTS

The introduction of bargained real wages, either without migration (the Bargaining scenario), or with migration (the Flow Migration scenario), reduces the size of the relative GDP stimulus in Scotland, as the responsiveness of wage rates gives rise to negative competitiveness effects that are maintained into the long-run (Figures 4 and 5).

In the case of the Bargaining scenario, the relative increase in GDP is the lowest out of all the configurations, with the long-run change in GDP less than 50% of the value in the other three cases (Figure 1). In this set-up, the export stimulus increases the derived demand for labour (Figure 3). With no interregional migration, real wages rise, reflecting the tightness of the regional labour market (Figure 4). Commodity output prices therefore rise relative to base, as does the overall CPI (Figure 2). This represents a significant negative competitiveness effect: real wages are 0.56% higher than base by period 50 (compared with no change in the Quasi IO case) and economy-wide prices are 0.32% higher (compared with 0.01% in the previous scenario). Furthermore, while the negative competitiveness effect that occurred in the Quasi IO case was a short-run and indirect effect, in the present set-up the effect remains significant for the duration of the simulation period, and operates directly through the labour market.

As a result of the reduction in Scottish competitiveness relative to that in the Quasi IO case, the increase in Scottish exports to the ROW is lower (Figure 6). This is reflected in a weaker overall GDP stimulus, and accounts for a more subdued increase in total Scottish employment relative to base over the period (Figures 1 and 3)[17].

Table 3: Bargaining Scenario Summary Results

	Period 3		Period 10		Period 50	
	Scotland	RUK	Scotland	RUK	Scotland	RUK
GDP	£173.85m	£23.81m	£296.47m	£77.44m	£359.41m	£124.50m
	0.28%	0.0%	0.47%	0.01%	0.57%	0.02%
Total employment	5,655	610	7,682	1,746	8,818	2,650
	0.30%	0.00%	0.41%	0.01%	0.47%	0.01%
Traded sector employment	0.44%	0.00%	0.61%	0.01%	0.7%	0.02%
Sheltered sector employment	-0.02%	-0.02%	-0.04%	0.00%	-0.04%	0.00%
CPI	0.36%	0.08%	0.35%	0.08%	0.32%	0.07%
Commodity output prices	0.59%	0.08%	0.56%	0.08%	0.53%	0.08%
Price of value added	0.86%	0.08%	0.77%	0.09%	0.71%	0.08%
Nominal wage	0.69%	0.09%	0.83%	0.09%	0.88%	0.09%
Real wage	0.32%	0.00%	0.47%	0.01%	0.56%	0.02%
Exports to the other region	-1.08%	1.25%	-0.85%	1.39%	-0.74%	1.44%
Exports to ROW	3.54%	-0.16%	3.98%	-0.15%	4.13%	-0.14%

4.4 REGIONAL BARGAINING: RUK EFFECTS

The presence of bargained real wages similarly reduces the GDP stimulus in the RUK economy compared to the effects under the Quasi IO scenario. In this scenario, increased

[17] These results are in line with those of McGregor *et al* (1999), which considers the spillover effects and interdependencies between the Scottish and RUK economies in a CGE context. The authors examine a demand shock in the presence of local wage bargaining and no migration, and find that there is some crowding out of the employment injection through reduced competitiveness.

demand for RUK intermediate inputs and consumption and investment goods results in a rise in RUK exports to Scotland (Figure 14). In fact, the changes in RUK exports to Scotland following the shock are fairly uniform over the different labour market configurations. The key factor underlying the different GDP trajectories is the change in RUK exports to the ROW (Figure 13), which itself is driven by price and competitiveness effects. In the Bargaining scenario, as output expands and the derived demand for labour increases, real wages are bid up (Figure 11). This reduces RUK competitiveness relative to the Quasi IO case, leading to a larger fall in ROW exports (Figure 13) and increasing import penetration. This contributes to a significantly lower GDP stimulus in this case relative to the Quasi IO scenario. By period 50, GDP is 0.02% higher relative to base in this scenario, compared with 0.10% in the Quasi IO case.

In the Bargaining set-up, the RUK economy is slower to adjust to the shock compared with the Scottish economy. This is in line with the results from the Quasi IO case, and reflects the indirect nature of the shock. Furthermore, the relative reduction in GDP that results from the introduction of regional wage bargaining compared with the benchmark Quasi IO configuration differs for the Scottish and RUK economies. While the existence of bargained real wages leads to approximately a 59% relative reduction in the Scottish GDP increase over base by period 50, compared to the Quasi IO case, the equivalent figure for the RUK is just over 82%. Thus the responsiveness of wages has a more significant adverse impact on the RUK economy than on the Scottish economy. In Scotland, this GDP reduction effect stems from the impact of weaker international competitiveness and an associated smaller increase in ROW exports over the time period, compared with the Quasi IO configuration (Figure 6). In contrast, the GDP reduction effect in the RUK results from both weaker international competitiveness effects that arise as wages are bid up in line with stronger RUK activity, and also from a weaker stimulus coming from the Scottish economy, compared with the Quasi IO case. Thus the aggregate relative effect on the RUK economy is more significant.

4.5 FLOW MIGRATION: SCOTTISH ECONOMY EFFECTS

The demand shock also results in a relative increase in Scottish GDP when migration is introduced, together with bargained real wages. In the Flow Migration case, the source of the long-run boost remains the same as in the previous two scenarios: higher export demand increases traded sector outputs, and the boost in activity feeds through to the wider economy.

In this model set-up, the responsiveness of the real wage works to reduce external competitiveness as activity rises, as in the Bargaining scenario. The introduction of migration, however, lessens this adverse effect. In fact, for the Scottish economy, the presence of migration almost fully mitigates these negative competitiveness effects brought about by the presence of bargained real wages. In the longer-run, the relative change in GDP in this scenario is much closer to that of the Quasi IO scenario, where there is no adverse labour market effect attributable to the responsiveness of real wages, than that of the Bargaining scenario (Figure 1).

In this set-up, as in the Bargaining scenario, the regional export shock increases economy-wide prices and real wages. The resultant negative competitiveness effects offset, to some extent, the positive demand impact. Whilst in the Bargaining scenario this negative competitiveness effect remains significant throughout the simulation period, the same is not true of the Flow Migration scenario. The allowance for migration means that, following the shock in the Scottish economy, some of the labour supply migrates away from the RUK economy into the Scottish economy, where the unemployment rate is relatively lower and real wages relatively higher than in the base period. Although there remains a UK-wide labour market constraint (zero net migration is assumed in the UK overall), there is considerable easing of labour market constraints in Scotland, but at the expense of a contraction in the RUK labour supply. Thus the presence of

Table 4: Flow Migration Summary Results

	Period 3		Period 10		Period 50	
	Scotland	RUK	Scotland	RUK	Scotland	RUK
GDP	£200.06m	£-11.000m	£438.53m	£-106.69m	£808.34m	£-446.68m
	0.32%	0.00%	0.70%	-0.02%	1.29%	-0.06%
Total employment	6,833	-886	12,923	-4,649	22,968	-14,079
	0.36%	0.00%	0.68%	-0.02%	1.21%	-0.07%
Traded sector employment	0.50%	0.00%	0.91%	-0.02%	1.55%	-0.07%
Sheltered sector employment	0.04%	-0.01%	0.18%	-0.03%	0.47%	-0.06%
CPI	0.36%	0.08%	0.30%	0.08%	0.12%	0.09%
Commodity output prices	0.56%	0.08%	0.43%	0.09%	0.15%	0.11%
Price of value added	0.82%	0.09%	0.58%	0.10%	0.18%	0.13%
Nominal wage	0.58%	0.10%	0.47%	0.12%	0.19%	0.16%
Real wage	0.23%	0.01%	0.17%	0.04%	0.07%	0.06%
Exports to the other region	-1.05%	1.27%	-0.69%	1.43%	-0.16%	1.54%
Exports to ROW	3.57%	-0.17%	4.14%	-0.17%	4.65%	-0.20%
Population	8,570	-8,570	27,534	-27,534	59,025	-59,025

interregional migration, and the increase in labour supply in Scotland, works to mitigate the increase in Scottish real wages in the long-run (Figure 4). By period 50, real wages are only 0.07% above their base values in the Flow Migration scenario, compared with 0.56% in the Bargaining case. The increase in nominal wages is therefore significantly less in the Flow Migration case in the long-run: nominal wages are 0.19% higher than base in period 50, compared with 0.88% in the Bargaining case. The Flow Migration scenario therefore reduces the loss in price competitiveness of Scottish exports. Scottish exports to the ROW are 4.65% higher, compared with 4.13% for Bargaining. As a result, the long-run GDP increase under the Flow Migration scenario is greater than under the Bargaining scenario, but still lower than under the Quasi IO set-up. In the latter case, the absence of a national population constraint means that there is no increase in real wages, thus price increases are more subdued in the short-run (and zero in the long-run) and the negative competitiveness effect is least prevalent (Figure 1).

4.6 FLOW MIGRATION: RUK EFFECTS

In contrast to the effects on the Scottish economy, the introduction of interregional migration makes for an overall reduction in long-run GDP relative to base for the RUK (Figure 8). By period 50, RUK GDP is 0.06% below its base value (Table 4). This compares with a relative increase in GDP of 0.1% for the Quasi IO scenario and 0.02% for the Bargaining closure.

As in the Bargaining scenario, the RUK economy experiences an increase in export demand from the Scottish economy (Figure 14). But the presence of interregional migration works to counteract the RUK stimulus in the Flow Migration scenario. Owing to the direct effects of the demand shock in Scotland, the short-run real wage increases and the proportionate rise in employment relative to base are stronger in Scotland compared with the RUK (Table 4). These changes in the Scottish/RUK unemployment and real wage ratios mean that some of the population flows into the Scottish economy, and the RUK economy experiences an adverse supply shock in the form of a reduced labour supply. In period 50, the RUK population is 59,025 lower relative to base[18].

