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THE NATIONAL IMPACT OF REGIONAL POLICY: SUPPLY-SIDE POLICY SIMULATION WITH LABOUR MARKET CONSTRAINTS IN A TWO-REGION COMPUTABLE GENERAL EQUILIBRIUM MODEL.

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Abstract

In a UK context, research into regional policy impacts has focused largely on the effects of a policy on the target region, with any consequences for other regions being largely ignored. This study aims to address this issue by providing a comprehensive evaluation of regional policy, focusing on both the regional and national implications of a policy shock. The paper examines the system-wide effects on the Scottish and rest of UK (RUK) economies of an increase in labour efficiency in the Scottish traded sectors. The research is carried out in an inter-regional computable general equilibrium framework of the Scottish and RUK economies, under alternative hypotheses regarding wage determination and inter-regional migratory behaviour. The findings suggest that regional policy can have significant national spillover effects, even when the target region is small relative to the RUK. Furthermore, the configuration of the labour market is important in determining the post-shock adjustment path of both economies. In particular, while Scottish economy results are sensitive to alternative versions of how regional labour markets function, RUK region effects prove to be even more so.

JEL classification: C68, D58, R58.

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

1. Introduction

This paper considers the system-wide effects on the Scottish and rest of UK (RUK) economies of an increase in labour efficiency in the Scottish traded sectors. The simulations are carried out in a two-region computable general equilibrium framework (AMOSRUK) that incorporates alternative wage-setting and migration assumptions.

The motivation for the analysis is twofold. Firstly, the shock being considered is closely in accord with current Scottish Executive policy. The Executive's 'Framework for Economic Development' (2004) sets out its objective to improve Scottish economic growth by increasing productivity levels and thus the competitiveness of the Scottish economy relative to other countries. This paper explores the consequences of a successful policy designed to boost productivity via increased labour market efficiency, though it does not explicitly consider the policies that could potentially achieve this effect. Secondly, despite the promotion of regional policy by the current Government as a means of increasing national growth and productivity, studies that consider the effect of regional policies on either non-target regions and/or the economy as a whole are rare. 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". The present study aims to address this issue by providing a comprehensive evaluation of regional policy, focusing on both the regional and national implications of the policy shock. The results help to illustrate whether non-target regions may benefit from regional policy, even if the target region is relatively small in comparison with the non-assisted region, and to what extent.

The discussion is structured in the following way. Section 2 outlines the AMOSRUK modelling framework. Section 3 describes the alternative labour-market model configurations used in the simulations. The results of the model simulations are reported in Section 4, and Section 5 concludes.

2. AMOSRUK: A Computable General Equilibrium Framework

AMOSRUK, the inter-regional version of the AMOS[1] simulation framework, is a computable general equilibrium model of the UK economy. 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 rest of the world.

The basic data set is an inter-regional Social Accounting Matrix (SAM) for 1999, which provides a 'snapshot' of the Scottish and rest of the UK's economies for that year and highlights 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. The SAM covers all intra-regional, inter-regional and international transactions in the economy over that year. 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

[1] 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, and Gillespie et al (2002) describes the inter-regional model AMOSRUK. Greenaway et al (1993) provides a general appraisal of CGE models and Partridge and Rickman (1998) reviews regional CGEs.

each sector's gross output. Production functions at each level of the production hierarchy can be CES, Cobb-Douglas or Leontief. The simulations in this paper use CES production functions at the value-added and gross-output level, and Leontief production functions at the intermediate-inputs level.

Consumption demand is linear in real income and homogenous of degree zero in all nominal variables. Real government demand is exogenous. Both inter-regional 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 inter-regional 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 macroeconomic 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 inter-regional 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 Model Configurations

In evaluating the full spatial impact of a supply 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. Inter-regional migration can, however, ease this labour market pressure. The five labour market configurations that are considered in this study are summarised in Table 1.

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	No	Yes

3.1 QUASI IO

The first, 'benchmark', scenario incorporates fixed real wages in both the Scottish and the RUK economies. There is no inter-regional migration of the labour force, so that regional employment is determined solely by regional labour demand. This configuration involves no effective 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 experiences competitiveness effects generated specifically through the labour market as labour efficiency increases. 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).

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.

3.3 FLOW MIGRATION

The third model scenario involves real wage bargaining at the regional level, as in the previous set-up, but also introduces inter-regional 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 immigration is positively related to the Scottish/RUK ratio of the real consumption wage and negatively related to the Scottish/RUK ratio of unemployment rates (Treyz *et al*, 1993). The specific form of this equation is derived from the Layard *et al* (1991) econometrically parameterised inter-regional migration function:

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

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, migration allows for a unified national labour market: an increase in regional demand lowers regional unemployment and induces migratory flows into that region. In the presence of bargained real wages, the ratio of the real wage ultimately remains constant (see Appendix A), as does the ratio of unemployment (see Appendix B). In this scenario, the population constraint works only at the national level: migration eases labour market pressures at the regional level.

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. Wage Spillover (1) incorporates no inter-regional 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 real wages do not directly respond to regional labour market pressures. In the RUK region, however, there is an effective population constraint, since real 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 an increase in labour efficiency in the Scottish traded sectors. There are two reasons for choosing this stimulus. Firstly, it relates closely to the direct impact expected from one of the policy priorities identified by the Scottish Executive. Increasing labour productivity has been identified as a key objective of the Executive's 'Framework for Economic Development' (2004). The Executive's report identifies that Scottish productivity rates are low by international standards and relative to the UK as a whole, and acknowledges that sustainable increases in the rate of growth of productivity will be achieved through, among other means, a skilled and knowledgeable labour force[2]. Secondly, throughout its present and previous sessions in office, the UK Government has promoted regional policy as a means of increasing national growth and reducing disparities across space. Despite this movement towards decentralised policy-making, however, there exists a limited understanding of the impact of local development policy outwith its immediate target area[3]. Thus the results help to illustrate whether non-target regions may benefit from regional policy, and to what extent.

[2] Though the model does not explicitly incorporate labour disaggregated by skill. This paper considers the effects of an increase in labour market efficiency across all skill levels of the Scottish traded sectors.

[3] In the UK there have been many studies of the effect of regional policy on the recipient regions (Taylor, 2002; Wren 2003). However, research that considers the effect of regional policies on either non-target regions and/or the economy as a whole is much less common.

The simulation method involves a 5% step increase in Harrod-neutral (labour-augmenting) technological progress in the Scottish traded sectors (i.e. the manufacturing and non-manufacturing traded sectors). 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 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. Figures 1-24 show the trajectories for the change in key variables relative to base for the five model configurations. Figures 1-12 relate to the Scottish economy; Figures 13-24 to the RUK economy. Tables 2-6 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 key 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. Each variable is expressed in terms of its change (absolute or percentage) relative to base.

4.1 QUASI IO: SCOTTISH ECONOMY EFFECTS

Following a positive labour efficiency shock in the Scottish economy, output per unit of labour increases in the traded sectors. This works to lower wages per efficiency unit of labour and thus the prices of value-added and commodity outputs in these sectors (Figures 1 and 2). By period 50, the prices of value-added and commodity outputs in the traded sectors are 2.72% and 2.06% lower than their base period values, respectively.

In the long run, these price effects feed through to the wider economy: even those sectors that did not experience the shock first-hand face downward price pressures. These other sectors face cheaper intermediate inputs to production, so economy-wide output prices fall over time. This results in a downward trajectory for prices over the period: CPI is 1.75% below the base value by period 50 (Figure 3). With fixed real wages in this scenario, nominal wages fall across all Scottish sectors (Figure 4).

The price effects provide a long-run competitiveness boost for the Scottish economy: inter-regional and ROW exports increase (Figures 6 and 7 respectively), especially so in the traded sectors, where the price effects are most significant due to the direct effects of the shock. Exports to the RUK increase due to cheaper commodity output prices in Scotland relative to the RUK and higher consumption demand in the RUK. The increase in exports to the ROW is also attributable to the fall in Scottish commodity output prices, but there are additional factors at work that contribute to the stronger increase in exports to the ROW relative to that of the RUK. Firstly, the efficiency shock creates a larger relative price advantage for Scottish exports to the ROW than for Scottish exports to the RUK. As commodity output prices fall in Scotland, so too do prices in the RUK, via the effects of cheaper intermediate inputs. The Scottish economy still experiences a price advantage over the RUK, due to the direct effects of the efficiency shock, but the exogeneity of the ROW – and a corresponding zero change in ROW prices – means that the relative price advantage that Scotland experiences with the ROW is more pronounced. Secondly, since real wages are fixed and CPI is falling, lower nominal wages mean that there is an additional competitiveness boost to Scotland's external trade.

Overall, the reduction in prices and nominal wages that stems from the productivity shock provides a long-run stimulus to Scottish GDP (Figure 8). Total output increases by 4.89% by period 50, relative to base. The quantity of traded sector commodity outputs increases by 5.46% by this period relative to base; sheltered sector outputs by 2.10%. In line with this output expansion, employment rises above its benchmark equilibrium in the long run (Figure 9). Traded sector employment is 1.57% above its base rate in period 50; sheltered sector employment 2.24% higher (Figures 10 and 11).

In the initial periods following the shock, however, employment falls in Scotland (Figure 9). This is due to two effects. Firstly, fewer labour inputs are required in the traded sector production process due to the efficiency shock. Secondly, the positive output effects resulting from lower prices and wages and higher competitiveness that work to counteract falling labour demand, take time to feed through due to capacity constraints. The direct effects of the efficiency boost result in traded sector employment being 2.1% (27,270) lower than base in the first period following the shock (Figure 10). This compares with a 0.7% increase (4,300) in employment in the sheltered sector - where the efficiency shock is not directly levied - relative to base for the same period (Figure 11). Over time, however, investment adjusts capital stocks and capacity constraints relax, allowing the economy to take fuller advantage of the competitiveness boost, and the increase in overall long run output relative to base is the strongest of all the scenarios considered in this paper (Figure 8).

Table 2: Quasi IO Summary Results

	Period 3		Period 50	
	Scotland	RUK	Scotland	RUK
GDP	1.84%	0.03%	4.89%	0.25%
	£1153.5m	£182.9m	£3062.6m	£1767.4m
Total employment	-0.78%	0.03%	1.75%	0.25%
	-14,820	6,899	33,139	50,777
Traded sector employment	-1.56%	0.04%	1.57%	0.28%
Sheltered sector employment	0.95%	0.02%	2.24%	0.14%
CPI	-0.59%	-0.05%	-1.75%	-0.25%
Commodity output prices	-0.64%	-0.03%	-2.06%	-0.22%
Traded sector commodity output prices	-1.06%	-0.03%	-2.88%	-0.23%
Price of value added	-0.89%	-0.03%	-2.72%	-0.22%
Traded sector price of value added	-1.54%	-0.02%	-4.01%	-0.21%
Nominal wage	-0.59%	-0.05%	-1.75%	-0.25%
Real wage	0.00%	0.00%	0.00%	0.00%
Exports to the other region	1.52%	0.41%	4.24%	1.00%
Exports to ROW	1.65%	0.07%	4.98%	0.45%

4.2 QUASI IO: RUK ECONOMY EFFECTS

The RUK economy also experiences a positive stimulus to long run economic activity following the efficiency shock in Scotland. In the RUK, too, the source of the expansion is a reduction in economy-wide prices and an increase in external competitiveness.

Close interregional trade linkages between Scotland and the RUK mean that cheaper intermediate inputs from Scotland lead to lower commodity output prices in the RUK across all sectors in the long run. In period 50, commodity output prices are 0.22% lower compared with the base value, and overall CPI is 0.25% lower (Figures 14 and 15). This fall in prices, combined with fixed real wages in this scenario, means that nominal wages fall 0.25% below the base value by period 50. These wage and price

effects together provide a positive boost to RUK trade to the ROW: exports to the ROW are 0.45% higher than base by period 50. Further, RUK exports to Scotland are 1.00% higher than base by the end of the simulation period, reflecting stronger activity in the Scottish economy. These improvements to export demand (Figures 18 and 19) act as the main driver behind an upward GDP trajectory for the RUK, compared with the benchmark equilibrium (Figure 20).

The magnitude of the overall effects in the Scottish and the RUK economies differs significantly in percentage terms. Whilst in Scotland the efficiency shock leads to a 4.89% increase in GDP relative to base in the long run, the comparative figure for the RUK is just 0.25%. In contrast, in terms of absolute magnitudes of the simulation effects, the results are much closer (Figures 8 and 20). Despite the Scottish economy being relatively small compared with the RUK, close trade linkages mean that spillover effects are nonetheless positive.

The results for the RUK labour market also illustrate the differing extent of the effects in each region. Total employment is 0.25% higher than base for the RUK by period 50, relative to an increase of 1.75% for the Scottish economy. Furthermore, the adjustment paths of the regional labour markets diverge: whilst total employment falls in the Scottish traded sector in the short run as a result of the efficiency shock - owing to there being fewer labour inputs required in the production process - the same is not true for the RUK. Since there is no increase in labour efficiency in the RUK economy, the changes in employment stem only from positive competitiveness effects and the resulting increase in export demand. In contrast to that of Scotland, RUK total employment increases throughout the simulation period for this set-up, relative to base. Traded sector employment rises by most (0.28% relative to 0.14% for the sheltered sector), reflecting that this sector would be most exposed to changes in the price of intermediate inputs from the Scottish traded sector, and thus most susceptible to the competitiveness boost that cheaper intermediate inputs from Scotland brings about.

4.3 REGIONAL BARGAINING: SCOTTISH ECONOMY EFFECTS

Within the regional bargaining configuration, similar effects work through the Scottish economy as in the previous Quasi IO scenario: increased output per unit of labour reduces wages per efficiency unit of labour, and this puts downward pressure on prices in the traded sectors, and also in the wider economy via cheaper intermediate inputs for non-traded sectors. In this scenario, however, the responsiveness of real wages over time works to dampen the competitiveness boost that occurs as a result of lower prices. The stimulus to long run economic activity is therefore significantly lower under the Bargaining scenario relative to the previous configuration, where real wages remain fixed.

In the long-run, as output expands and unemployment falls in response to the efficiency shock, real wages are bid up via equation (1), so that by period 50, real wages are 0.73% higher relative to base (Figure 5). With rising real wages, economy-wide prices fall by less in the long run in this scenario relative to the previous one. CPI is 1.32% lower than its base value in period 50; this compares with a relative reduction of 1.75% in the Quasi IO scenario. Less significant relative decreases in the prices of value added and commodity outputs in the traded sector (-3.21 % and -2.28% respectively, compared with -4.01% and -2.88% in the Quasi IO case) mean that downward price pressures still feed through to the other sectors via cheaper intermediate input prices, but that the effect on economy-wide prices is more subdued. Furthermore, the fall in CPI, combined with a rise in real wages, results in nominal wages falling by less in this set-up (-0.6%) by period 50 compared with the Quasi IO scenario (-1.75%) (Figure 4). Although the fall in CPI and nominal wages does improve competitiveness, the increase in interregional and international trade is also less significant than in the previous scenario (Figures 6 and 7). By the end of the simulation period, exports to the RUK and the ROW increase by 3.16% and 3.51% respectively, relative to base. The equivalent Quasi IO relative increases are 4.24% and 4.98%. Thus the overall impact of the efficiency stimulus is a relative increase in long-run Scottish GDP, but the effect is less strong than under the previous scenario (Figure 8). GDP increases by 3.75% over base by the end of the simulation period in this scenario, compared with 4.89% for the Quasi IO case.