The increase in demand for RUK goods from the Scottish economy, combined with reduced population, means that there is still upward pressure on commodity output prices and overall CPI in the RUK economy (Figure 9). As in the Scottish economy, this causes a detrimental effect on RUK exports to the ROW (Figure 13). In contrast to that of

[18] Lisenkova *et al* (2008) explores the macroeconomic impacts of demographic change in Scotland in a CGE context, and similarly finds that a tightening of the labour market will have adverse consequences for employment, growth and competitiveness in the Scottish economy.

Scotland, however, the overall effect of the demand disturbance in this scenario is a long-run fall in GDP and employment relative to base (Figures 8 and 10). The source of the different outcomes is the effect on the regions' labour supply. When both regions have bargained real wages – without migration – each region experiences an increase in output and employment in the short and long-run. This is because the reduced ROW competitiveness – brought about by the responsiveness of real wages – is offset by the demand stimulus. The introduction of migration, however, results in an increase in the labour supply in Scotland and a reduction in the RUK labour supply, which exacerbates the loss of competitiveness in this region.

4.7 WAGE SPILLOVER (1) AND (2): SCOTTISH ECONOMY EFFECTS

Both Wage Spillover set-ups provide very similar long-run results for the Scottish economy, and the adjustment path for each of the scenarios is closely related. These configurations result in a relative increase in GDP for the Scottish economy that is less than that for the long-run Quasi IO outcome, but higher than that of the Flow Migration and Bargaining scenarios (Figure 1). GDP is 1.35% higher than base in period 50 for both Spillover closures, with and without migration. As in the previous scenarios, higher demand in the Scottish traded sectors boosts economy-wide activity. In the Bargaining and Flow Migration cases, the responsiveness of wages means that wage rates rise and bring about a negative competitiveness effect (though in the latter set-up, in-migration of labour supply helps to limit this effect in the long-run). In contrast, in the Wage Spillover cases, it is the factors that determine the RUK nominal wage that determine the Scottish nominal wage, and thus the extent of wider economic activity in the region. Because the Scottish economy is relatively small compared with the RUK, the effects of the Scottish export stimulus on the RUK economy are fairly limited, as are the effects on the RUK real wage and the Scottish nominal wage (Figures 11 and 5 respectively). This means that the Scottish economy does not experience the significant negative competitiveness effects that are evident in the Bargaining and Flow Migration cases; hence the comparatively stronger short-run increase in GDP relative to base for these two cases (Figure 1).

In the long-run, as RUK activity rises as a result of increased interregional exports to Scotland, labour demand rises in the RUK in the Wage Spillover (1) set-up (Figure 10). Bargaining subsequently increases the real and nominal RUK wage, increasing the linked Scottish nominal wage. The indirect nature of the effect means that nominal wages increase by only 0.08% over base in this scenario in the period immediately following the shock, compared with an increase of 0.34% in the Quasi IO case, where real wages remain fixed at the regional level. Consequently, in the Wage Spillover scenario, the Scottish real wage initially falls (Figure 4), since the percentage increase in the RUK nominal wage is less than the percentage increase in the Scottish CPI. The initial relative fall in Scottish real wages, and the accompanying smaller increase in nominal wages compared with the other model configurations, accounts for the rapid initial expansion in Scottish GDP in this model set-up relative to the other scenarios (Figure 1). In Period 3, GDP is 0.55% higher than base in the Wage Spillover (1) scenario, compared with 0.44% for the Quasi IO closure. In the long-run, however, there is some increase in the Scottish real wage, brought about by the stimulus to RUK economic activity. This explains the slightly lower long-run GDP increase over base relative to the Quasi IO configuration.

The introduction of migration has a limited effect on overall activity in Scotland. The adjustment paths of GDP, employment and exports for both Wage Spillover scenarios are in close accord for the duration of the simulation period. In the Wage Spillover (2) configuration there are, however, significant changes in the size of the population. Following the demand stimulus, as employment rises in Scotland, the population migrates inward from the RUK. Unlike in the Bargaining scenario, regional real wages are not directly linked to the tightness of the regional labour market in Scotland.

However, the introduction of migration does still have an impact on wages in Scotland. Scottish in-migration and the tightening of the RUK labour market have consequences for nominal wages in the RUK, and therefore in Scotland too, though the effect is small. Exports to the RUK increase by less under the Wage Spillover configuration with migration (Figure 7), reflecting weaker RUK activity in this case (see Section 4.8).

Table 5: Wage Spillover (1) Summary Results

	Period 3		Period 10		Period 50	
	Scotland	RUK	Scotland	RUK	Scotland	RUK
GDP	£347.11m	£30.87m	£627.44m	£103.31m	£844.57m	£181.43m
	0.55%	0.00%	1.00%	0.01%	1.35%	0.03%
Total employment	12,784	840	19,093	2,476	24,010	4,099
	0.68%	0.00%	1.01%	0.01%	1.27%	0.02%
Traded sector employment	0.84%	0.00%	1.28%	0.02%	1.62%	0.03%
Sheltered sector employment	0.30%	0.00%	0.40%	0.00%	0.49%	0.00%
CPI	0.28%	0.08%	0.17%	0.06%	0.05%	0.10%
Commodity output prices	0.39%	0.07%	0.22%	0.07%	0.06%	0.06%
Price of value added	0.58%	0.08%	0.30%	0.80%	0.07%	0.07%
Nominal wage	0.08%	0.08%	0.08%	0.08%	0.08%	0.08%
Real wage	-0.20%	0.00%	-0.09%	0.02%	0.03%	0.03%
Exports to the other region	-0.80%	1.25%	-0.35%	1.42%	-0.03%	1.50%
Exports to ROW	3.78%	-0.15%	4.44%	-0.13%	4.79%	-0.11%

Table 6: Wage Spillover (2) Summary Results

	Period 3		Period 10		Period 50	
	Scotland	RUK	Scotland	RUK	Scotland	RUK
GDP	£346.26m	£-34.25m	£623.67m	£-202.19%	£841.47m	£-483.67m
	0.55%	-0.01%	1.00%	-0.03%	1.34%	-0.07%
Total employment	12,784	-1,945	18,946	7,906	23,895	-15,043
	0.67%	-0.01%	1.00%	-0.04%	1.26%	-0.07%
Traded sector employment	0.84%	-0.01%	1.27%	-0.04%	1.61%	-0.08%
Sheltered sector employment	0.30%	-0.02%	0.40%	-0.04%	0.50%	-0.06%
CPI	0.29%	0.08%	0.21%	0.08%	0.10%	0.10%
Commodity output prices	0.40%	0.08%	0.26%	0.09%	0.13%	0.11%
Price of value added	0.60%	0.08%	0.35%	0.10%	0.14%	0.13%
Nominal wage	0.10%	0.10%	0.14%	0.14%	0.16%	0.16%
Real wage	-0.19%	0.02%	-0.07%	0.06%	0.06%	0.06%
Exports to the other region	-0.9%	1.27%	-0.43%	1.47%	-0.11%	1.55%
Exports to ROW	3.76%	-0.16%	4.38%	-0.17%	4.69%	-0.21%
Population	15,699	-15,699	41,936	-41,936	61,905	-61,905

4.8 WAGE SPILLOVER (1) AND (2): RUK EFFECTS

In contrast to the Scottish economy results, the two Wage Spillover configurations generate significantly different results for the RUK economy depending on whether migration is included in the set-up (Figure 8). In the Wage Spillover (1) scenario, GDP is 0.03% above base by the end of the simulation period, compared with a 0.07% fall in GDP in the Wage Spillover (2) closure (Tables 5 and 6). Under both scenarios, RUK exports to Scotland increase, in response to a rise in demand for RUK intermediate inputs. The direct effects of the shock in the Scottish economy, however, mean that the fall in Scottish unemployment is greater than in the RUK (unemployment falls by 3.77% in Scotland compared with a fall of 0.26% in the RUK in period 3). Under the Wage

Spillover (2) configuration, this encourages some of the labour supply to out-migrate from the RUK economy, and the resultant labour market constraints account for the significantly lower GDP trajectory in this scenario.

5. NATIONAL EFFECTS

Under all configurations, the policy shock leads to an increase in national GDP and employment relative to base, and for the duration of the simulation period (Figures 15 and 16). In the long-run, the Quasi IO case leads to the largest relative increase in national employment, with an increase of 44,358 relative to base in period 50 (Table 7). As in the case of the individual regions, the inflexibility of wages in this scenario means that the UK economy does not experience negative competitiveness effects generated through the labour market as employment rises, and this underlies the strength of the GDP results. The Wage Spillover (1) configuration provides the next best long-run improvement in employment relative to base, with an increase in employment of 28,109 by period 50. Although the national economy is population-constrained in this set-up, unlike in the Quasi IO case, the increase in employment and corresponding increase in real wages is diluted as the effects feed through via the RUK economy, so the dampening effect of rising real wages on competitiveness is limited. In contrast, the responsiveness of wages and the associated deterioration in competitiveness in the Bargaining scenario results in this closure providing the third best relative increase in employment in the long-run. The presence of migration, and the corresponding capacity constraints for the RUK economy, mean that the Wage Spillover (2) and Flow Migration configurations provide the two weakest long-run increases in national employment, despite these closures resulting in significant increases in Scottish employment relative to base.

These are surprising results: intuitively, we would suggest that regional migration restrictions and wage rigidity would create distortions in the national market, giving rise to a misallocation of resources amongst regions. So we would expect that those scenarios incorporating wage flexibility and no barriers to migration would generate higher increases in employment and activity relative to scenarios that do not allow for either or both of these features[19]. But the reverse is true in this analysis: the most flexible labour market scenario, the Flow Migration case, yields the second lowest national economic performance in terms of output and employment. The other model set-up to include migration, the Wage Spillover (2) configuration, provides the lowest outcome. The explanation for these finding are embodied within the initial SAM data, which are assumed to represent an equilibrium position. The equilibrium unemployment rate in Scotland is higher than that in the RUK - which we take to represent the presence of a compensating amenity value attached to living in the target region. Employee productivity is also lower in Scotland. Thus the Flow Migration and Wage Spillover (2) equilibria require the population to shift from a higher to a lower per capita productivity region, and following the shift, the migrants, despite feeling better off overall, take on the productivity and unemployment characteristics of the population in Scotland[20].