In the shorter run, and in contrast to the Quasi IO case, the competitiveness effect is actually reinforced with the bargained real wage closure. Following the efficiency shock, employment falls relative to base for around 7 periods in both the Bargaining and Quasi IO cases (Figure 9): fewer labour inputs are required in the production process, and capacity constraints mean that positive output effects do not initially feed through to outweigh these effects. In the Bargaining case, however, falling employment in the short run leads to a fall in real wages, whilst real wages remain unchanged in the Quasi IO configuration (Figure 5). This, in turn, leads to a larger relative reduction in the nominal wage (-1.19% in period 3) compared with the previous scenario (-0.59%) (Figure 4). This additional stimulus creates a higher increase in GDP in the short run under the Bargaining scenario (2.14% in period 3) relative to the Quasi IO scenario (1.84% in period 3) (Figure 8). The responsiveness of the real wage in the Bargaining scenario means that the reverse is true over time: after period 7, employment rises in both scenarios, but real wages rise only under the Bargaining case, resulting in a more subdued boost to output relative to the Quasi IO scenario during the remainder of the simulation period.

Table 3: Bargaining Scenario Summary Results

	Period 3		Period 50	
	Scotland	RUK	Scotland	RUK
GDP	2.14%	0.01%	3.75%	0.05%
	£1339.9m	£87.81m	£2349.9m	£319.94m
Total employment	-0.40%	0.02%	0.61%	0.04%
	-7,507	3,055	11,431	8,410
Traded sector employment	-1.15%	0.02%	0.25%	0.05%
Sheltered sector employment	1.28%	0.00%	1.46%	0.01%
CPI	-0.68%	-0.05%	-1.32%	-0.11%
Commodity output prices	-0.92%	-0.03%	-1.31%	-0.06%
Traded sector commodity output prices	-1.17%	-0.04%	-2.28%	-0.08%
Price of value added	-1.26%	-0.02%	-1.76%	-0.04%
Traded sector price of value added	-1.71%	-0.01%	-3.21%	-0.05%
Nominal wage	-1.19%	-0.03%	-0.60%	-0.04%
Real wage	-0.52%	0.03%	0.73%	0.07%
Exports to the other region	1.81%	0.39%	3.16%	0.75%
Exports to ROW	2.09%	0.07%	3.51%	0.14%

4.4 REGIONAL BARGAINING: RUK EFFECTS

For the RUK economy, the efficiency shock in the Scottish traded sector generates a potential stimulus via cheaper intermediate input prices from Scotland, and increased demand for RUK exports from the Scottish economy. As in the Quasi IO scenario, Scotland experiences a fall in economy-wide prices and an improvement in demand and competitiveness. The effects are therefore felt by the RUK economy - albeit to a weaker extent - as they filter through interregional trade linkages. Overall commodity prices fall in the RUK, but by less so than in Scotland, and this is reflected in a slightly weaker boost to RUK exports to the ROW relative to that of Scotland (Table 3).

In the Bargaining scenario, the long-run extent of the effects on Scottish prices, demand and competitiveness are weaker relative to the Quasi IO scenario, and this means that the impact on the RUK economy is further reduced as the effects feed though interregional linkages. By the end of the simulation period, RUK GDP is 0.05% higher than base in this scenario, compared with 0.25% in the previous case. This scenario results in a smaller long-run fall in RUK CPI relative to the previous case (-0.11% compared with -0.25%) and a less significant reduction in nominal wages (-0.04% compared with -0.25%). As a result of a weaker competitiveness boost, exports to the ROW increase by less in the long-run (0.14% compared with 0.45%). Furthermore, since the effect on Scottish demand is more subdued in the Bargaining case compared with the Quasi IO case, RUK exports to Scotland also increase by less (0.75% compared with 1.00%).

In addition, the short-run competitiveness boost that benefits the Scottish economy in this scenario does not materialise for the RUK. Since there is no direct efficiency shock in the RUK, there is no initial fall in employment due to less labour inputs being required in the production process (Figure 21) and therefore no initial fall in real wages to boost short-run export demand (Figure 17).

4.5 FLOW MIGRATION: SCOTTISH ECONOMY EFFECTS

As in the previous two scenarios, the efficiency shock also increases GDP relative to base when the potential for population migration is introduced into the model set-up (Figure 8). The source of this long-run boost remains the same as in the previous Bargaining case: higher labour productivity reduces prices in the traded sectors and also in the wider economy via cheaper intermediate inputs. The resultant downward pressure on whole-economy prices boosts external competitiveness. In this case, however, the positive competitiveness effects are enhanced by in-migration.

In the previous Bargaining scenario, the results suggest that the presence of bargained real wages (in the absence of migration) dampens this competitiveness boost due to real wages being bid up and economy-wide price reductions therefore being smaller in

Scotland. Thus the increase in GDP relative to base is somewhat weaker than in the Quasi IO scenario, where real wages remain fixed. In the Flow Migration case, however, the presence of inter-regional migration works to limit this increase in real wages over time (Figure 5). In the longer run, as employment and wages rise, labour supply flows in to Scotland from the RUK (Figure 12) and eases regional labour market constraints to some extent, though there does remain a UK-wide labour market constraint (we assume zero net inmigration in the UK overall). By period 50, real wages are 0.15% higher in this scenario relative to base, compared with 0.73% higher in the Bargaining set-up. Overall commodity output prices therefore fall by more in this scenario than in the Bargaining case (-1.78% by period 50, compared with -1.31%), as do nominal wages (a fall of -1.41% compared with -0.60%). Thus the improvements in competitiveness vis-à-vis the RUK and the ROW are more pronounced in the Flow Migration set-up than in the Bargaining configuration. Exports to the RUK increase by 3.84% compared with 3.16%, and to the ROW by 4.42% compared with 3.51%. As a result, the long-run GDP increase under this scenario is greater than under the Bargaining scenario, but lower than under the Quasi IO scenario, where the real wage increase is zero, and the competitiveness effect stronger (Figure 8)[4].

The initial adjustments in the Scottish economy under the Flow Migration scenario highlight the economy-wide implications of inter-regional labour supply movements in the short run relative to the long run. Immediately following the shock, employment falls, as in the previous two scenarios (Figure 9). Real wages therefore fall and commodity output and economy-wide prices fall (Figure 3). In response to initial lower employment, higher unemployment and a corresponding fall in real wages (Figure 5), some of the labour force moves to the RUK. In the short-run the labour market in Scotland is slacker due to the direct effect of the efficiency shock (Figure 12). As the price effects work through to create a positive output stimulus, some of the labour supply migrates back to Scotland from the RUK. As employment continues to rise and unemployment falls, inward migration continues, and thus an

[4] Gillespie et al (2001) explores the consequences of an improvement in Scottish manufacturing efficiency that results from an increase in inward investment, in the context of a standalone CGE model of the Scottish economy. The results are consistent with those reported here. The authors find that in a situation of regional bargaining and migration, the increase in activity that follows an efficiency shock is driven by an improvement in price competitiveness and a corresponding increase in exports, and that migration works to restore the original real wage in the long run in the single region case.

overall increase in the labour supply eases regional labour market constraints in the long run.

Table 4: Flow Migration Summary Results

	Period 3		Period 50	
	Scotland	RUK	Scotland	RUK
GDP	2.03%	0.03%	4.59%	-0.04%
	£1272.5m	£194.81m	£2876.10m	£-300.25m
Total employment	-0.55%	0.04%	1.47%	-0.05%
	-10,481	7,520	27,694	-9,995
Traded sector employment	-1.31%	0.04%	1.23%	-0.05%
Sheltered sector employment	1.13%	0.02%	2.07%	-0.06%
CPI	-0.66%	-0.05%	-1.55%	-0.08%
Commodity output prices	-0.83%	-0.04%	-1.78%	-0.02%
Traded sector commodity output prices	-1.15%	-0.04%	-2.64%	-0.05%
Price of value added	-1.13%	-0.01%	-2.40%	0.01%
Traded sector price of value added	-1.68%	-0.02%	-3.72%	0.00%
Nominal wage	-0.94%	-0.05%	-1.41%	0.04%
Real wage	-0.28%	-0.01%	0.15%	0.12%
Exports to the other region	1.74%	0.37%	3.84%	0.86%
Exports to ROW	1.95%	0.08%	4.42%	0.04%
Population	-22,080	22,080	68,480	-68,480

4.6 FLOW MIGRATION: RUK EFFECTS

In contrast, the introduction of inter-regional migration makes for an overall relative reduction in long-run GDP for the RUK (Figure 20). By the end of the simulation period, RUK GDP has fallen by 0.04% relative to base. This compares with a relative increase in GDP of 0.25% for the Quasi IO scenario and 0.05% for the Bargaining closure. Both the Scottish and the RUK economies still experience falling prices and therefore an effective increase in competitiveness due to the efficiency shock, as in

the previous two scenarios. Owing to the direct effects of the efficiency shock, however, the real wage increases and the increase in employment are ultimately stronger in Scotland relative to the RUK in the long-run. These changes in the Scottish/RUK unemployment and real wage ratios imply that labour supply flows into the Scottish economy in the long run from the RUK (Figure 24), so that the RUK economy is unable to take full advantage of the competitiveness effects due to labour shortages. In period 50, the RUK population is 68,480 lower relative to base. RUK exports to the ROW are therefore most subdued in this scenario compared with the other labour market configurations in the long run (Figure 19). In contrast, RUK exports to Scotland are comparatively strong (Figure 18), attributable to the increase in economic activity in this region (Figure 8).

The RUK economy does, however, experience a short run increase in labour supply. In period 3, the RUK population is 22,080 higher relative to base, and the economy enjoys net inward migration for 12 periods following the efficiency shock. The initial increase in Scottish unemployment – owing to there being less units of labour required in the production process – means that Scottish real wages fall, and the population migrates towards the relatively more attractive conditions in the RUK labour market. During this period, the increase in GDP relative to base in the Flow Migration scenario outweighs that of the Bargaining configuration (Figure 20), as the additional pool of labour supply allows the RUK economy to take fuller advantage of the competitiveness improvement that feeds through from the Scottish economy. The serious labour market constraints that occur in the longer run, however, mean that RUK GDP falls below base in the long run (Figure 20).

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

The wage spillover set-ups result in the weakest output stimulus for the Scottish economy: the Scottish GDP trajectories for both these scenarios are significantly lower than for the previous three configurations (Figure 8), with GDP around 3.18% higher than base for both Wage Spillover scenarios at period 50, compared with a 4.89% increase under the Quasi IO scenario. The source of the impact, albeit a weaker stimulus, is the same as in the previous model set-ups: as wage per efficiency

unit of labour falls, lower commodity prices provide a competitiveness boost for the economy. The difference in these scenarios relative to the previous configurations is that the effects are somewhat more indirect and therefore less strong. In the Wage Spillover set-ups, it is the factors that determine the RUK nominal wage that determine the Scottish nominal wage, and thus the extent of the competitiveness effects and wider economic activity in Scotland. Following the shock, cheaper intermediate input prices from Scotland work to lower overall prices in the RUK. Lower RUK CPI lowers nominal wages in the RUK, and Scotland adopts this nominal wage. Because the Scottish economy is relatively small compared with the RUK, however, the effects on the RUK are fairly limited, and thus the effects on the Scottish economy even more so. The overall effects on the Scottish economy are therefore much more diluted than in the alternative configurations. Scotland still gets the benefit of the reduction in commodity prices as a result of the efficiency gain, but not the associated wage effects that help to significantly boost activity in the three previous scenarios. In the Wage Spillover (1) and (2) scenarios, Scottish nominal wages fall only marginally, compared with the effects in the other scenarios (Figure 4), and real wages rise (Figure 5). Weaker competitiveness effects mean that the stimulus to exports, and overall activity, is subdued relative to the previous scenarios. In period 50, exports to the RUK and the ROW are 2.63% and 2.81% higher than base for both scenarios. This compares to equivalent relative increases of 4.24% and 4.98% for the Quasi IO scenario.

The introduction of migration has a limited effect on overall activity. The adjustment paths of GDP, employment and exports for the Wage Spillover (1) and (2) scenarios are in close accord for the duration of the simulation period. In the Wage Spillover (2) configuration – where migratory behaviour is allowed for – there are, however, significant changes in the population. Following the efficiency shock, both unemployment and real wages rise in Scotland, but the unemployment effects outweigh the real wage effects such that some of the labour force migrates towards the RUK economy. The population deviation from base is most significant in period 5, when the population is 43,457 lower relative to its base value. Thereafter, immigration to Scotland occurs, and the population returns to its base value by period 33, and rises marginally above base during the remaining simulation periods (Figure 12). Unlike in the previous Flow Migration scenario, the fall in population does not

present serious capacity constraints: despite a lower labour supply, exports and GDP results for the Wage Spillover (2) scenario are very close to that of the Wage Spillover (1) scenario, where no population adjustment occurs. Since the price and competitiveness effects are more diluted in these scenarios relative to the Flow Migration case, the stimulus to economic activity is not strong enough to significantly tighten the labour market. The overall effect of the Wage Spillover (2) scenario is 'as if' the labour market is not tightening at all – there is sufficient capacity in the labour market to accommodate the change in activity.

Table 5: Wage Spillover (1) Summary Results

	Period 3		Period 50	
	Scotland	RUK	Scotland	RUK
GDP	1.59%	0.01%	3.18%	0.04%
	£995.13m	£86.19m	£1989.02m	£299.75m
Total employment	-1.13%	0.02%	0.03%	0.04%
	-21,285	3,051	520	7,976
Traded sector employment	-1.92%	0.02%	-0.42%	0.05%
Sheltered sector employment	0.64%	0.00%	1.07%	0.01%
CPI	-0.51%	-0.04%	-1.21%	-0.09%
Commodity output prices	-0.39%	-0.02%	-0.94%	-0.05%
Traded sector commodity output prices	-0.96%	-0.02%	-1.98%	-0.07%
Price of value added	-0.55%	-0.01%	-1.28%	-0.04%
Traded sector price of value added	-1.39%	-0.01%	-2.80%	-0.04%
Nominal wage	-0.02%	-0.02%	-0.03%	-0.03%
Real wage	0.49%	0.02%	1.10%	0.06%
Exports to the other region	1.26%	0.41%	2.63%	0.70%
Exports to ROW	1.26%	0.04%	2.81%	0.11%

Table 6: Wage Spillover (2) Summary Results

	Period 3		Period 50	
	Scotland	RUK	Scotland	RUK
GDP	1.59%	0.03%	3.18%	0.04%
	£997.12m	£236.06	£1988.60m	£281.25m
Total employment	-1.12%	0.05%	-0.03%	0.04%
	-21,210	9,424	507	7,355
Traded sector employment	-1.92%	0.05%	-0.42%	0.04%
Sheltered sector employment	0.64%	0.03%	1.07%	0.01%
CPI	-0.53%	-0.04%	-1.12%	-0.09%
Commodity output prices	-0.43%	-0.03%	-0.94%	-0.05%
Traded sector commodity output prices	-0.99%	-0.03%	-1.98%	-0.07%
Price of value added	-0.60%	-0.03%	-1.28%	-0.03%
Traded sector price of value added	-1.44%	-0.01%	-2.80%	-0.04%
Nominal wage	-0.06%	-0.06%	-0.03%	-0.03%
Real wage	0.47%	-0.02%	1.10%	0.06%
Exports to the other region	1.32%	0.36%	2.62%	0.71%
Exports to ROW	1.32%	0.06%	2.81%	0.11%
Population	-35,159	35,159	2,446	-2,445

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

In the RUK, under the Wage Spillover (1) and (2) scenarios, the stimulus works via the same channels as in the previous scenarios: cheaper intermediate inputs feed through from the Scottish economy and provide a competitiveness boost to the region relative to the ROW, and, further, there is a demand stimulus as a result of economic expansion in Scotland. In response to higher output and lower unemployment, real wages rise, resulting in a lower GDP trajectory than under the Quasi IO scenario, where real wages remain fixed and the RUK stimulus to trade is most significant. Furthermore, because the effect on Scottish economic activity is relatively weak under these scenarios, the RUK economy does not benefit as greatly from the increase in

Scottish demand for RUK exports. Of all the labour market configurations, the Wage Spillover scenarios provide the second-weakest long run stimulus to RUK GDP, after the Flow Migration Scenario, where RUK GDP falls relative to base. Output is around 0.04% higher relative to base in period 50 for both Wage Spillover configurations. This compares to an equivalent figure of 0.25% for the Quasi IO closure, which provides the highest GDP trajectory for the RUK economy.

In contrast to that of Scotland, the adjustment paths for the RUK economy under the Wage Spillover (1) and (2) scenarios differ significantly. In the periods following the shock, as labour demand falls in Scotland in the Wage Spillover (2) scenario, the RUK economy experiences net inward migration. The increase in labour supply helps to lower real and nominal wages, which therefore provides an additional external competitiveness stimulus. In period 3, nominal wages are 0.06% below base in Wage Spillover (2), compared with 0.02% below base in Wage Spillover (1), and exports to the ROW are relatively higher over the period (Figure 19).

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 spillovers may be significant, even though the target region is small relative to the RUK. An increase in labour efficiency, which is the desired and anticipated response to some Scottish Executive policies, clearly has both regional and national GDP impacts. Even under the most neoclassical assumptions about the operation of regional labour markets, with fully flexible real wages in both regions and flow migration (the 'Flow Migration' scenario), there are significant effects in Scotland and the RUK.

Under all configurations, the efficiency shock results in a positive stimulus for the Scottish economy, and labour and migratory behaviour appear to be important factors in determining the magnitude of the positive stimulus and the adjustment path of the economy. Under all configurations, spillover effects do arise for the RUK, with obvious consequences for national effects. Furthermore, the results suggest that quite different RUK GDP changes can be associated with labour market configurations that have quite similar overall long-run impacts on the target region. While own-region results prove sensitive to alternative versions of how regional labour markets function, other-region effects prove to be even more so.

In addition, the results suggest that a move to long-run equilibrium is generally slow. From a policy perspective, this could prove misleading, since the ordering of the magnitude of the effects under the different labour market scenarios changes over time. Moreover, the time horizon for the evaluation of local regeneration policy is a ten year maximum (HM Treasury, 1995), yet significant adjustments occur outwith this time period in 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. Thus the analysis helps to highlight the importance of appropriately capturing the characteristics of regional labour markets for assessing the regional and national impacts of regional policies.

Appendix A

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

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

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:

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

and

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

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

$$\frac{-\delta - 0.06\left[\beta^S - \beta^R\right]}{-0.01322} = \left[\ln u^S - \ln u^R\right] \quad (3)$$

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.

Appendix B

Since the ratio of unemployment rates remains constant in equilibrium (Appendix A, equations (3)), then:

$$\left[\ln u^S - \ln u^R\right] = K \qquad (4)$$

where K is a constant.

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

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

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

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

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
Scottish Price of Value Added: % Change from Base