Incorporating some degree of wage flexibility also reduces the positive impact of the shock on the national economy, contrary to expectations: the Quasi IO set-up, with fixed real wages, results in the strongest long-run national employment and output performance overall. In this analysis, it is the open-economy assumption that drives this result, since the export market is rendered less competitive in those scenarios with flexible wages.

[19] Labour market flexibility continues to be one of the key issues of global labour market reform, and there exists an extensive literature on the effects of labour market flexibility on economic activity, though much of the focus has been on regulatory reform. Studies that focus on the responsiveness of wages to labour market conditions and the associated impact on economic efficiency include Faggio and Nickell (2005) and Millard (2000). Research that considers the gains from the elimination of global migration barriers include Iregui (2004) and Moses and Letnes (2004) and in an interregional context Archibald (1969).

[20] Partridge and Rickman (1997, 2003) consider that higher regional amenity levels can serve as compensating differentials for higher regional unemployment rates. In this analysis, although national economic performance is lowest for the configuration incorporating migration, unless the amenity value of Scotland is reduced by the in-migration, there is not a negative national effect in terms of welfare/utility.

The strong performance of the Quasi IO scenario is less surprising in consideration of the complete lack of population constraints in this set-up.

In the years immediately following the shock, however, it is the Wage Spillover (1) and (2) closures that lead to the best outcome for the UK economy in terms of the relative increase in employment. In period 2, employment is 11,904 and 10,585 higher than base, respectively. This compares with an increase of 9,407 for the Quasi IO scenario (Figure 16). The rapid initial expansion in national employment is attributable to the significant increase in Scottish employment, which itself arises because of the fall in real wages in the short-run. In the absence of migration, the Wage Spillover (1) case continues to out-perform that of the Quasi IO scenario until period 7. In the presence of migration, labour market displacement effects mean that the Quasi IO case outperforms the Wage Spillover (2) case by period 3.

Table 7: National Summary Results

		Period 3	Period 10	Period 50
Absolute Change in National GDP	QUASI IO	£319.87m (0.04%)	£749.58m (0.09%)	£1574.10m (0.02%)
	BARGAINING	£197.66m (0.03%)	£373.91m (0.05%)	£483.91m (0.06%)
	FLOW MIGRATION	£189.07m (0.02%)	£331.84m (0.04%)	£361.65m (0.05%)
	SPILLOVER (1)	£377.99m (0.05%)	£730.75m (0.09%)	£1026.01m (0.13%)
	MIGRATION SPILLOVER (2)	£312.02m (0.04%)	£421.48m (0.05%)	£357.79m (0.05%)
Absolute Change in National Employment	QUASI IO	11,360	22,576	44,358
	BARGAINING	6,265	9,428	11,468
	FLOW MIGRATION	5,947	8,273	8,889
	SPILLOVER (1)	13,624	21,568	28,109
	MIGRATION SPILLOVER (2)	10,803	11,040	8,852

5. Conclusions

In a UK context, research into regional policy impacts has focused almost wholly on the effects of the policy on the target region, with any consequences for other regions being largely ignored (Taylor, 2002). The results reported here suggest that regional policy spillovers may be significant, even when the target region is small relative to the national economy. Under all model scenarios, an increase in Scottish trade - which is the desired and anticipated response to some aspects of Scottish government policy - results in a positive stimulus for the Scottish economy. The configuration of the regional labour market and migratory behaviour appear to be important factors in determining the magnitude of the stimulus and the adjustment path of the economy. In each model set-up, spillover effects do arise for the RUK, with obvious consequences for national effects, and the labour market characteristics are also important in determining the overall national outcome.

The incorporation of both a time element and non-target region effects into the study highlights some important policy issues. Firstly, the results suggest that the move to long-run equilibrium is generally slow. The time horizon for the evaluation of local regeneration policy is a ten year maximum (HM Treasury, 1995), but significant adjustments occur beyond this time period in both the Scottish and RUK economies. GDP is not close to its long-run equilibrium until around period 25 for the Scottish economy, and longer for some of the RUK scenarios. Within the Treasury's ten-year evaluation period, the extent of the policy responses is much smaller than in long-run equilibrium, and this could prove misleading from a policy perspective.

Furthermore, both the size and the direction of the results can differ in each region, depending on the labour market scenario. The benchmark scenario, the Quasi I-O configuration, results in the highest increase in GDP for both regions during the whole of the simulation period. This is expected, given the absence of a national population constraint, or other restrictions on expansion in the long-run. However, the introduction of more realistic labour market characteristics leads to a significant variation in the results across the regions. In particular, the Flow Migration scenario leads to a long-run expansion in GDP in Scotland, but a contraction in the RUK. Thus policy makers focusing on the effects in the target region only would view this policy scenario as having a more positive long-run effect than they would do than if the national effects of the stimulus were to be taken into account. Similarly, policy makers who focus only on the target-region effects of the policy under the Bargaining scenario would have a misleading impression about the overall impact of the policy shock, since the target-region effects are an ‘under-estimation’ of the national effects. This matters not because the ranking of results for each of the scenarios is of interest, but because it implies that: (i) the overall outcome of a regional policy change depends on other-region effects, which themselves are sensitive to the macroeconomic structure of the economy; and (ii) the regional effects are not necessarily a good indicator of the national policy impact.

Analysing the interregional effects of the policy shock within a period-by-period framework also highlights a number of important points. The relative effects of the shock differ for the two regions in terms of both the timing and the size of the effects. The RUK economy takes longer to adjust to the shock, due to the constraints imposed on the transmission mechanism by the presence of active supply-side effects. In some cases, the results differ markedly between the ten-year and fifty-year results, depending on the characteristics of the labour market. This suggests that a longer evaluation period than the Treasury’s current ten-year timescale may be required for policy decision-making.

These various issues have obvious effects on the aggregate impact of the shock for the national economy, and ultimately on appropriate policy responses. These are insights that would not be revealed if policy makers were to focus only on the target-region effects of regional policy, or on long-run equilibrium outcomes. Overall, the results reinforce policy makers' movement away from assuming zero national effects of regional policy. This study goes further to fully reject the notion of complete crowding out, even in the case of a demand disturbance. This has significant consequences for current policy design and evaluation methods, since the size and direction of the other-region effects can no longer be accurately measured a priori. If the national effects of regional policy are not presumed to be zero, then an essential component of the policy evaluation process ought to be the measurement of both target and non-target region impacts. Such a comprehensive analysis of the subject requires more detailed modelling techniques – of the kind employed in this study - that identify the national and interregional effects of government policies. Within this, the direction of the effects and an appreciation of the absolute and relative scale of the effects are important.

Despite this, the Treasury's previous doubt over the net benefits of regional policy appears to remain embedded in the current decision making process. In practice, the Treasury provides no guidance on how to measure spillover effects. Nor has it commented on the size or timing of potential spillovers. At present, there is no evidence of the Treasury adopting an evaluation approach that is in line with its apparent shift away from the assumption of full crowding out. Continued implementation of the current evaluation process could potentially encourage an overall implicit bias against regional policy, in that it may lead to an underestimation of the net benefits associated with such policies.

A number of extensions could potentially add value to this research. At present, data constraints limit the analysis in this chapter to a two-region, three sector framework. However, a more disaggregated framework - which necessitates the publication of more timely and consistent official regional and national I-O tables - would allow for more detailed consideration of precise policy measures. Additionally, it may be useful to consider the public sector cost implications associated with the export stimulus. We suggest that the export demand shock could arise, for example, as a costless consequence of international obligations to increase the share of energy consumption derived from renewable energy sources. In practice, however, costly policy measures may be required to support the development of an export market for the Scottish renewable energy sector. These could include, for example, capital expenditure grants for manufacturers, or public sector investment in an offshore energy transmission structure. An informative exercise could therefore be to combine a regional export stimulus with an increase in public expenditure that is paid for through higher taxation at the national level. Furthermore, sensitivity analysis of alternative key parameter values and functional forms in addition to the labour market scenarios that are considered could be beneficial.

APPENDIX A: AMOSRUK model listing

Table A.1 presents a condensed version of the period-by-period AMOSRUK model used in this analysis, with the equations provided in general form. Variables, superscripts and subscripts are listed at the end of this appendix. Harrigan et al. (1991) provides a full listing of the AMOS model. In practice, the exact model set-up is determined by the model user, in their choice of functional form for production or for composite commodities, between Leontief, Cobb-Douglas or CES and so forth. This determines the specific choice of the output price and the input demand functions.

In this model listing, there are assumed to be two regions, *x* and *y*. For many equations specifying the characteristics of region *x*, a corresponding equation applies for region *y*. In order to report this summary version of the model, a number of simplifications are made. These relate to the model description only, and are not applied in practice to the model itself:

(i) intermediate demands are suppressed throughout. That is, only primary factor demands are reported for the determination of prices, and only final demands are reported for the determination of commodity demand.
(ii) many of the income transfers between transactor groups are suppressed.
(iii) taxes are ignored.
(iv) time subscripts are suppressed.

Equation A.1 describes the determination of commodity value-added prices: pv_i^x represents the value-added price in sector i in endogenous region x. It is assumed that each of the three commodities is produced by a perfectly competitive industry in each region. The three commodities/industries are the manufacturing, non-manufacturing traded and sheltered sectors. The sheltered sector includes those service sectors which engage in very low levels of extra-regional trade.