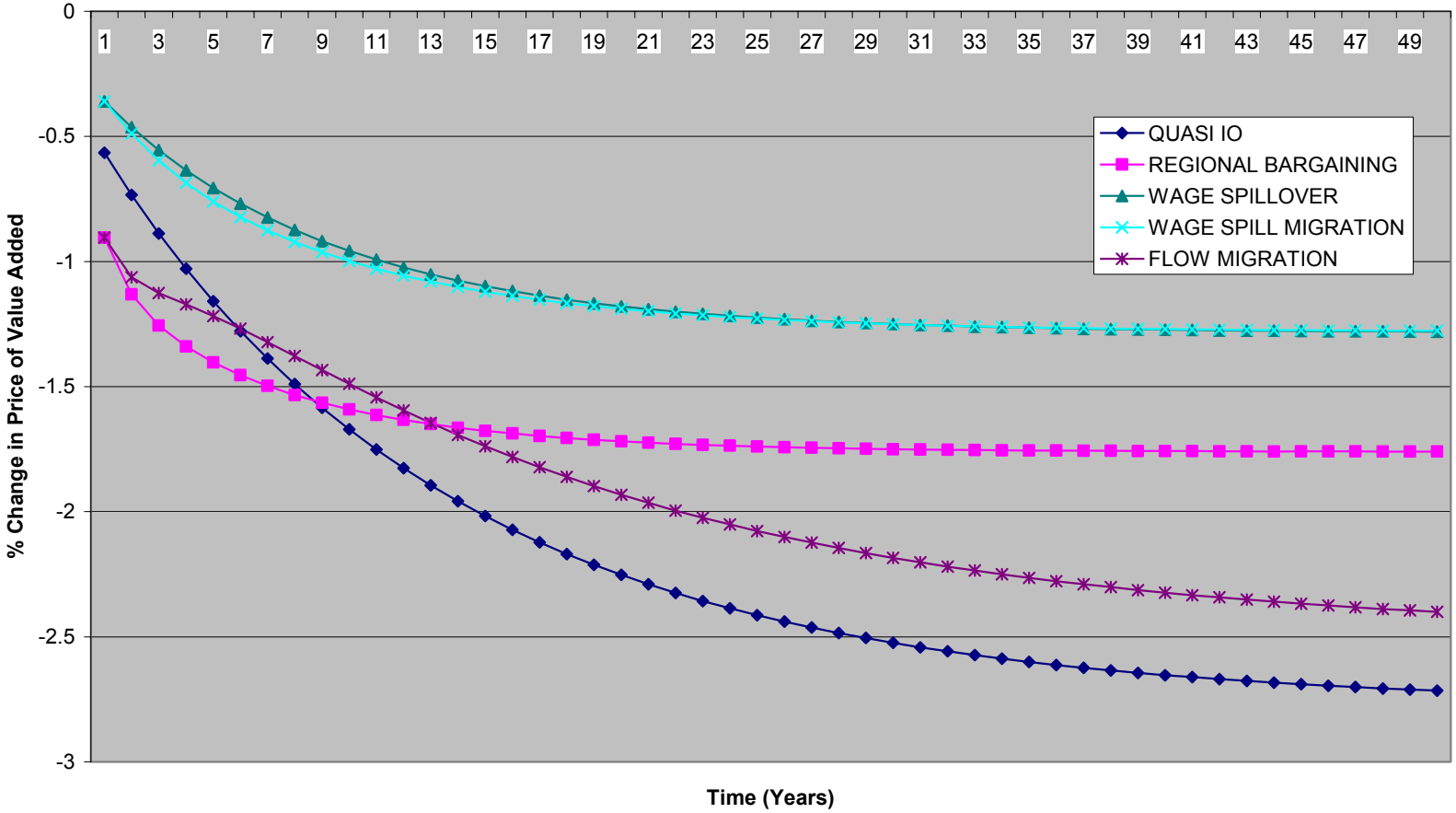


Figure 2
Scottish Price of Commodity Outputs: % Change from Base

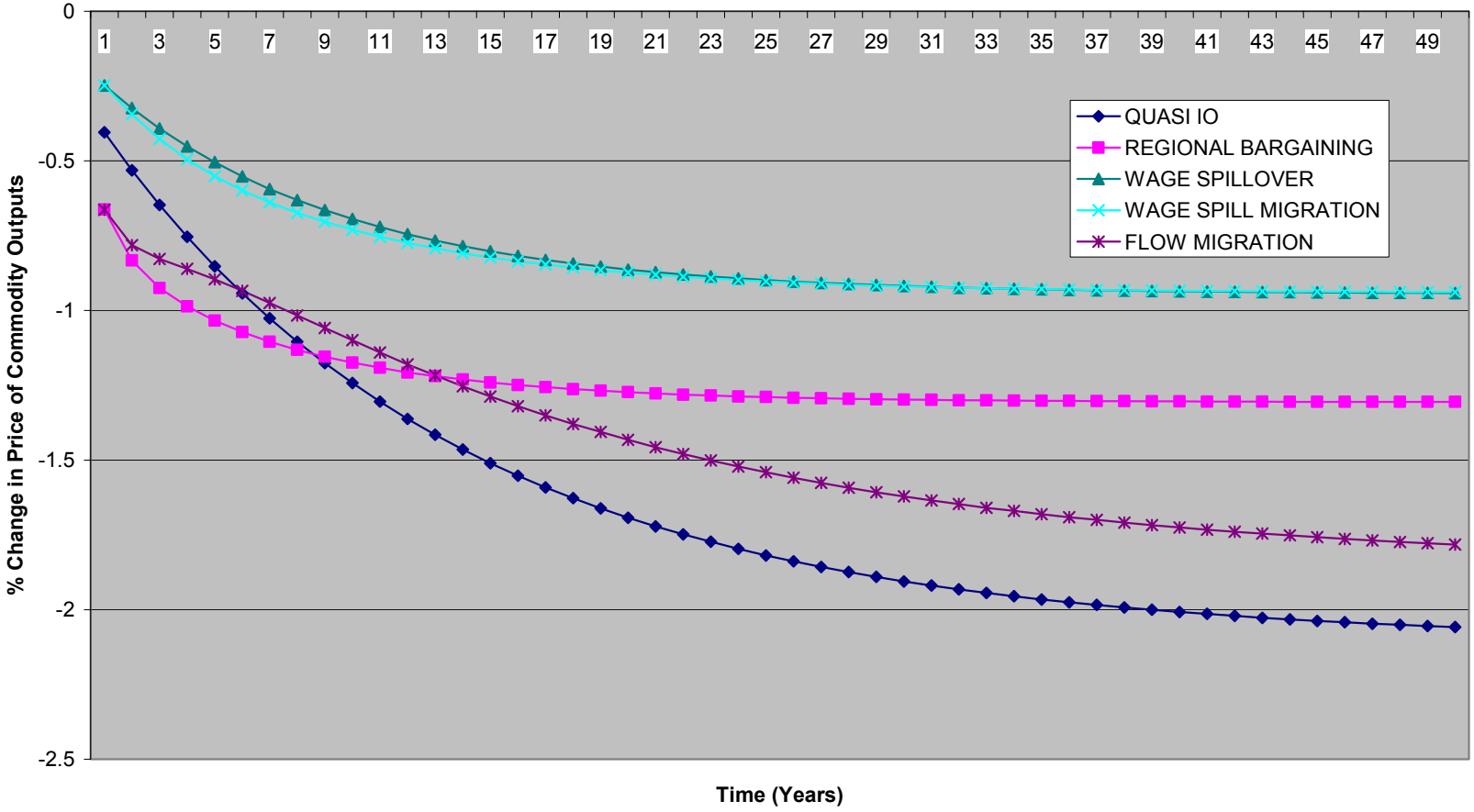


Figure 3
Scottish CPI: % Change from Base

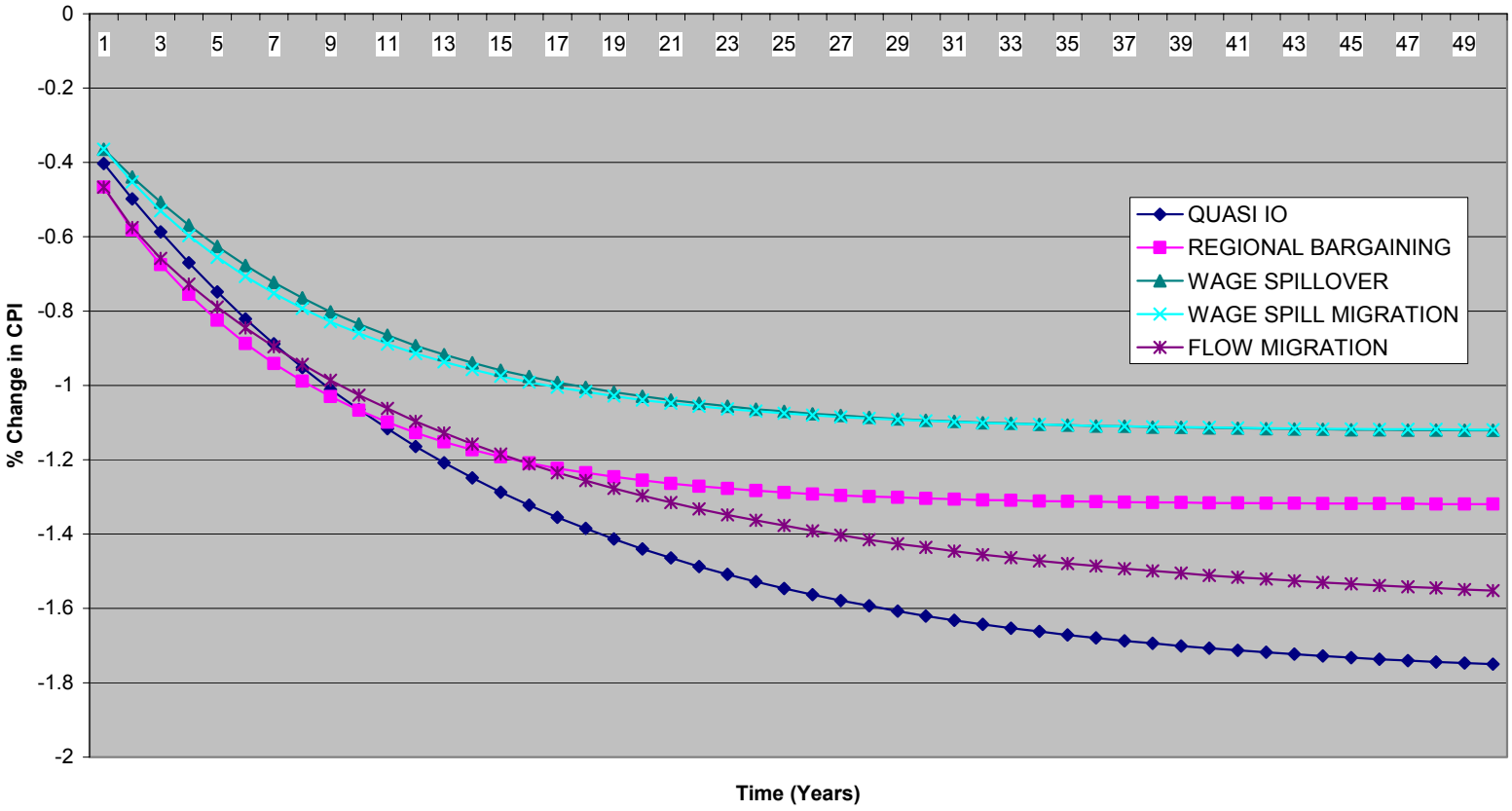


Figure 4
Scottish Nominal Wage: % Change from Base

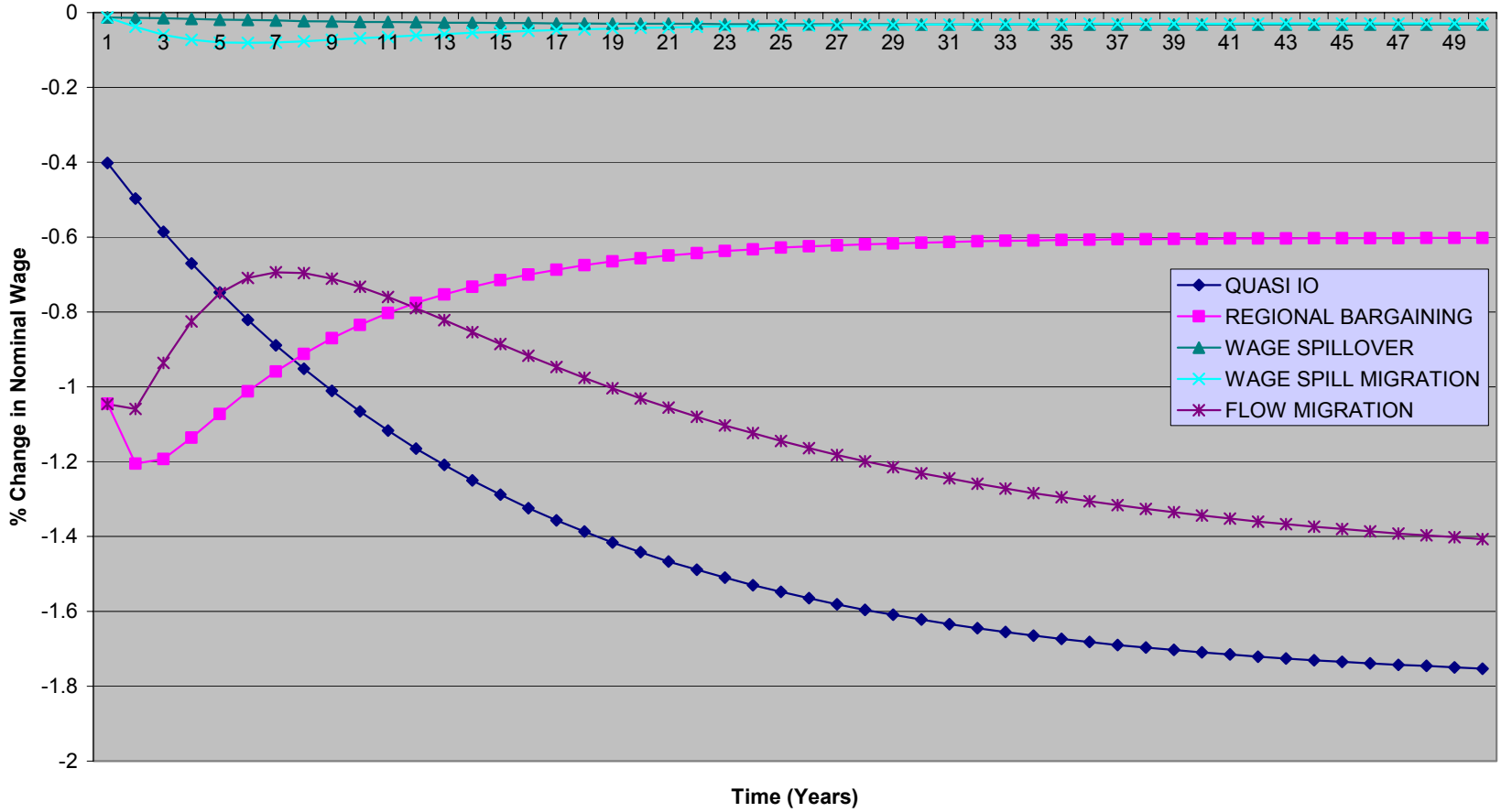


Figure 5
Scottish Real Wage: % Change from Base

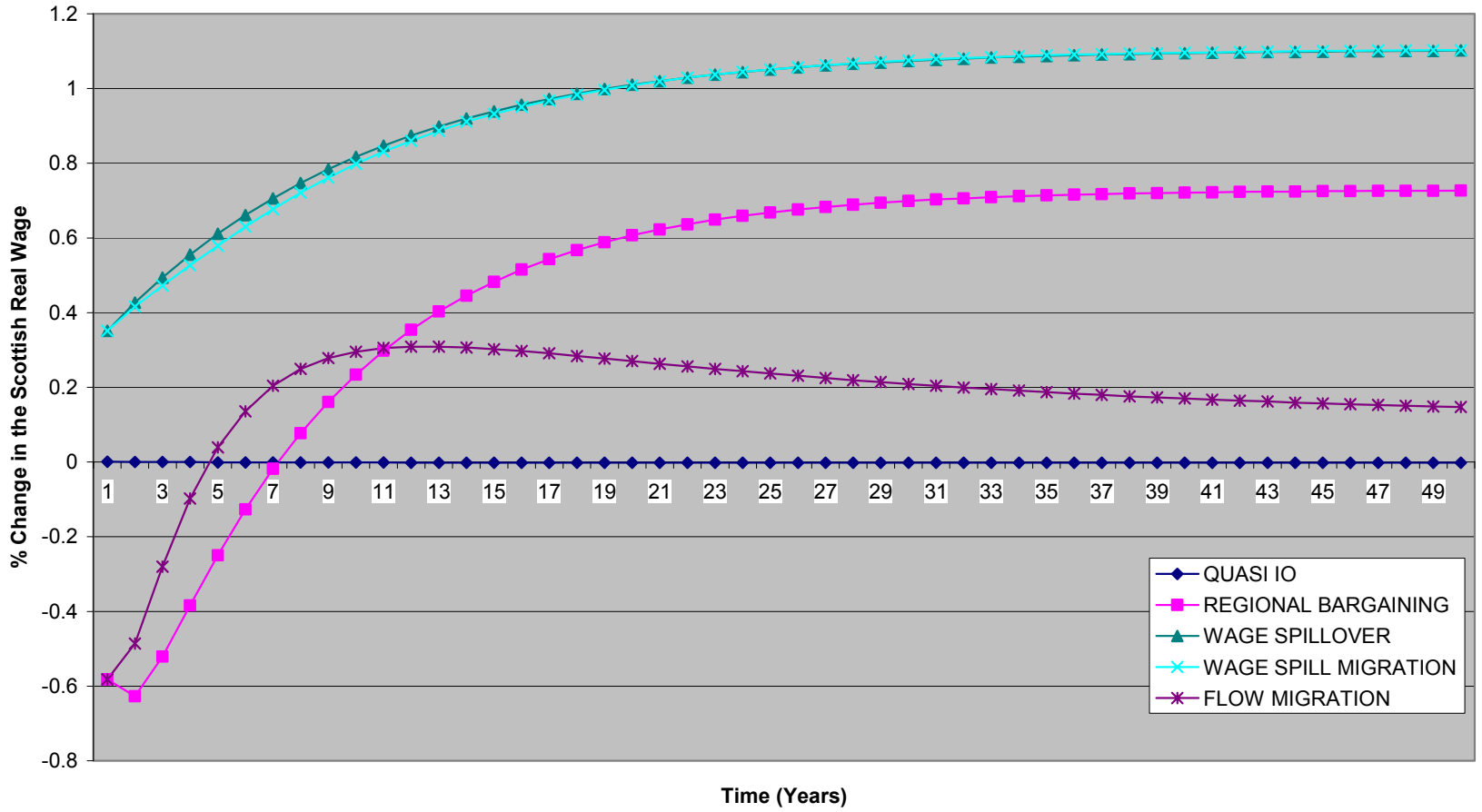


Figure 6
Scottish Exports to RUK: % Change from Base

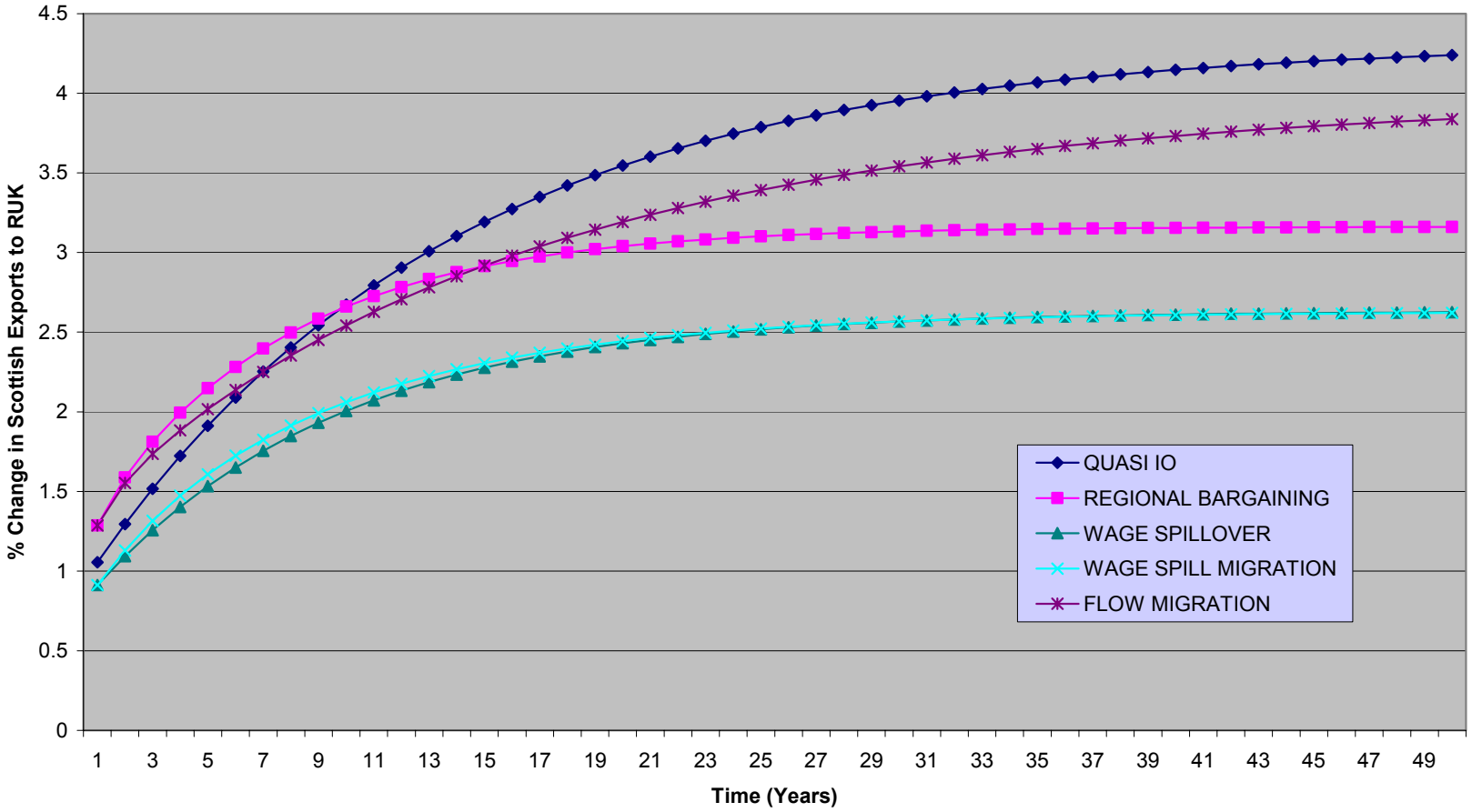


Figure 7
Scottish Exports to ROW: % Change from Base

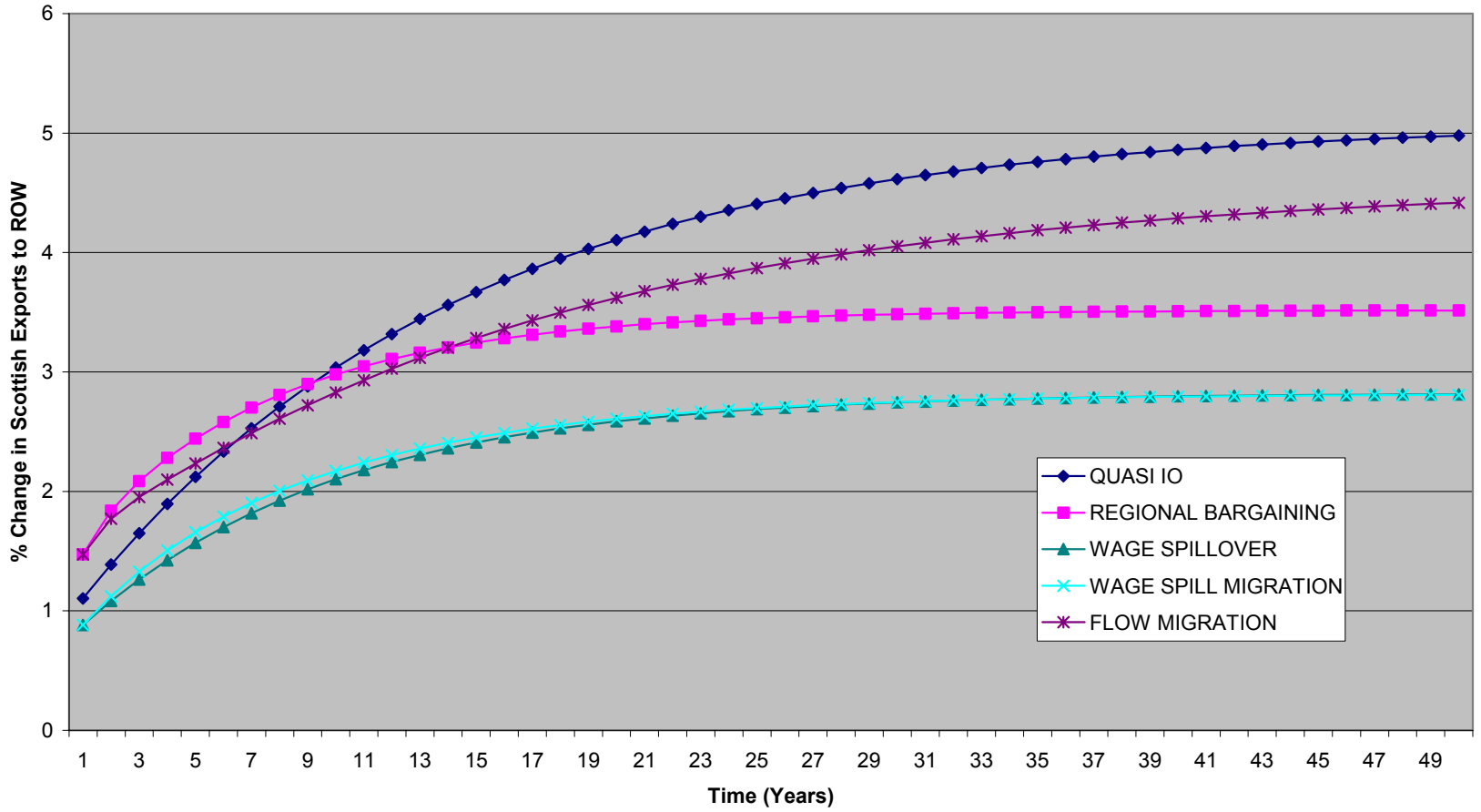


Figure 8
Scottish GDP: Absolute Change from Base (£m)

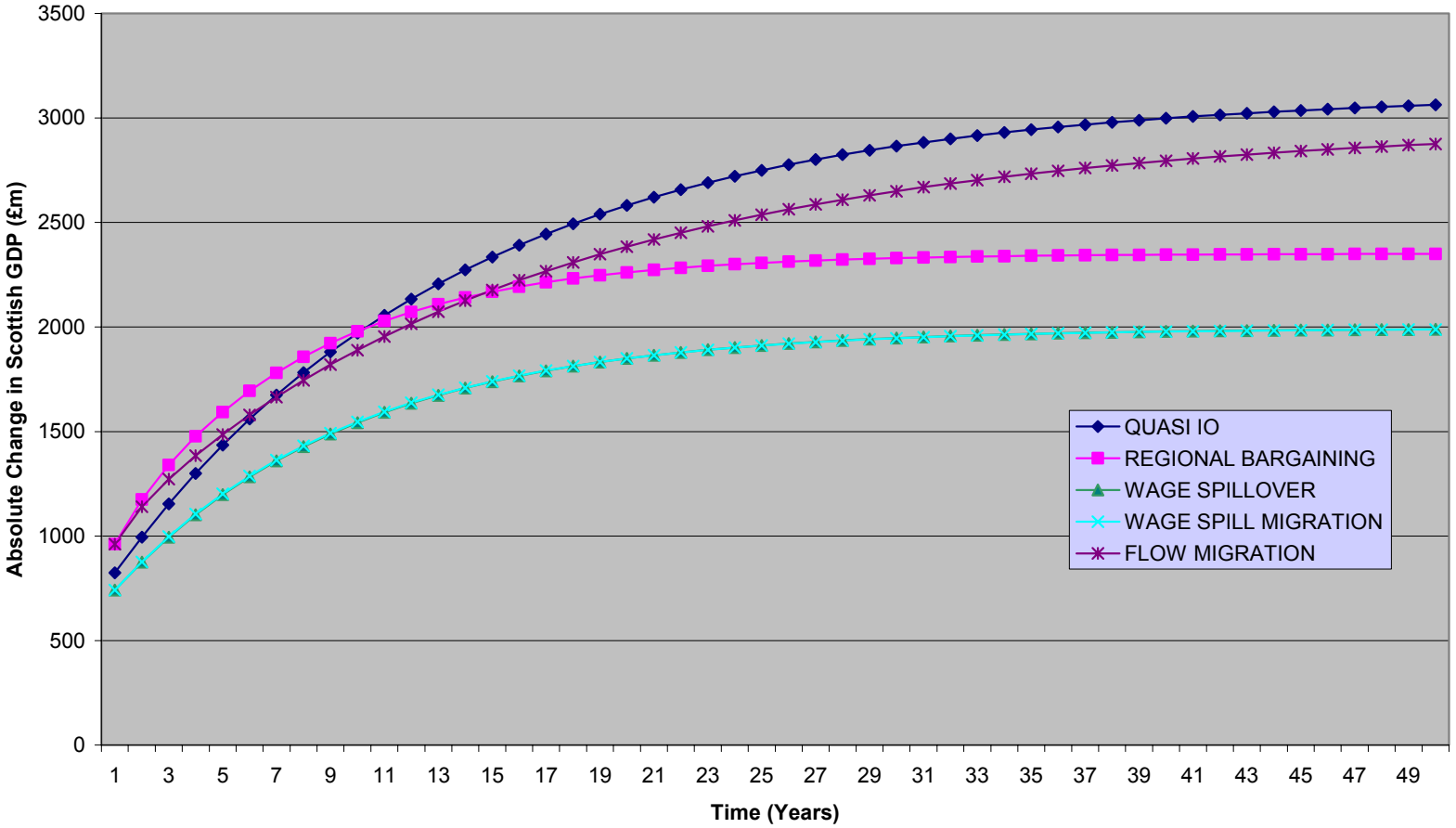


Figure 9
Total Scottish Employment: Absolute Change from Base (000s)

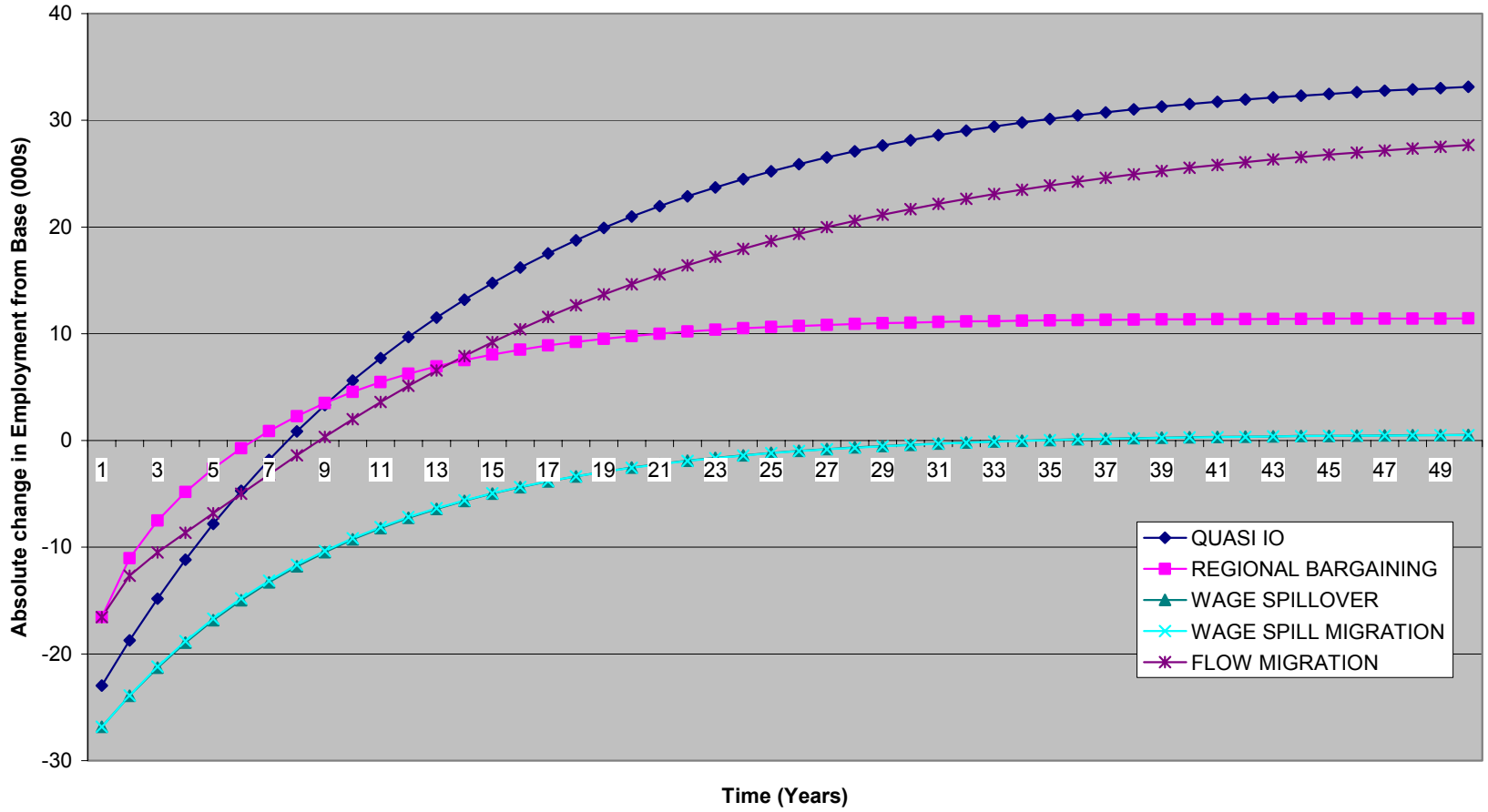


Figure 10
Scottish Traded Sector Employment: % Change from Base

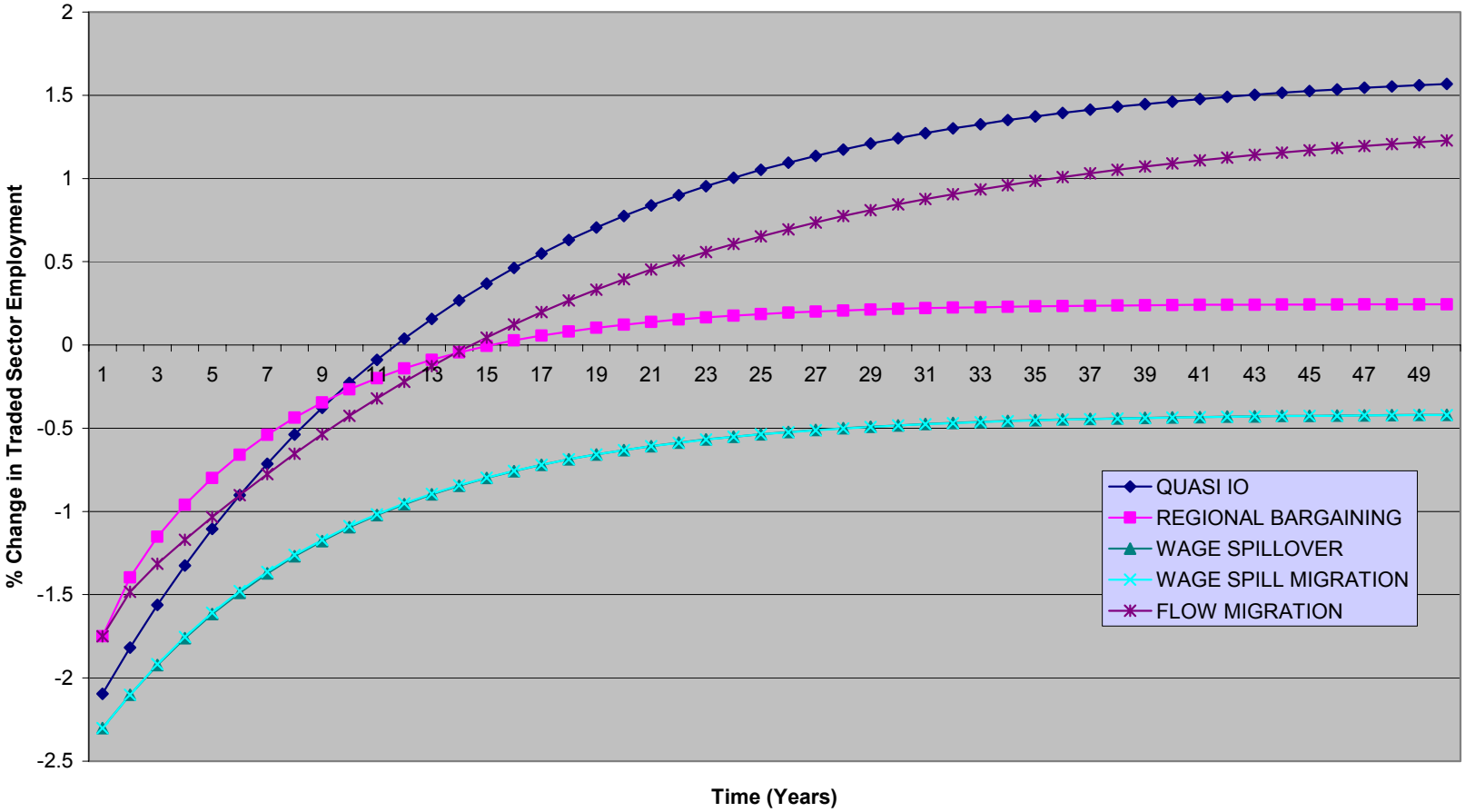


Figure 11
Scottish Sheltered Sector Employment: % Change from Base

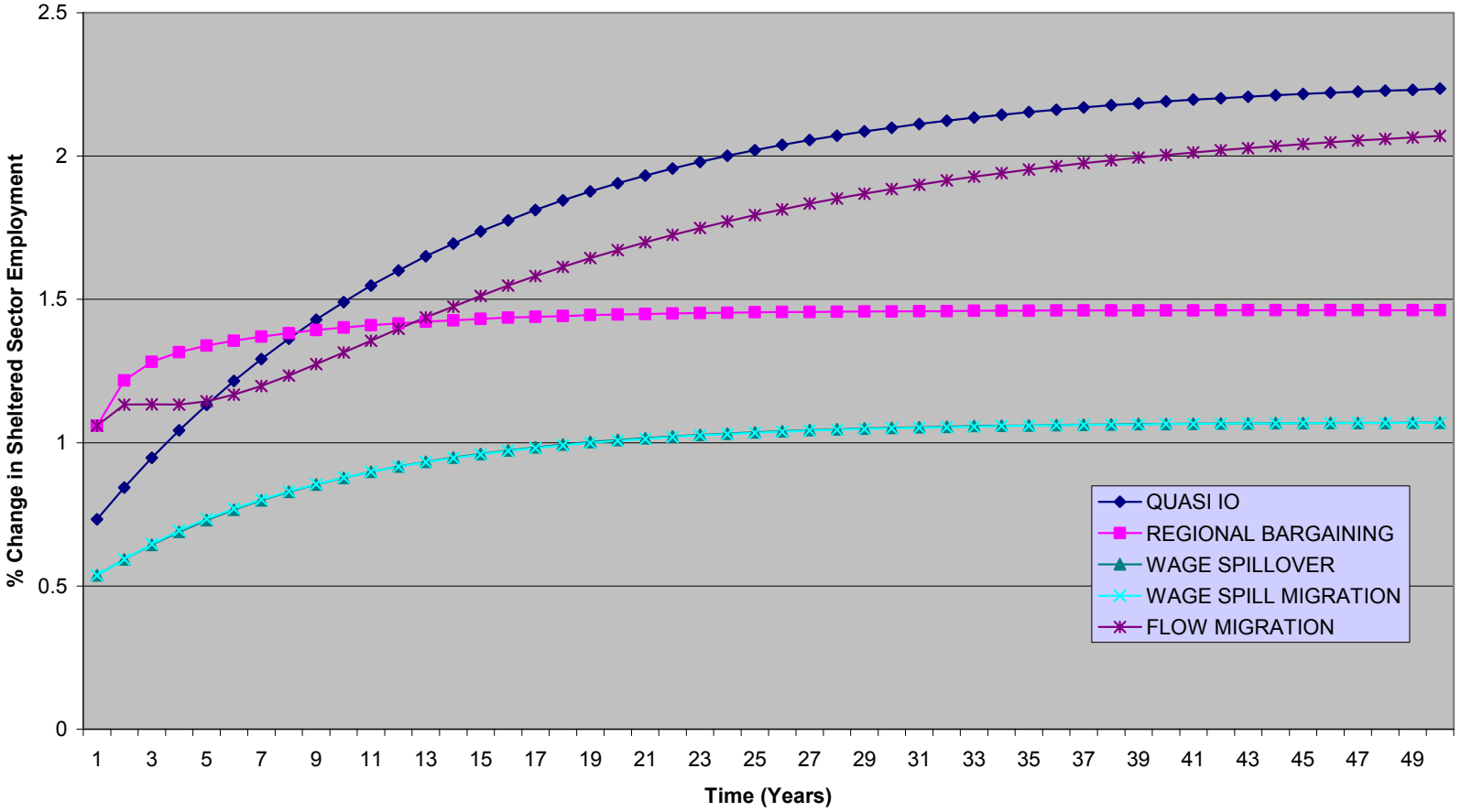


Figure 12
Scottish Population: Absolute Change from Base (000s)