There is linear homogeneity in the production of value added and an implied assumption of cost minimisation and zero profits. Thus value-added prices are determined by corresponding industry cost functions, and the value-added price is a linear homogeneous function of the regional factor prices, w_n^x and w_k^x, which are the wage rate and the capital rental rate, respectively. Likewise, commodity prices in the regions, p_i^x, is a linear homogenous function of the value-added price and the vector of intermediate prices. The latter is made up of the vector of other commodity prices in that region, $\underline{p}_{j-i}^x$, the vector of commodity prices in the other region, $\underline{p}^y$, and the vector of the domestic currency prices of foreign imports, $\underline{\overline{p}}^w$. Equation (A.2) describes this relationship. Equations A.3 and A.4 provide the regional consumer and capital indices, cpi^x and kpi^x, respectively. These are the weighted sums of all the commodity prices in the system. Equations A.5 and A.6 describe the cost-minimising demand functions for the factors capital and labour. In each industry in each region, the demand for labour, N_i^x and the demand for capital, K_i^x, is a function homogenous of degree one in regional industry output, Q_i^x, and of degree zero in the regional factor and the value-added and commodity price. Within each region, perfect sectoral mobility of labour and capital is assumed. The capital rental rate in each sector in each region is determined by equating capital demand, K_i^x, with the existing capital supply, K_i^{sx} (Equation A.7).

Regional nominal household income, Y^x (Equation A.8) is the share of the labour and capital income generated in the region, φ_n^x and φ_k^x respectively, plus welfare transfers associated with unemployment. The extent of transfers depend on the number of unemployed people in the region, $L^x T^x u^x$, multiplied by the unemployment benefit f. The demand for commodity i in region x, Q_i^x, is determined by Equation A.9, and is equal to the sum of consumption, intermediate, investment, and government demand, and interregional and international export demands. These elements are: C_i^x, J_i^x, I_i^x, G_i^x, X_i^x, and X_i^{xw}, respectively. The individual components of commodity demand are themselves denoted by Equations A.10 to A.15. The aggregate consumption demand (Equation A.10) is linear in regional real income and homogenous of degree zero in all nominal variables. A representative transactor approach is adopted. Regional data constraints mean that household income is not disaggregated by income group. Intermediate demand (Equation A.11), is homogenous of degree zero in regional value-added and all commodity prices, and is a linear function of all regional outputs. Investment demand is the sum of investment in each region in each industry, which is equal to the change in capital stock adjustment in each regional industry, ΔK_i^x (Equation A.12). The vector of ΔK_i^x values is transformed into investment demands for the output of sector i via a fixed-coefficient capital matrix, which contains elements b_{ij}^x. The vectors of own-region, other-region and world commodity prices are also determinants of the investment demand equation. These reflect the proportion of activity that remains in the region rather that being diverted elsewhere via interregional or international imports, driven by changed price competitiveness. Government demand is a fixed proportion, α_i^x, of total (exogenous) UK government expenditure, $\overline{G}^N$ (Equation A.13).

Equations A.14 and A.15 describe interregional and international export demands for industry i, respectively. The former depends on consumption, intermediate, investment and government demand for industry i in the other region, y, and the relevant price vectors. The latter is a homogeneous function of degree one in foreign demand, $\overline{D}^w$ (which is exogenous), and zero in regional and foreign prices.

Equations relating to the between-period updating functions that are available for capital stocks and population are described in Equations A.16 to A.19. Actual capital stock in each regional industry i in each time period, t, $K_{i,t}^{sx}$, is equal to the capital stock in regional industry i in the previous time period, $t-1$, less depreciation (δ_i^x) and plus gross investment ($K_{i,t-1}^{sx}$) in the previous time period, $t-1$ (Equation A.16). Therefore capital investment made in period $t-1$ adds to capacity in period t. Equation A.17 relates to the capital-stock-adjustment process. The desired capital stock is equal to the capital demand equation (Equation A.6), but for the substitution of the final term, the risk-adjusted user cost of capital (ucc), in place of the actual capital rental rate. This means that when the capital rental rate exceeds the risk-adjusted user cost of capital, the desired capital stock is greater than the actual stock. In such a scenario, capital accumulation occurs until the risk adjusted user cost of capital and the capital rental rate are equalised. Thus in long run equilibrium, the capital rental rate across all sectors equals the corresponding risk-adjusted user cost. The value of the user cost of capital depends on the interest rate, the depreciation rate, the relevant tax and subsidy rates, and the regional capital price index, though since interest, tax and subsidy rates are held constant in the simulations, changes in the regional capital rental rates are determined only by changes in the regional capital price index (Equation A.18). Total capital stock adjustment (or investment) in each period, then, is equal to a fraction, λ, of the difference between desired and actual capital stocks, plus depreciation (Equation A.19), where λ is the capital stock adjustment parameter.

Table A.1: Condensed Model Listing

Value-added prices	$pv_i^x = pv_i^x(w_n^x, w_k^x)$	(A.1)
Commodity prices	$p_i^x = p_i^x(pv_i^x, \underline{p}_{j-i}^x, \underline{p}^y, \underline{\overline{p}}^w)$	(A.2)
Consumer price index	$cpi^x = \sum_i \theta_i^{xx} p_i^x + \sum_i \theta_i^{xy} p_i^y + \sum_i \theta_i^{xw} \overline{p}_i^w$	(A.3)
Capital price index	$kpi^x = \sum_i \gamma_i^{xx} p_i^x + \sum_i \gamma_i^{xy} p_i^y + \sum_i \gamma_i^{xw} \overline{p}_i^w$	(A.4)
Labour demand	$N_i^x = N_i^x(Q_i^x, p_i^x, pv_i^x, w_n^x)$	(A.5)
Capital demand	$K_i^x = K_i^x(Q_i^x, p_i^x, pv_i^x, w_k^x)$	(A.6)
Capital rental rate	$K_i^x = K_i^{sx}$	(A.7)
Household income	$Y^x = \varphi_n^x N^x w_n^x + \varphi_k^x K^x w_k^x + L^x T^x u^x f$	(A.8)
Commodity demands	$Q_i^x = C_i^x + J_i^x + I_i^x + G_i^x + X_i^{xy} + X_i^{xw}$	(A.9)

Consumption demand	$C_i^x = C_i^x(\underline{p}^x, \underline{p}^y, \underline{\overline{p}}^w, Y^x)$	(A.10)
Intermediate demand	$J_i^x = J_i^x(\underline{Q}^x, \underline{pv}^x, \underline{p}^x, \underline{p}^y, \underline{\overline{p}}^w)$	(A.11)
Investment demand	$I_i^x = I_i^x(\underline{p}^x, \underline{p}^y, \underline{\overline{p}}^w, \sum_j b_{ij}^x \Delta K_j^x)$	(A.12)
Government demand	$G_i^x = \alpha_i^x \overline{G}^N$	(A.13)
Interregional export demand	$X_i^{xy} = X_i^{xy}(\underline{p}^x, \underline{p}^y, \underline{\overline{p}}^w, \overline{G}^N, \underline{J}^y, \underline{Q}^y, Y^y)$	(A.14)
International export demand	$X_i^{xw} = X_i^{xw}(\underline{p}^x, \underline{\overline{p}}^w, \overline{D}^w)$	(A.15)
Capital stock	$K_{i,t}^{sx} = (1-\delta_i^x)K_{i,t-1}^{sx} + \Delta K_{i,t-1}^x$	(A.16)
Desired capital stock	$K_{i,t}^{*sx} = K_{i,t}^{*sx}(Q_i^x, p_i^x, pv_i^x, ucc^x)$	(A.17)
User cost of capital	$ucc^x = ucc^x(kpi^x)$	(A.18)
Investment	$\Delta K_{i,t}^x = \lambda(K_{i,t}^{*sx} - K_{i,t}^{sx}) + \delta_i^x K_{i,t-1}^{sx}$	(A.19)
National population	$\overline{L}^N = L^s + L^r$	(A.20)
Regional population	$L_t^s = L_{t-1}^s + m_{t-1}^s$	(A.21)
Migration	$m_t^s = m^s\left[\frac{w_t^s}{cpi_t^s}, \frac{w_t^r}{cpi_t^r}, u_t^s, u_t^r, L_t^s\right]$	(A.22)
Unemployment rate	$u^x = \frac{L^x T^x - \sum_i N_i^x}{L^x T^x}$	(A.23)
Bargaining	$w_n^x = w_n^x(u^x, cpi^x)$	(A.24)
Quasi IO	$w_n^s = \beta^x cpi^x$	(A.25)
Wage Spillover	$w_n^x = w_n^y$	(A.26)

Endogenous variables:

cpi : consumer price index

kpi : capital price index

m : Scottish immigration

p : commodity price

pv : value-added price

u : unemployment rate

ucc : user cost of capital

w_n : nominal wage rate

w_k : capital rental rate

C : consumption

D : foreign demand

G : government expenditure

I : investment demand

J : intermediate demand

K : capital demand

K^s : capital supply

ΔK : capital stock adjustment

L : population

N : employment

Q : output

X : exports

Y : household income

Parameters and exogenous variables:

b : capital coefficient

f : benefit payment per registered unemployed

D : rest of the world demand

T : participation rate

α : government expenditure coefficient

β : real wage coefficient

δ : depreciation rate

φ : regional share of factor income

θ : consumption expenditure share

γ : capital expenditure share

λ : capital stock adjustment parameter

Subscripts:

i, j : sectors

k : capital

n : labour

t : time

Superscripts:

r : rest of the UK

s : Scotland

w : rest of the world

x, y : generic regional identifiers

Functions:

$m(.)$: migration function

$p(.), pv(.)$: cost function

$ucc(.)$: user cost of capital function

$w(.)$: wage curve

$C(.)$: Armington consumption demand function

I(.): Armington investment demand function

$J(.)$: Armington intermediate demand function

$K(.), N(.)$: factor demand functions

$X(.)$: Armington export demand function

Notes:

- A bar above a variable indicates that this variable is exogenous for the purposes of the simulations) i.e. a bar over a variable denotes exogeneity.
- Underlined variables are vectors whose elements are the sectoral values of the corresponding variables. Where the subscript $j-i$ is used, this represents a vector of all sectoral values, excluding sector i.
- A starred variable indicates desired value.
- Implicit time subscripts apply to all the variables, and these are stated explicitly only for the relevant updating equations (Equations A.1 to A.10 in Table A.1).