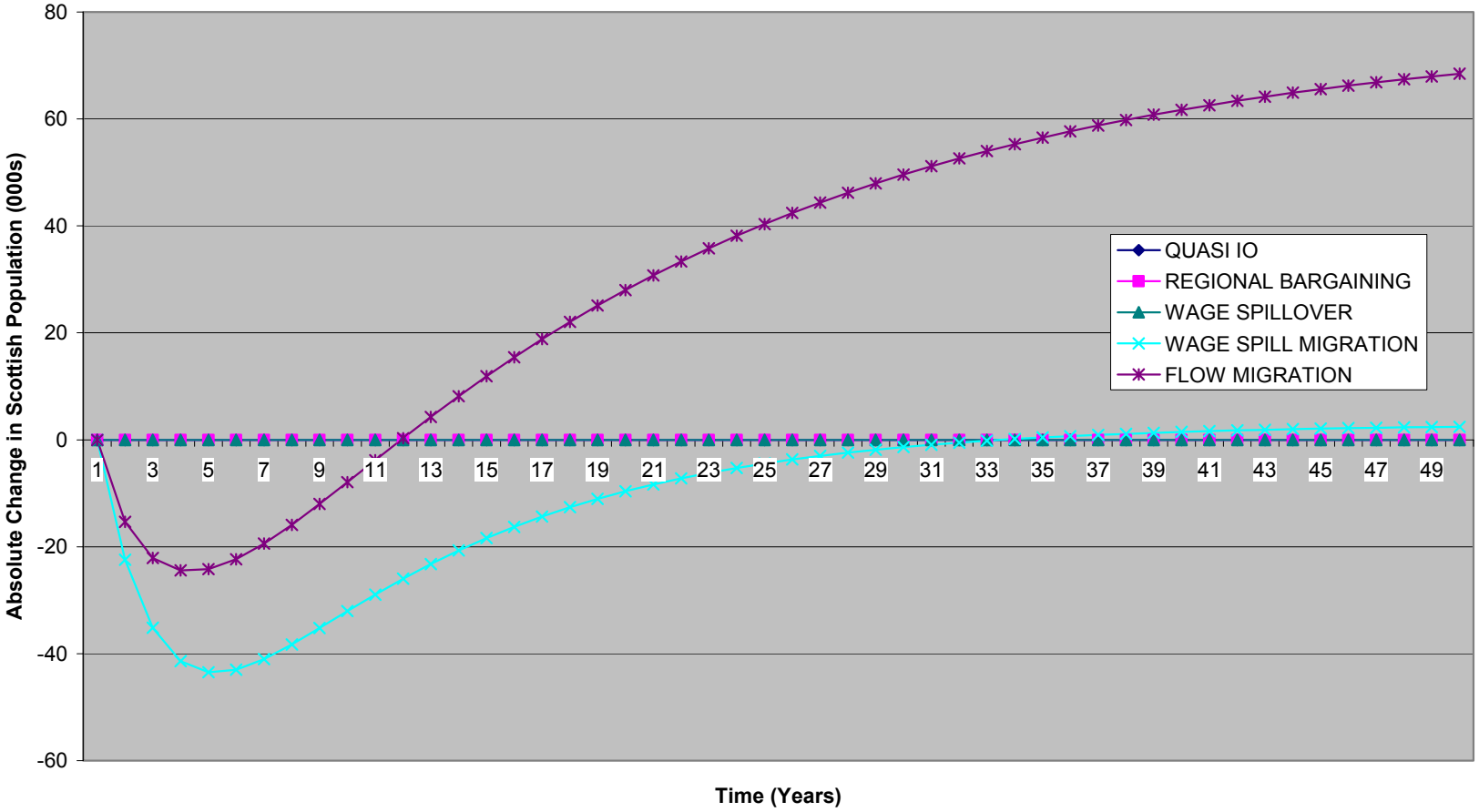


Figure 13
RUK Price of Value Added: % Change from Base

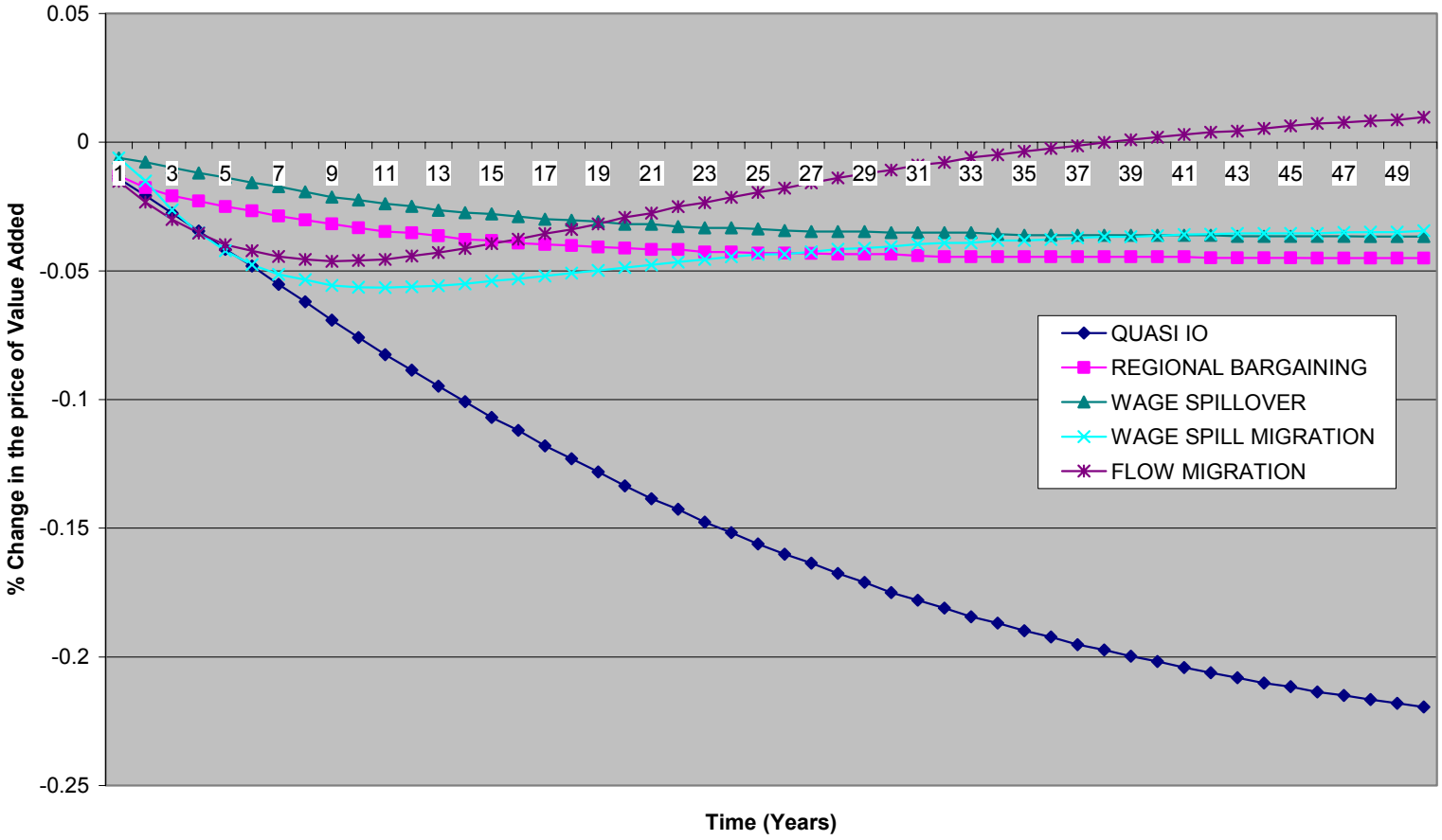


Figure 14
RUK Price of Commodity Outputs: % Change from Base

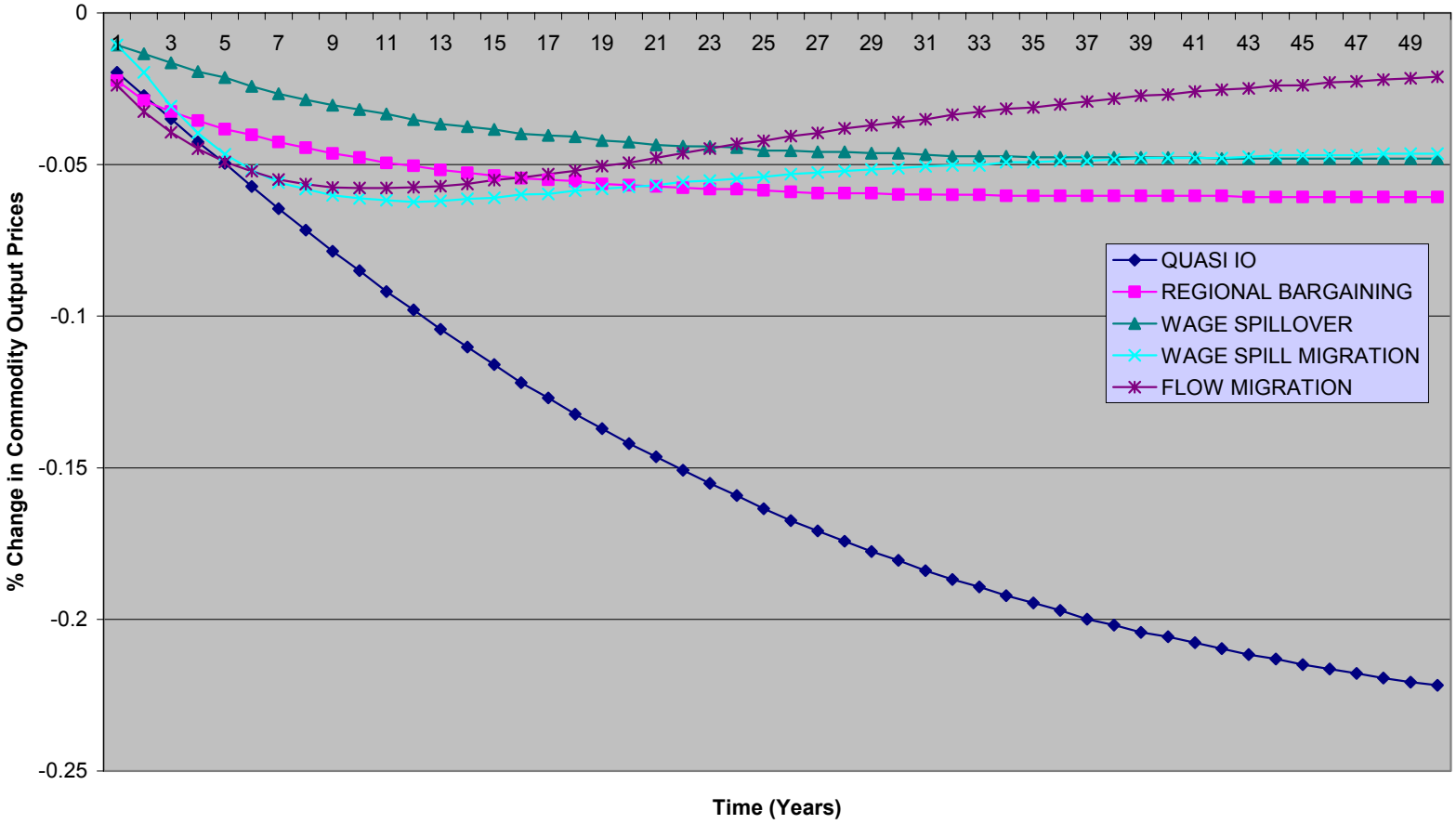


Figure 15
RUK CPI: % Change from Base

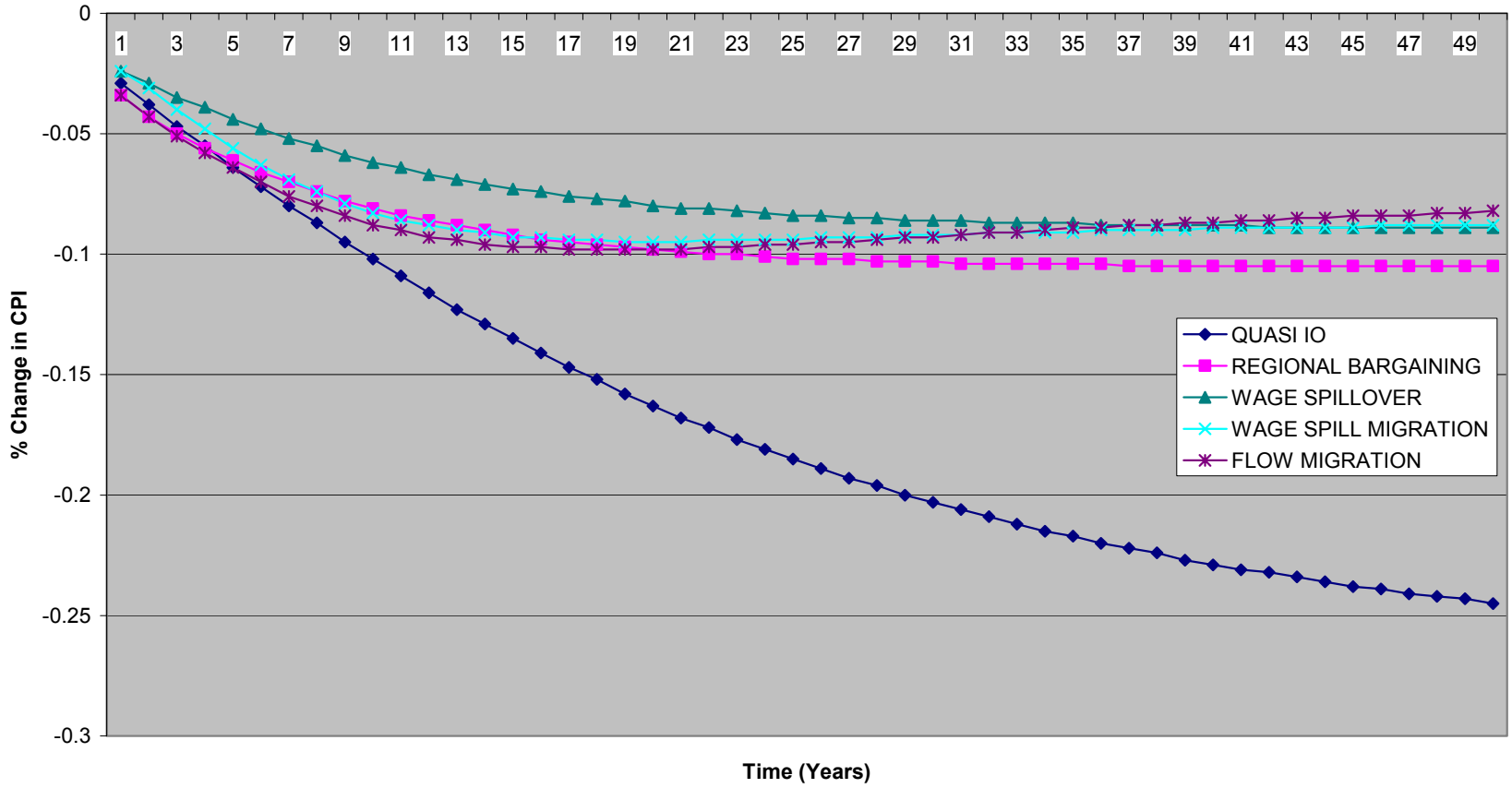


Figure 16
RUK Nominal Wage: % Change from Base

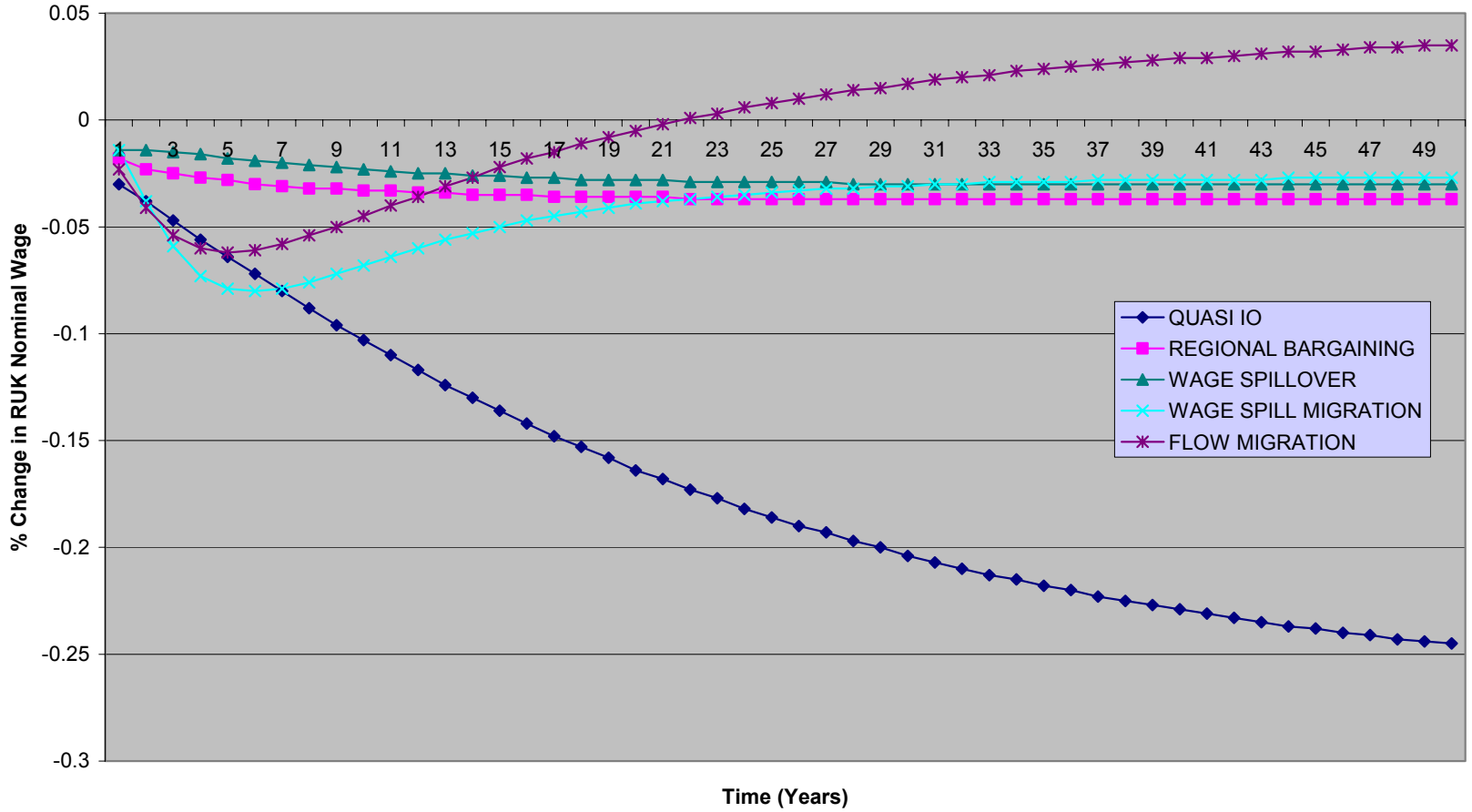


Figure 17
RUK Real Wage: % Change from Base

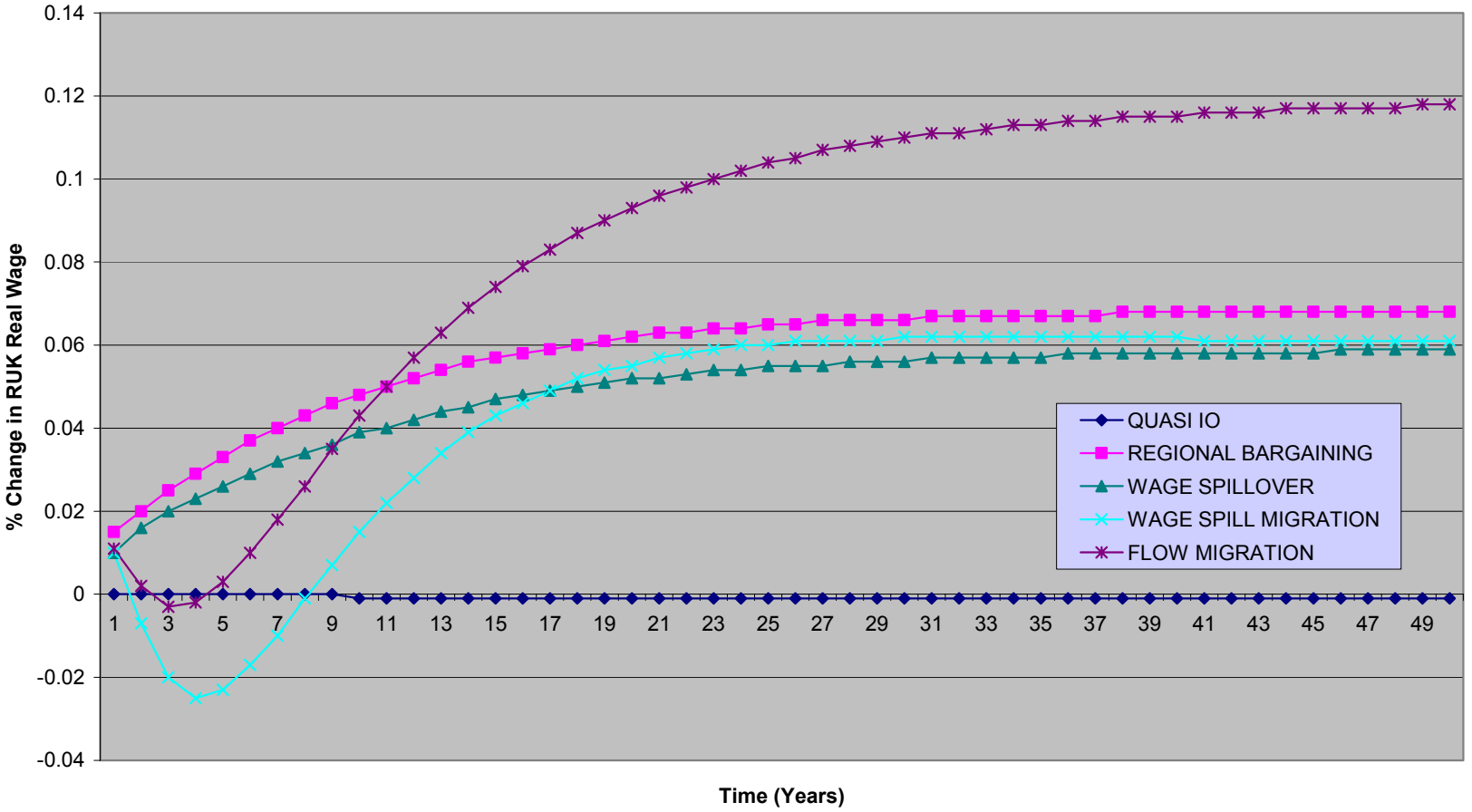


Figure 18
RUK Exports to Scotland: % Change from Base

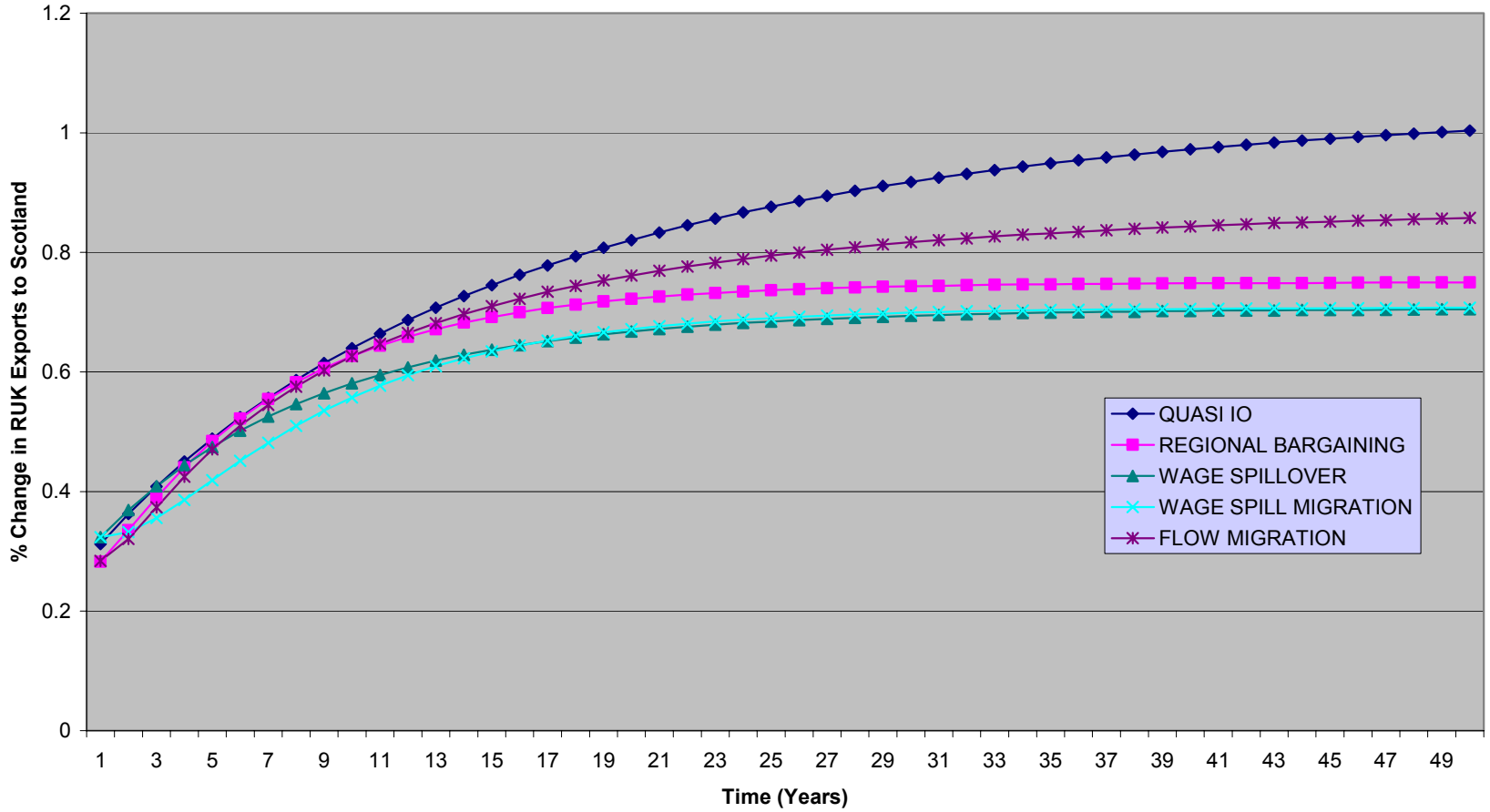


Figure 19
RUK Exports to Rest of the World: % Change from Base

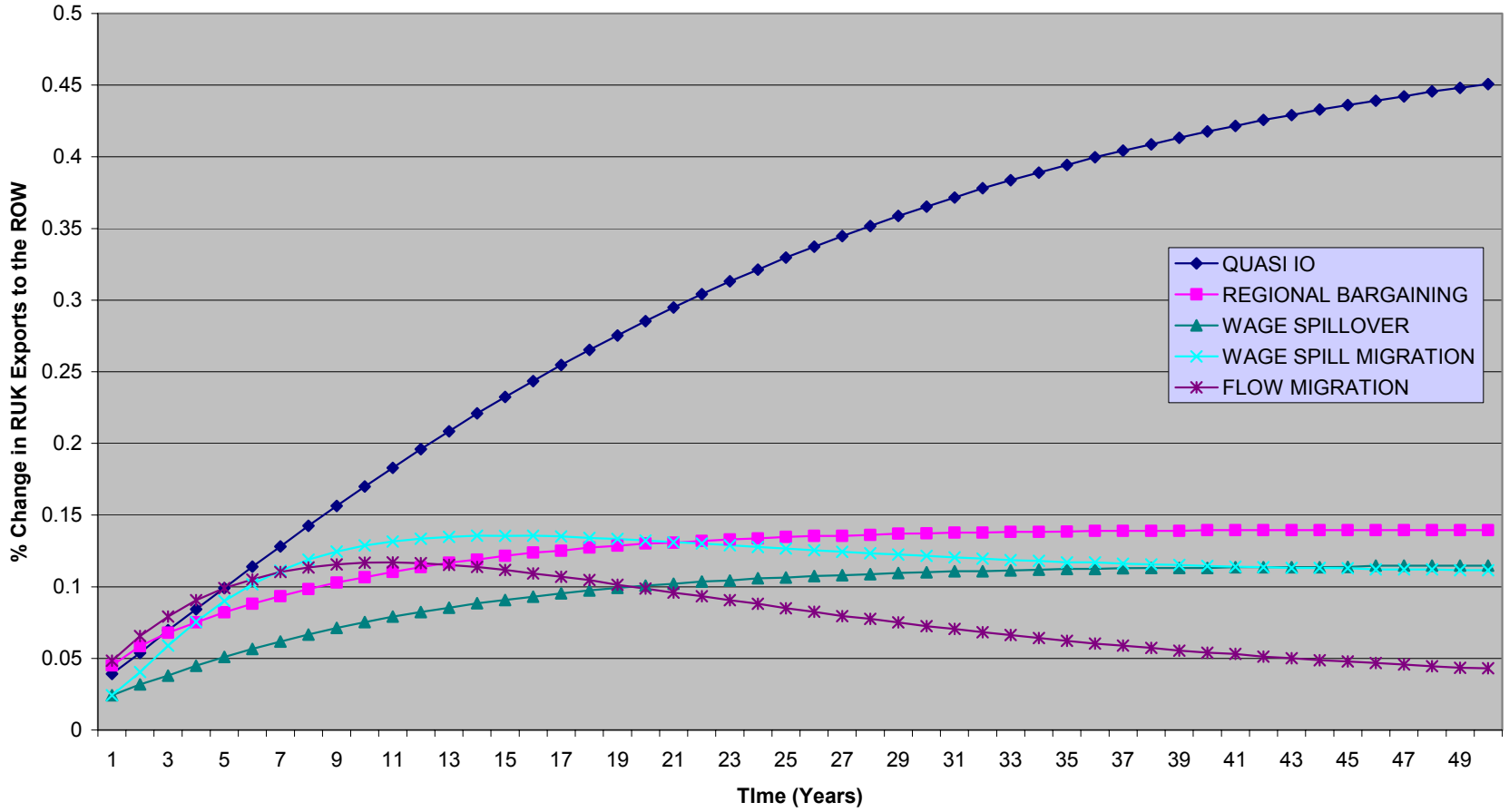


Figure 20
RUK GDP: Absolute Change from Base (£m)

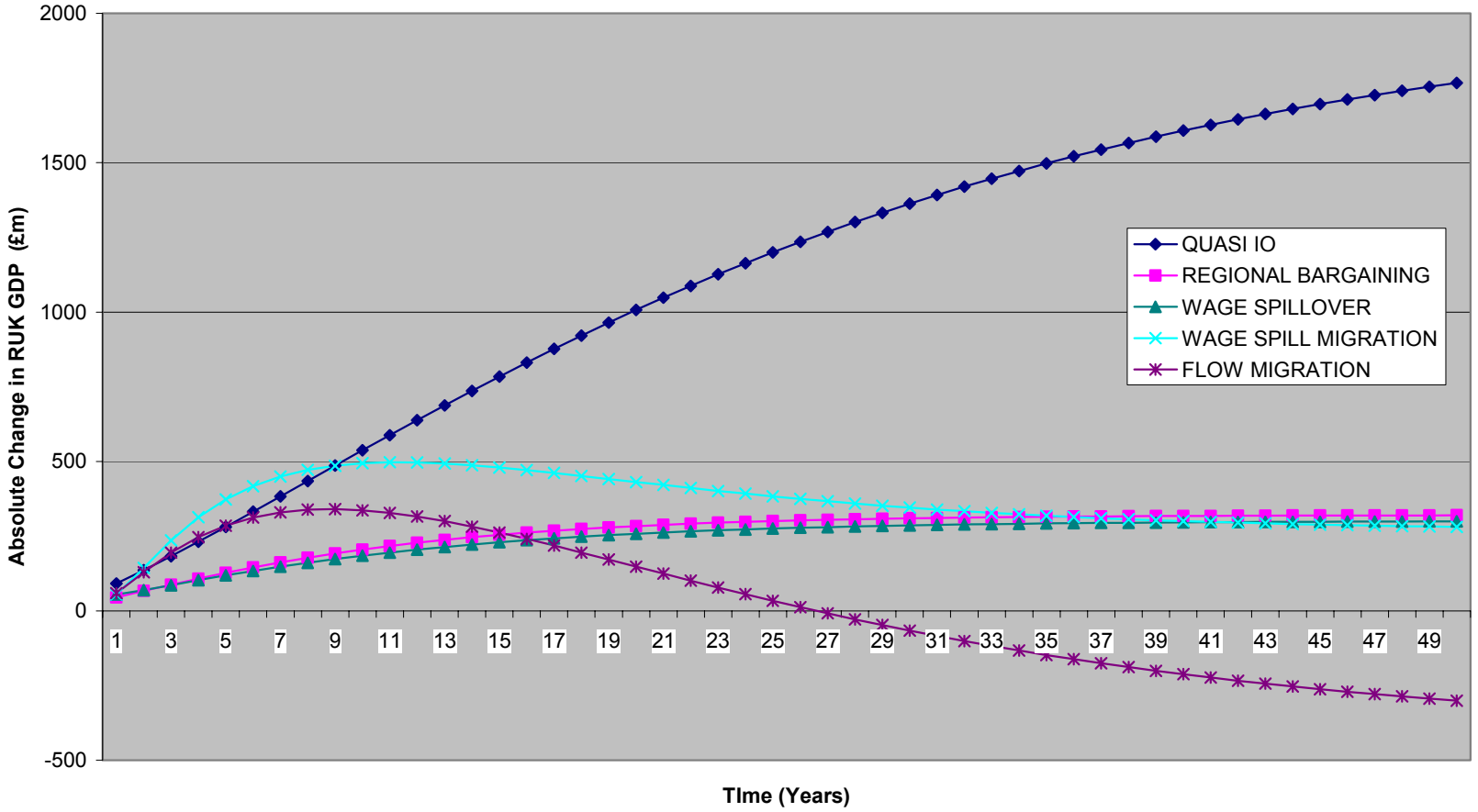


Figure 21
RUK Total Employment: Absolute Change from Base (000s)