Appendix B

In the AMOSRUK model, a zero net migration condition exists in equilibrium. Since:

$$\ln\left[\frac{m^S}{L^S}\right] = \delta - 0.08\left[\ln u^S - \ln u^R\right] + 0.06\left[\ln\left[\frac{w^S}{cpi^S}\right] - \ln\left[\frac{w^R}{cpi^R}\right]\right] \tag{2}$$

then, in equilibrium:

$$0 = \delta - 0.08\left[\ln u^S - \ln u^R\right] + 0.06\left[\ln\left[\frac{w^S}{cpi^S}\right] - \ln\left[\frac{w^R}{cpi^R}\right]\right]$$

And since:

$$\ln\left[\frac{w^S}{cpi^S}\right] = \beta^S - 1.113\ln u^S \qquad \text{from equation (1)}$$

and

$$\ln\left[\frac{w^R}{cpi^R}\right] = \beta^R - 1.113\ln u^R \qquad \text{from equation (1)}$$

then, in equilibrium:

$$0 = \delta - 0.08\left[\ln u^S - \ln u^R\right] + 0.06\left[\beta^S - \beta^R + 1.113(\ln u^S - \ln u^R)\right]$$

and

$$0 = \delta + \left[-0.08 + 0.06(1.113)\right]\left[\ln u^S - \ln u^R\right] + 0.06\left[\beta^S - \beta^R\right]$$

so

$$\frac{-\delta - 0.06\left[\beta^S - \beta^R\right]}{-0.01322} = \left[\ln u^S - \ln u^R\right]$$

Since this condition holds in equilibrium, then the initial (equilibrium) ratio of unemployment rates (and therefore real wages) is the same as the ratio of unemployment that exists in the long-run equilibrium, where there is also zero net migration. The ratio of unemployment rates remains constant so long as the relevant coefficients in the regional bargaining functions (Equation 1) are the same in both regions, which is the case in the AMOSRUK model.

Since the ratio of unemployment rates remains constant in equilibrium, then:

$$\left[\ln u^{S} - \ln u^{R}\right] = K \tag{4}$$

where K is a constant.

Since:

$$\ln\left[\frac{w^{S}}{cpi^{S}}\right] = \beta^{S} - 1.113 \ln u^{S}$$ from equation (1)

and

$$\ln\left[\frac{w^{R}}{cpi^{R}}\right] = \beta^{R} - 1.113 \ln u^{R}$$ from equation (1)

then

$$\ln u^{S} = \frac{\beta^{S} - \ln\left[\frac{w^{S}}{cpi^{S}}\right]}{1.113}$$

and

$$\ln u^{R} = \frac{\beta^{R} - \ln\left[\frac{w^{R}}{cpi^{R}}\right]}{1.113}$$

Using equation (4):

$$\frac{\beta^{S} - \ln\left[\frac{w^{S}}{cpi^{S}}\right]}{1.113} - \frac{\beta^{R} - \ln\left[\frac{w^{R}}{cpi^{R}}\right]}{1.113} = K$$

so

$$\beta^{S} - \beta^{R} + \ln\left[\frac{w^{R}}{cpi^{R}}\right] - \ln\left[\frac{w^{S}}{cpi^{S}}\right] = 1.113K$$

and

$$\ln\left[\frac{w^{R}}{cpi^{R}}\right] - \ln\left[\frac{w^{S}}{cpi^{S}}\right] = \beta^{R} - \beta^{S} + 1.113K \tag{5}$$

Since the ratio of unemployment rates remains constant in equilibrium (equation (4)), so too does the ratio of wage rates remain constant in equilibrium.

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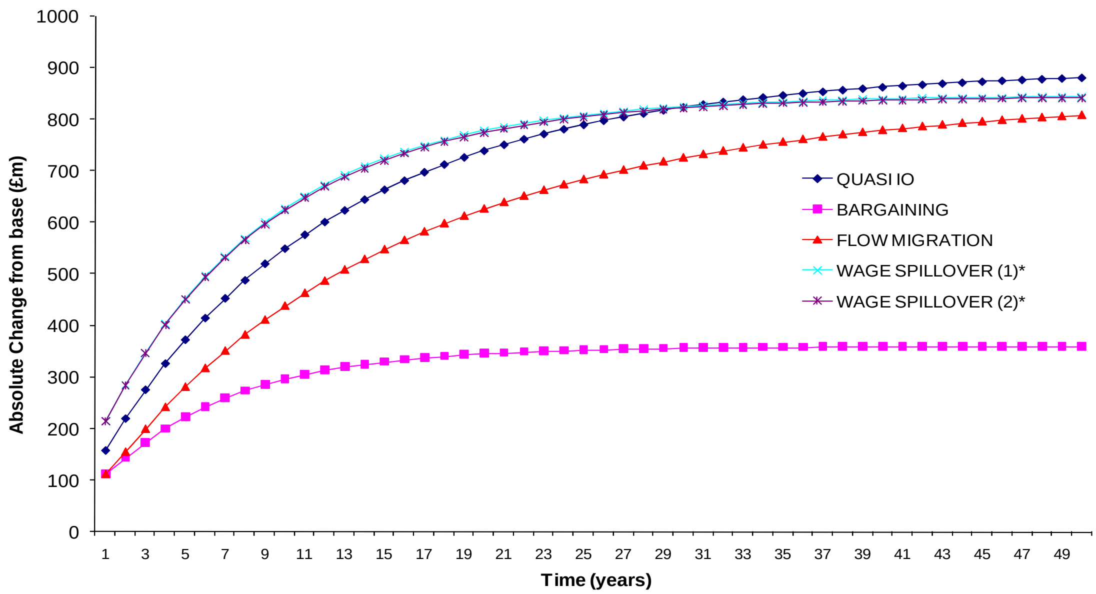
Figure 1 Absolute change in Scottish GDP (£m)



* The wage spillover (1) and wage spillover (2) results lie virtually on top of one another.

Figure 2 Percentage change in Scottish CPI

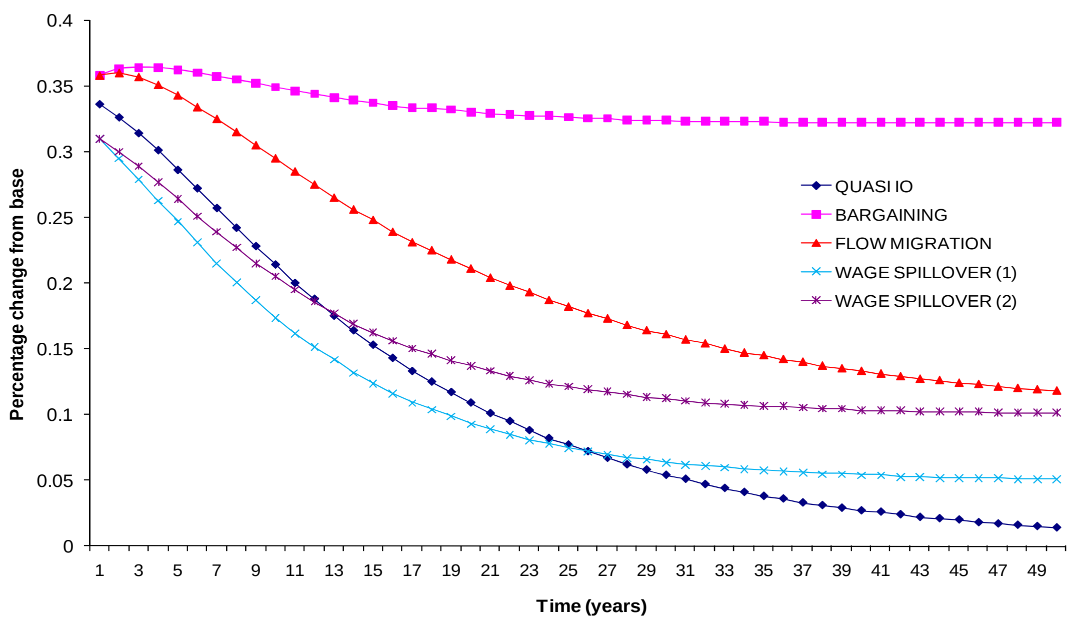
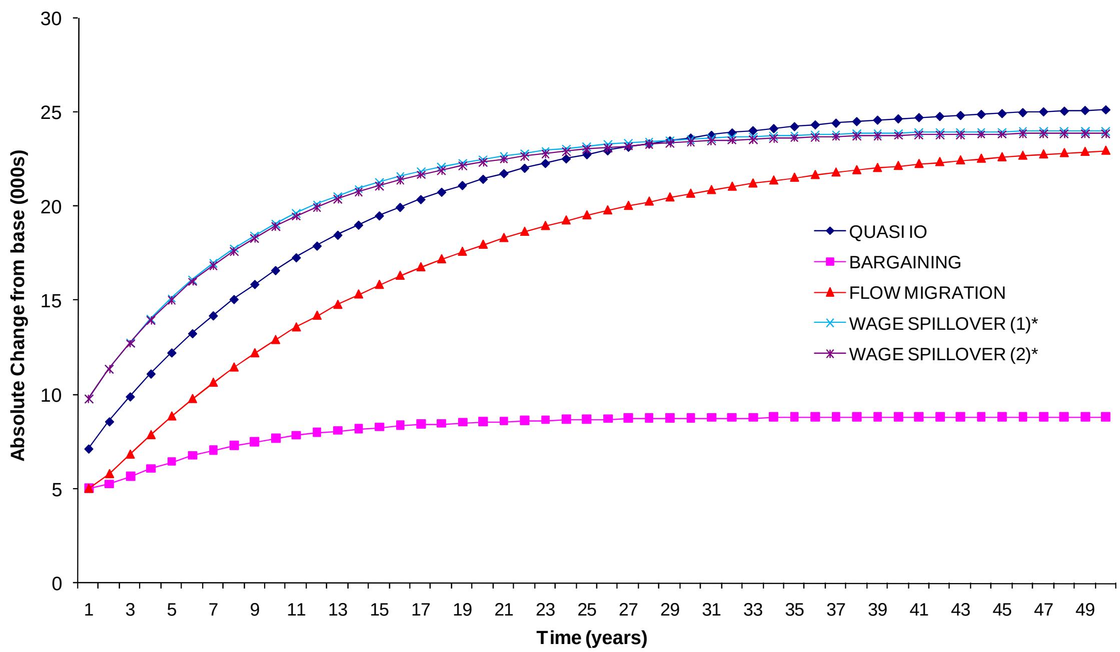


Figure 3 Absolute change in Scottish total employment (000s)



* The wage spillover (1) and wage spillover (2) results lie virtually on top of one another.