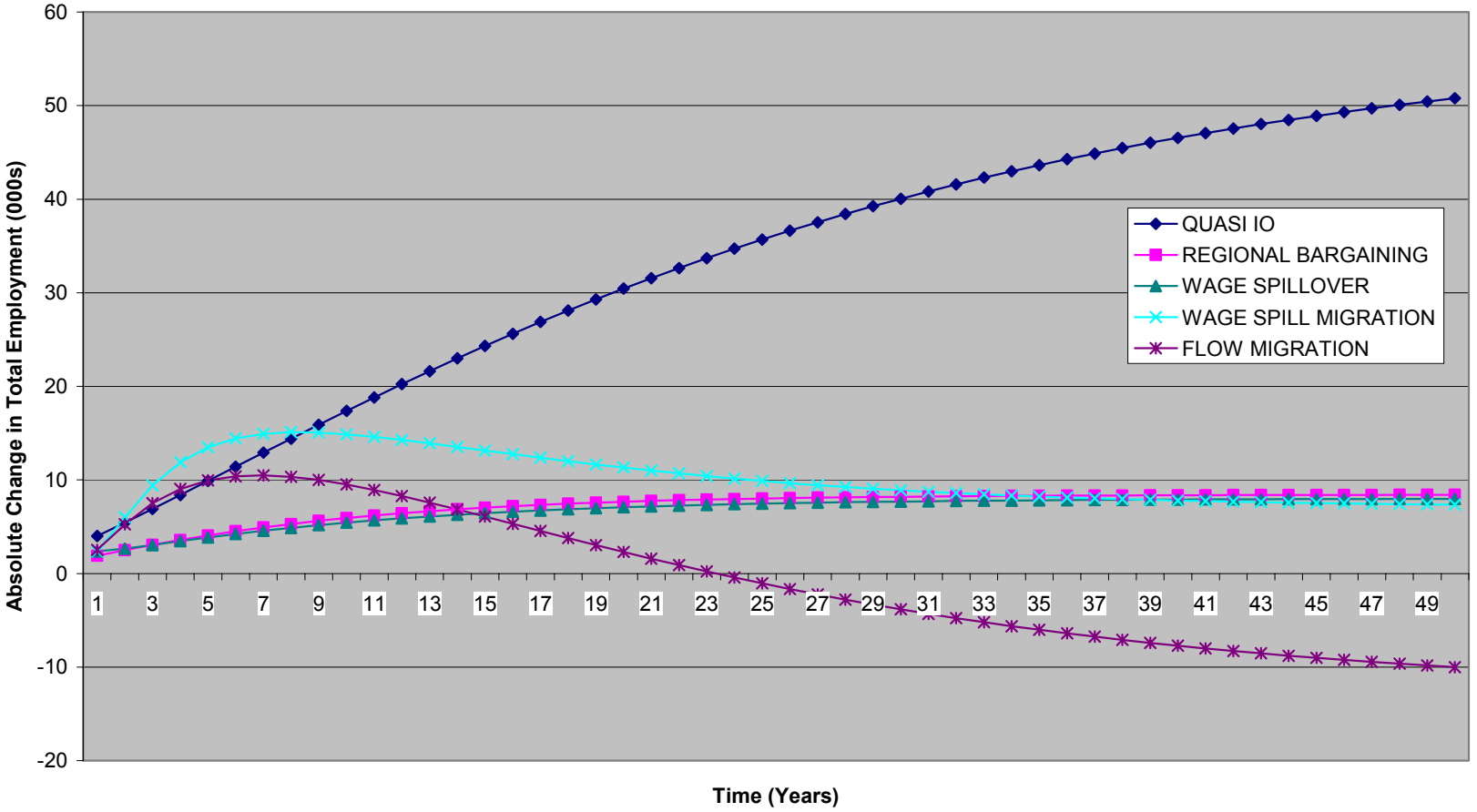


Figure 22
RUK Traded Sector Employment: % Change from Base

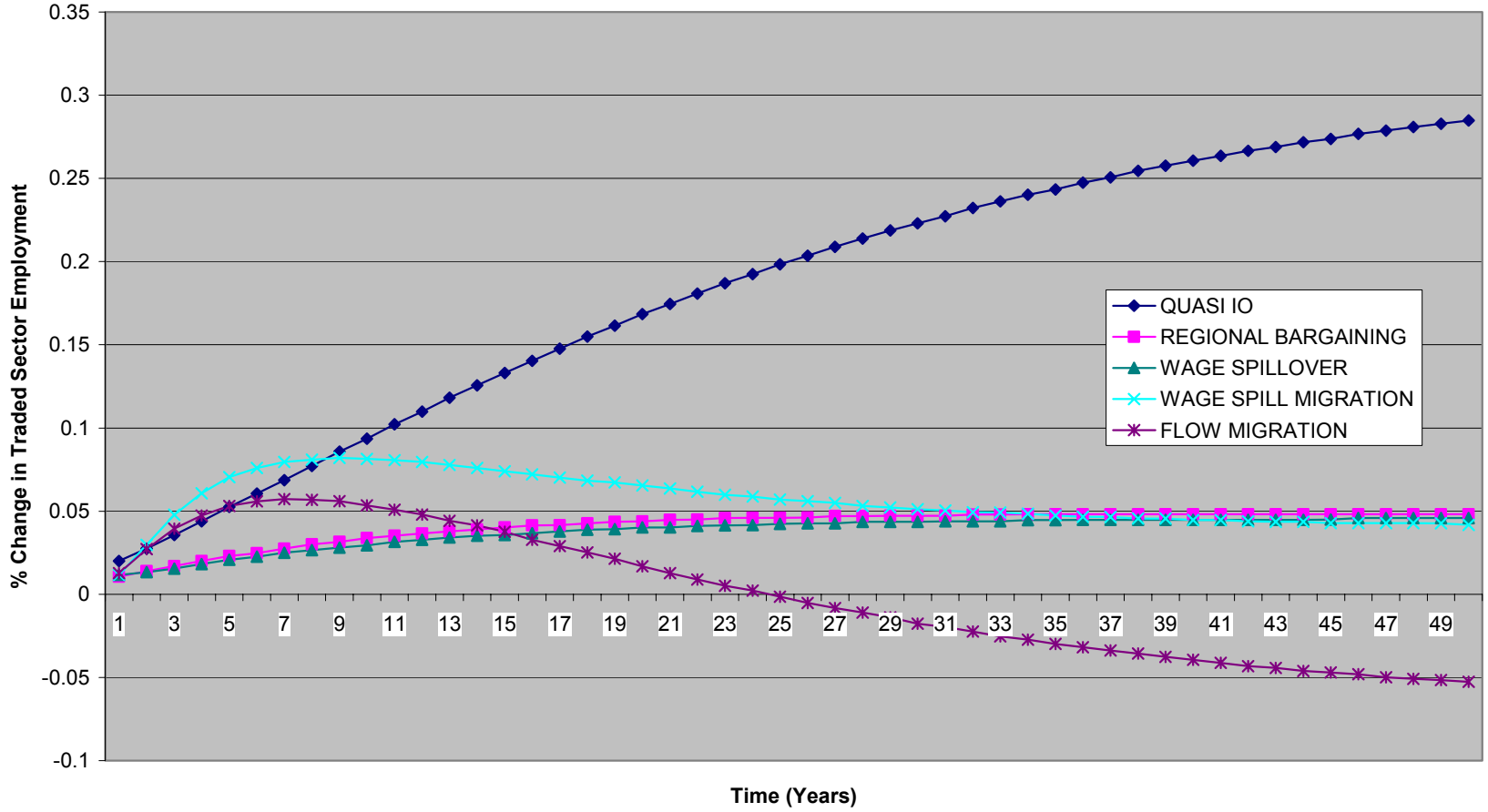


Figure 23
RUK Sheltered Sector Employment: % Change from Base

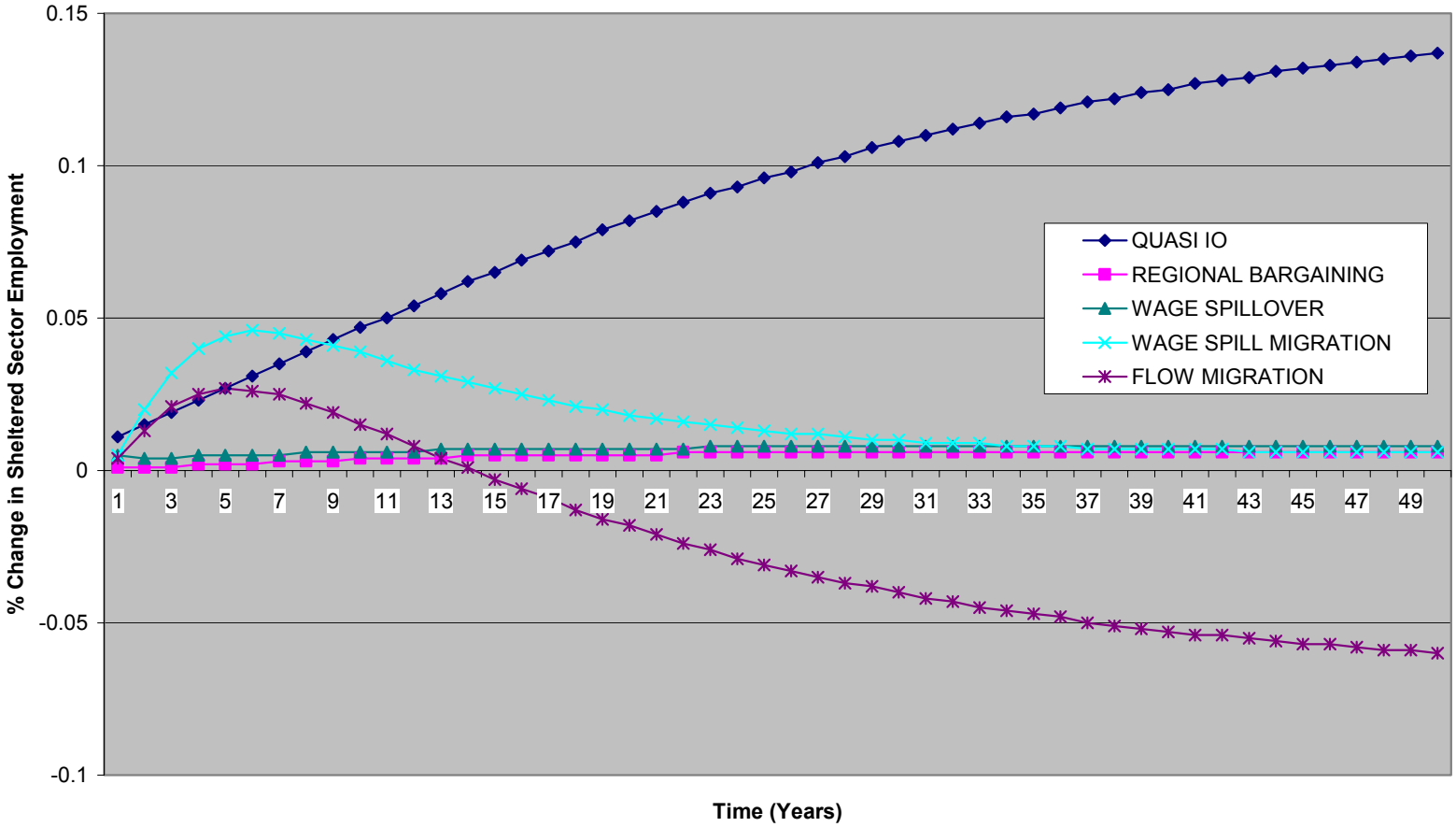
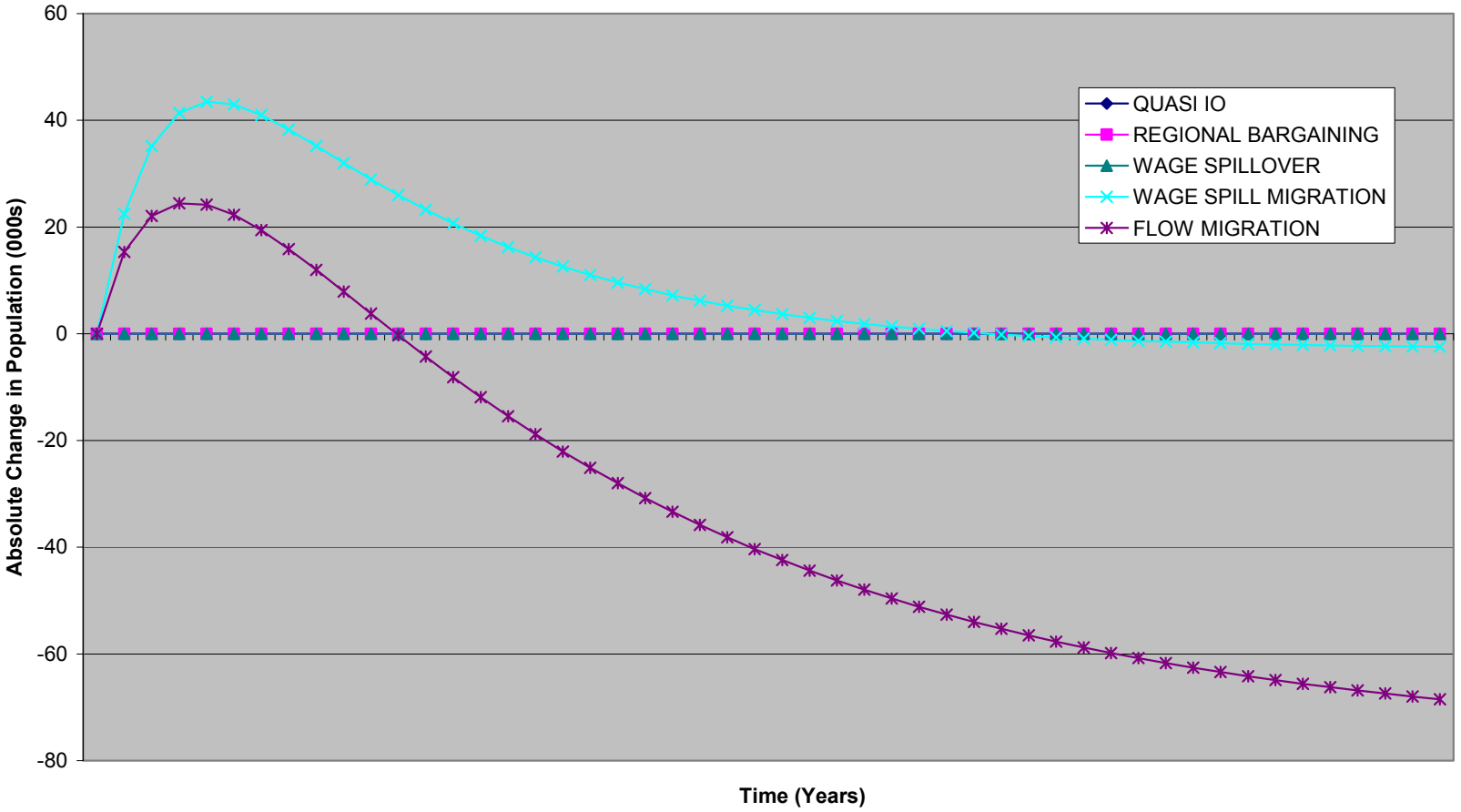


Figure 24
RUK Population: Absolute Change from Base (000s)



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