Figure 4 Percentage change in Scottish real wages

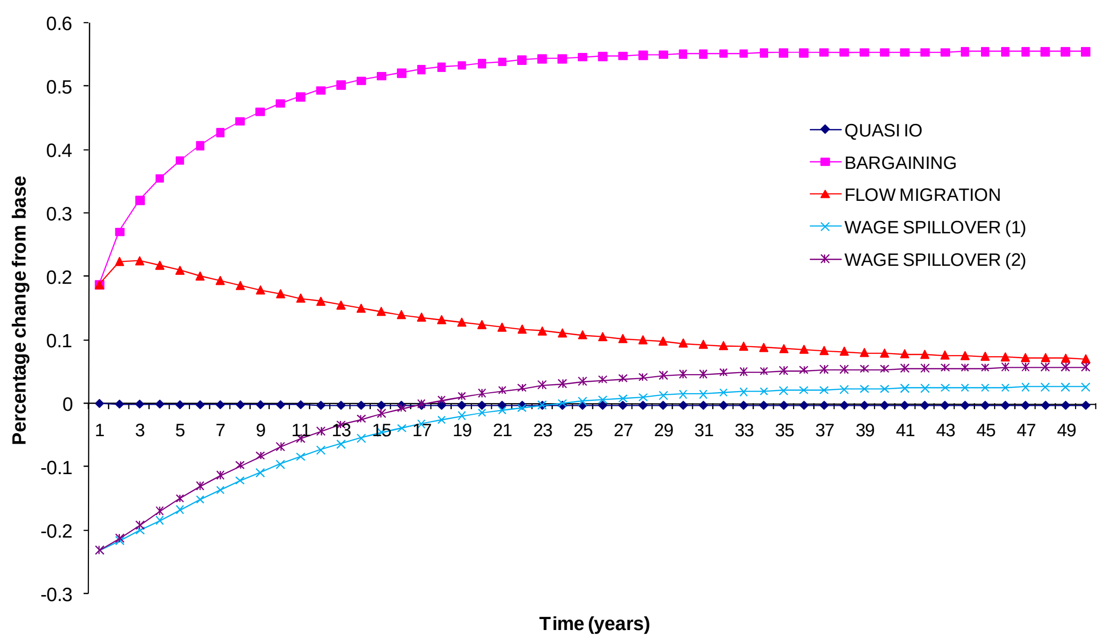


Figure 5 Percentage change in Scottish nominal wages

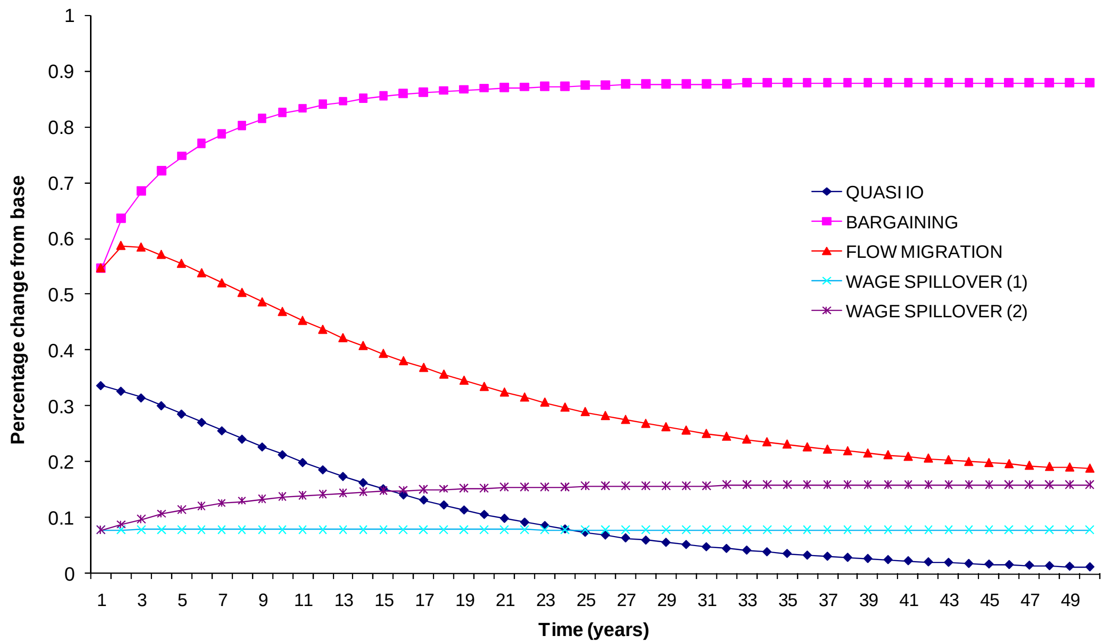


Figure 6 Percentage change in Scottish exports to the ROW

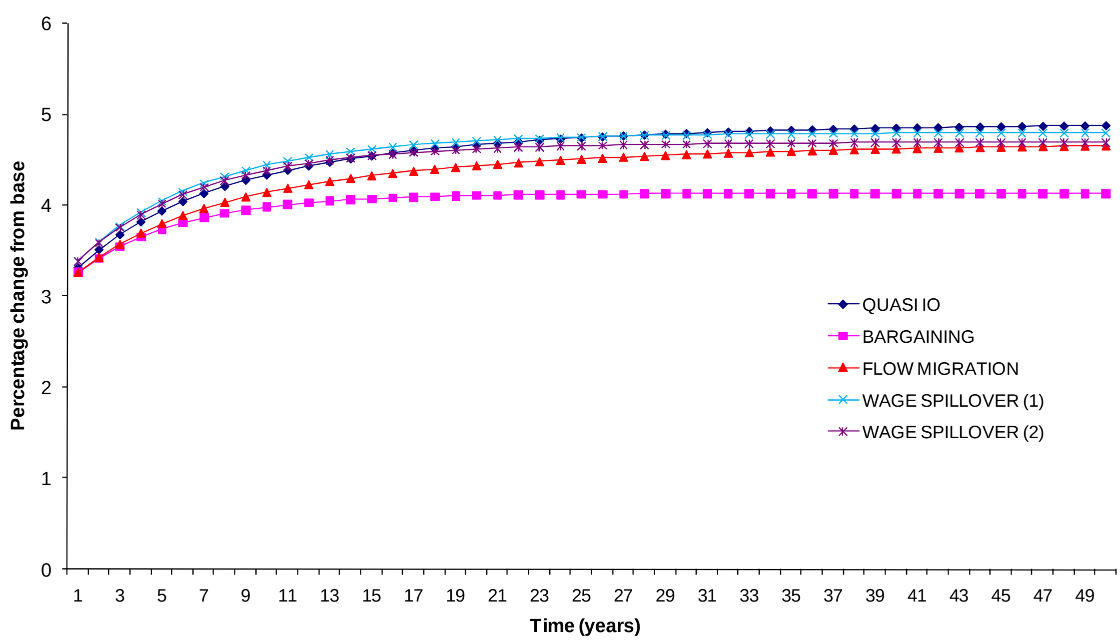


Figure 7 Percentage change in Scottish exports to the RUK

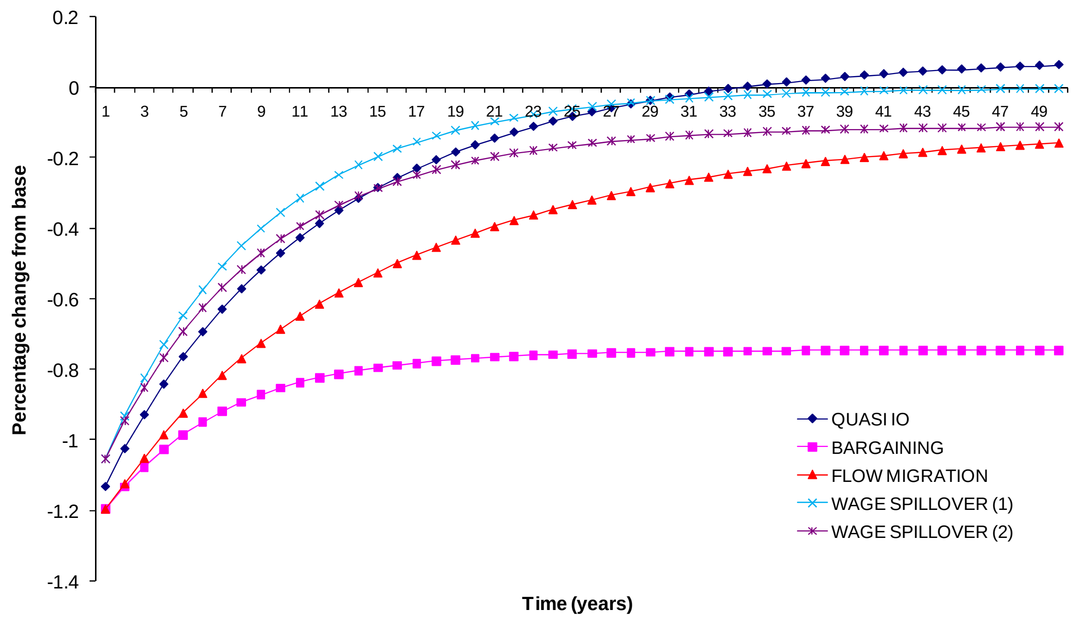


Figure 8 Absolute change in RUK GDP (£m)

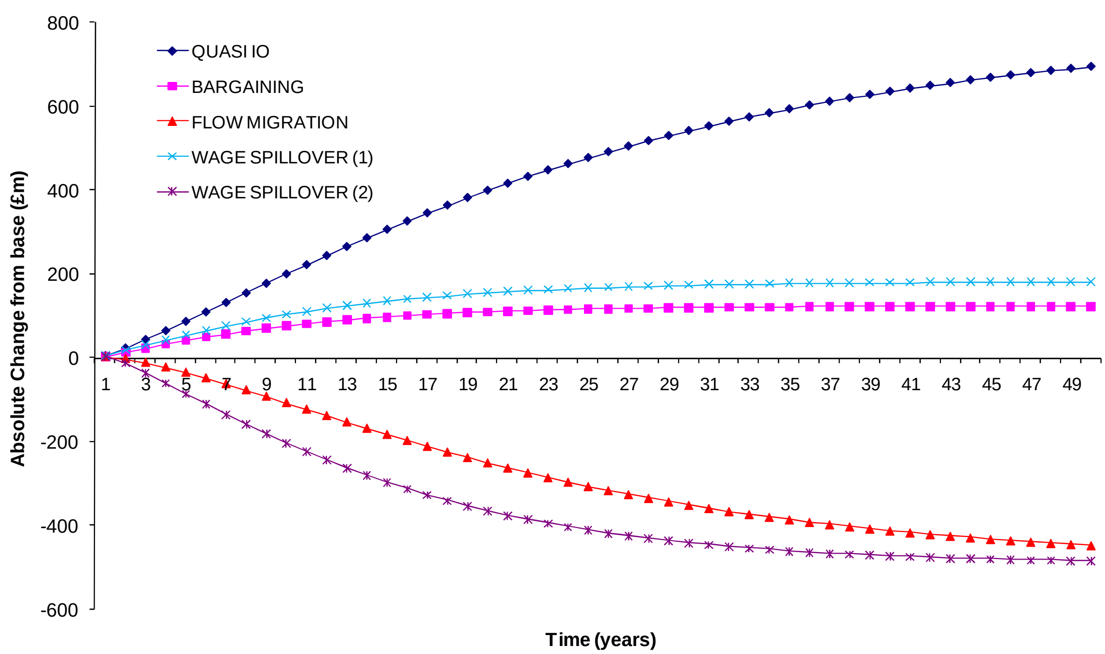


Figure 9 Percentage change in RUK CPI

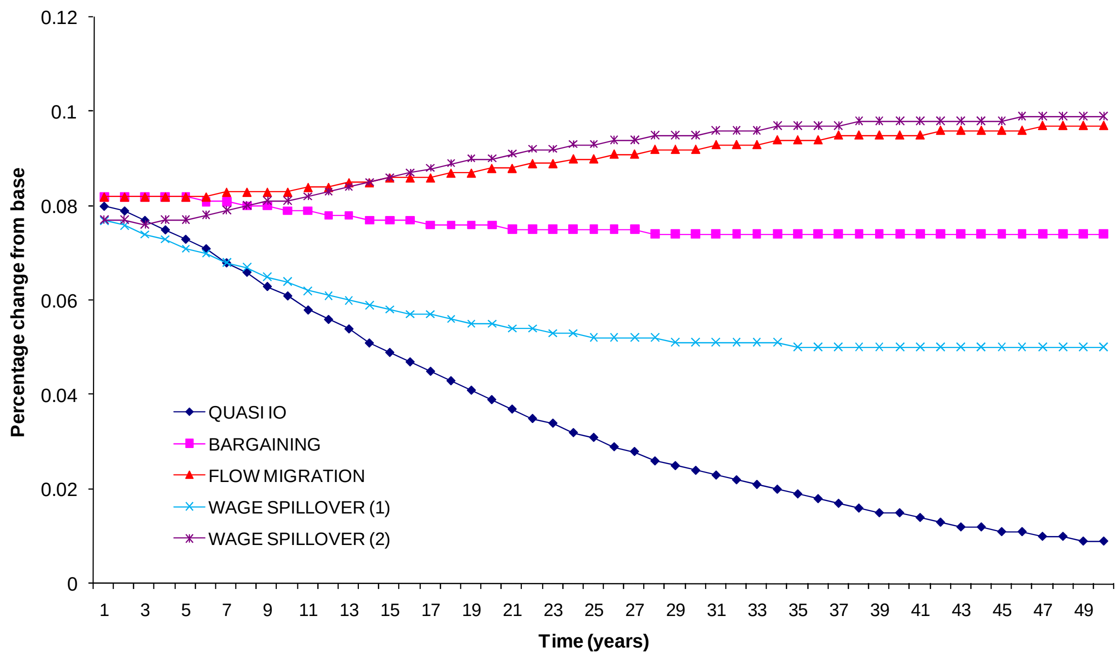


Figure 10 Absolute change in RUK total employment (000s)

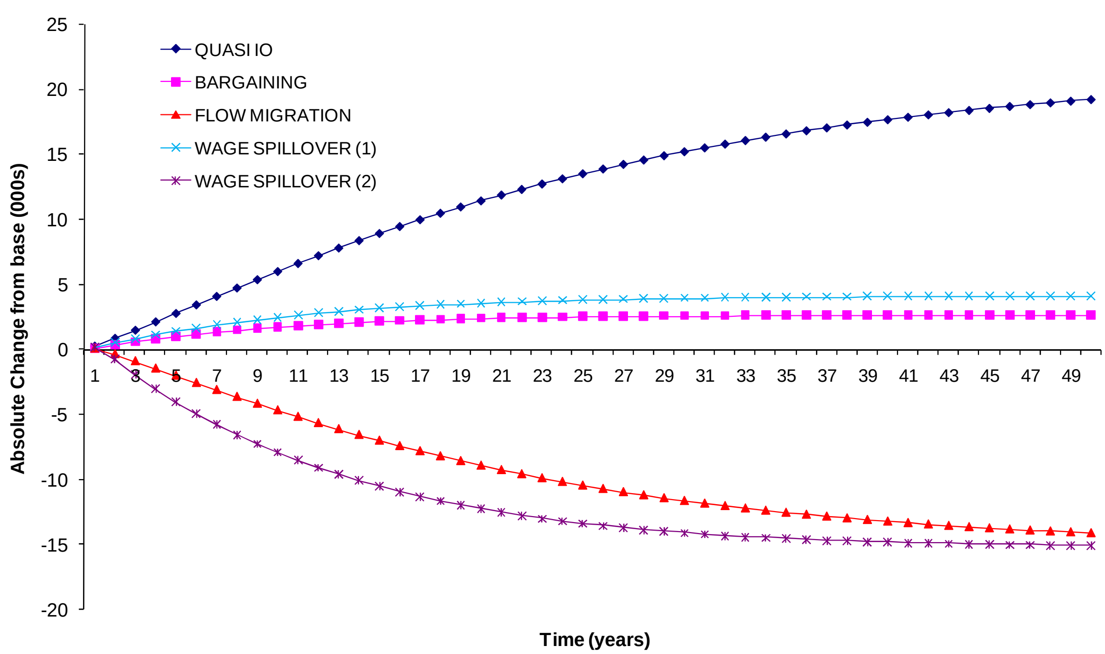


Figure 11 Percentage change in RUK real wage

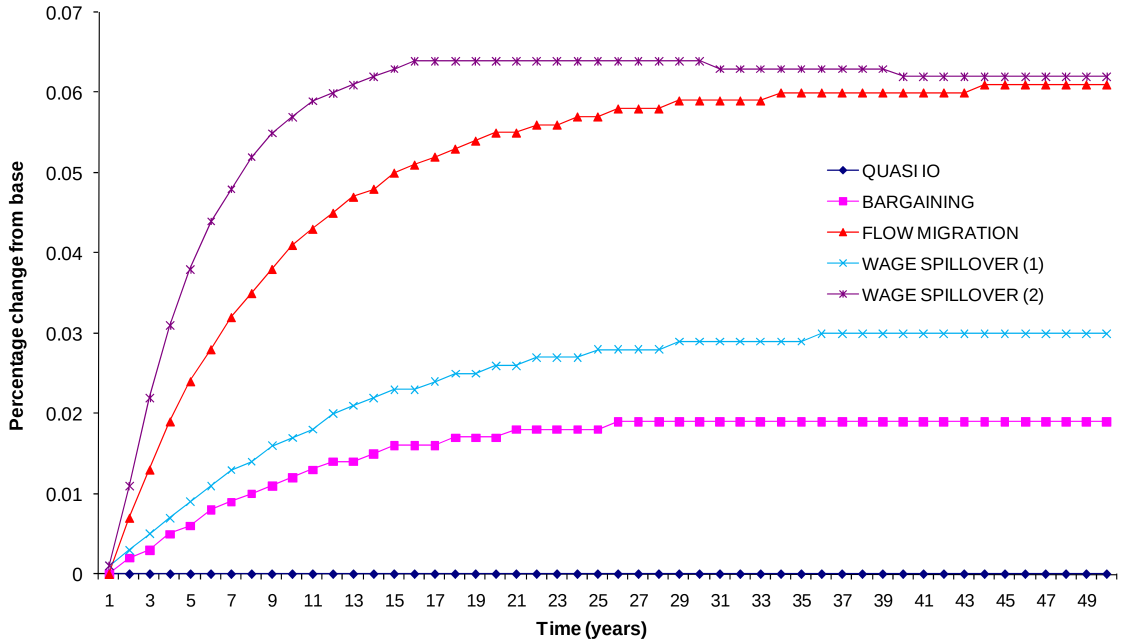


Figure 12 Percentage change in RUK nominal wage

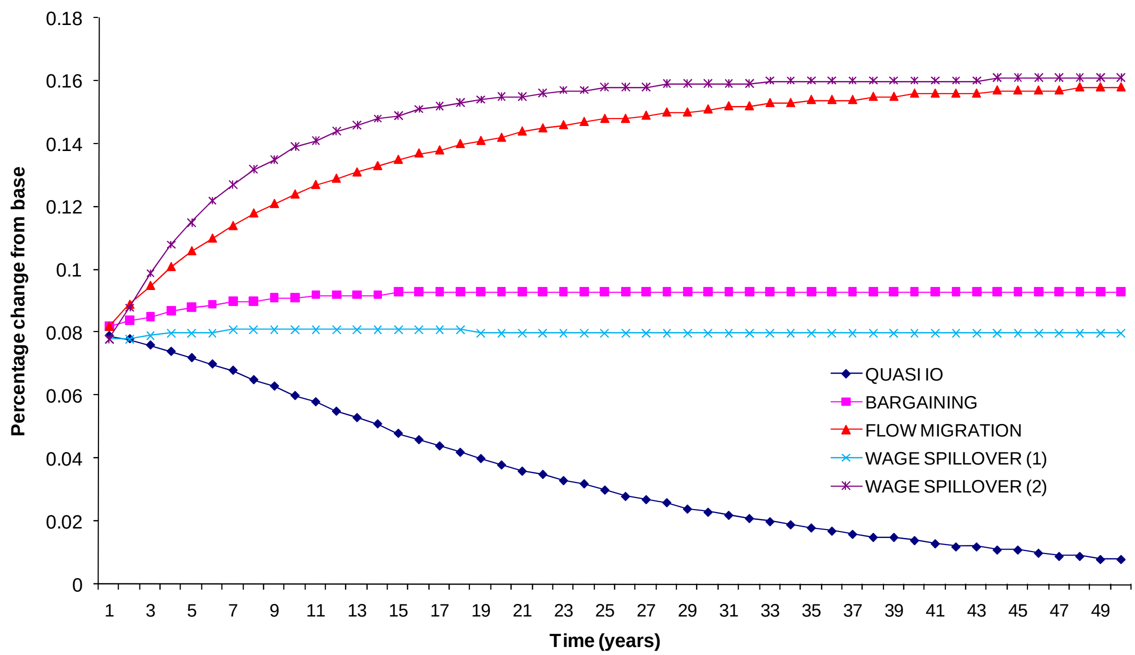


Figure 13 Percentage change in RUK exports to the ROW

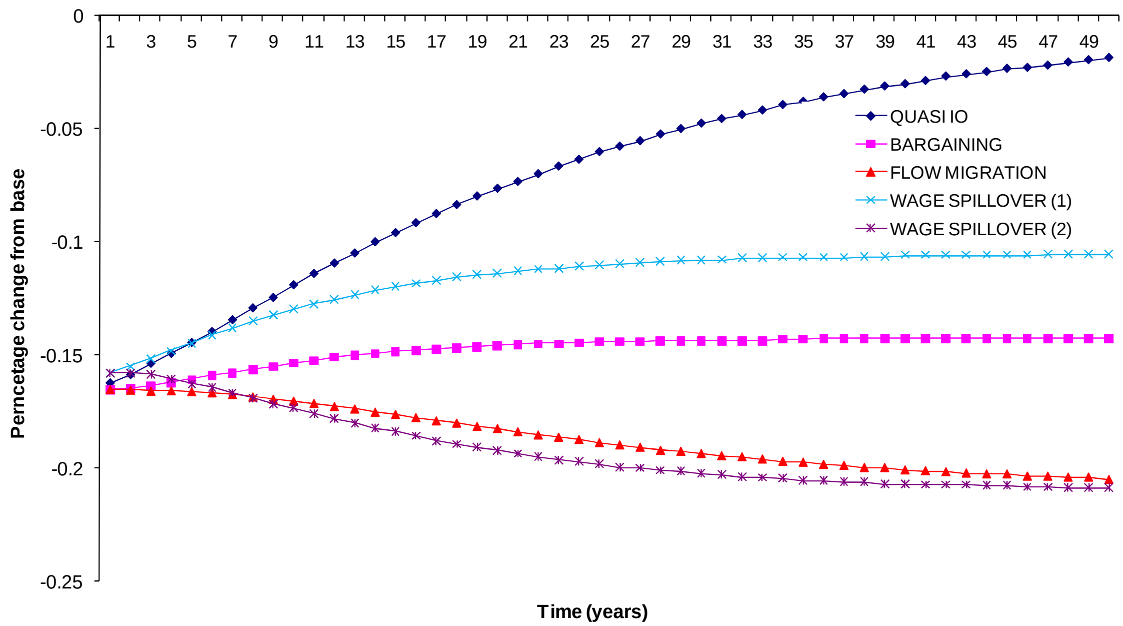


Figure 14 Percentage change in RUK exports to Scotland

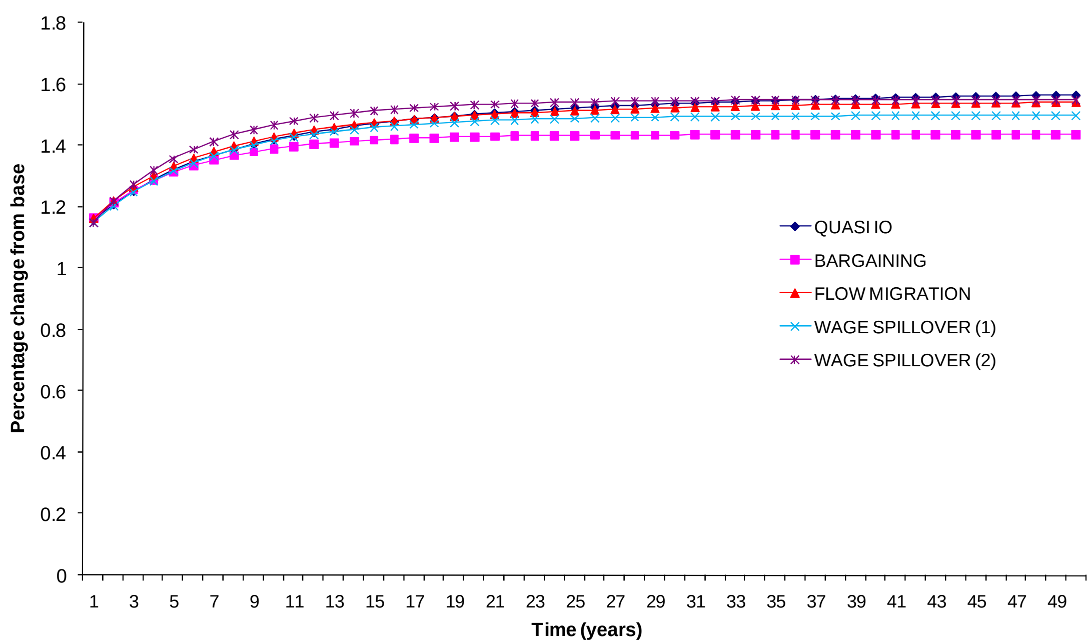


Figure 15 Absolute change in national GDP (£m)

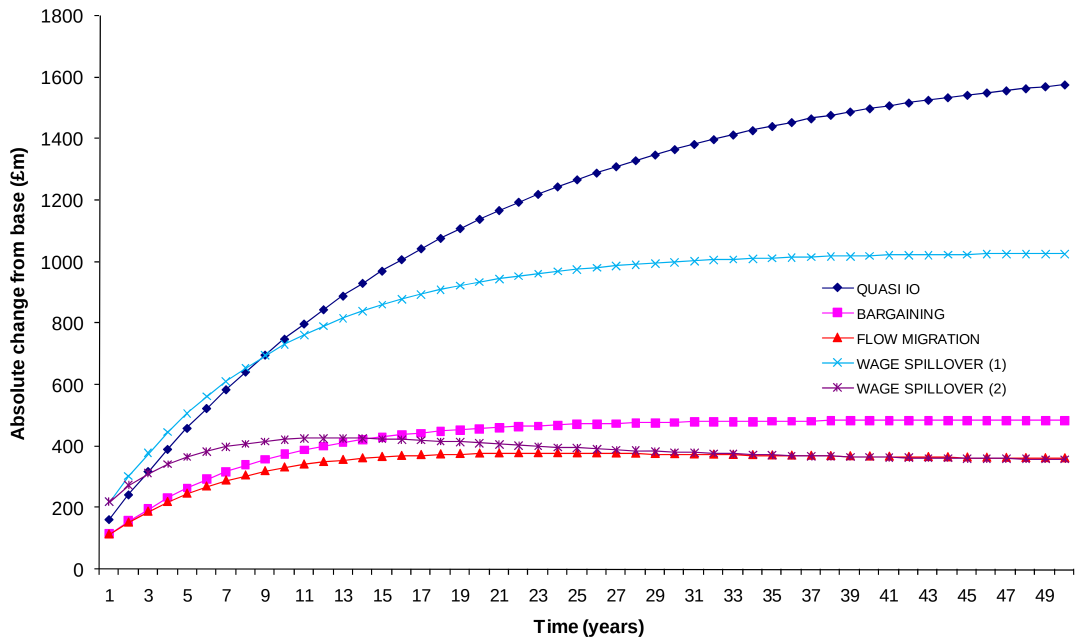


Figure 16 Absolute change in national employment (000s)