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

BY

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The National Impact of Regional Policy: Demand-Side Policy Simulation with Labour Market Constraints in a Two-Region Computable General Equilibrium Model.

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The National Impact of Regional Policy: Demand-Side Policy Simulation with Labour Market Constraints in a Two-Region Computable General Equilibrium Model.

Abstract

UK governments generally advocate regional policy as a means of reducing regional disparities and stimulating national growth. However, there is limited comprehension regarding the effects of regional policy on non-target economies. This paper examines the system-wide effects on the Scottish and rest of UK (RUK) economies of an increase in Scottish traded sector exports to the rest of the world. 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 exports to the rest of the world (ROW) from 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 expand 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' scheme[1]. This paper explores the consequences of a successful policy designed to stimulate exports, though it does not explicitly consider the policies that could potentially achieve this effect. Secondly, despite the UK Government having promoted regional policy 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[2]. 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, and to what extent.

The discussion is structured in the following way: Section 2 outlines the AMOSRUK modelling framework and Section 3 describes the alternative labour-market model

[1] 'A Smart, Successful Scotland: Ambitions for the Enterprise Networks', The Scottish Executive, January 2001.

[2] 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 less common.

configurations used in the simulations. Section 4 reports the results of the model simulations and Section 5 concludes.

2. AMOSRUK: A Computable General Equilibrium Framework

AMOSRUK, the inter-regional version of the AMOS[3] 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 detailed in Section 3 and in Table 1.

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 a 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.

[3] 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) and McGregor et al (1999) describe the inter-regional model AMOSRUK. Greenaway et al (1993) gives a general appraisal of CGE models and Partridge and Rickman (1998) reviews regional CGEs.

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. 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. 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 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 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. 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 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 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.

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 Bargaining 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, the presence of migration allows for a unified national labour market: an increase in regional demand lowers regional unemployment and induces migratory flows into that region. This equally affects the log of the real wage in both regions, while 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 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 Scottish economy: an increase in Scottish exports to the rest of the world (ROW). There are two reasons for choosing an export-led demand shock. The first is conceptual. The effects of a demand disturbance within a conventional, purely demand-driven single and multi-regional IO model are already well understood[4]. 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 successful demand stimulus. Secondly, the shock being considered relates closely to one of the policy priorities identified by the Scottish Executive. Increasing Scottish exports has been identified as a key objective of the Executive's 'Framework for Economic Development' (2004). Further, the shock replicates the direct impact expected from one of the policy priorities identified

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

by Scottish Enterprise under the Development Agency's 'Global Connections' strategy[5].

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). The model is run forward for 50 periods with the values of all other exogenous variables held constant, and the percentage change or the absolute change from the initial base-period values is 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 similarly adjusted from period to period. 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 1-26 show the trajectories for the change in key variables relative to base for the five model configurations: Figures 1-13 relate to the Scottish economy; Figures 14-26 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 variables are reported in percentage terms. Some key variables (such as capital rental rates, 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[6]. Each variable is expressed in terms of its change (absolute or percentage) relative to base.

[5] The Scottish Executive (2001).

[6] 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 upon the Scottish

4.1 QUASI IO: SCOTTISH ECONOMY EFFECTS

Figure 1 shows the projections for the change in Scottish GDP 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 the end of the simulation period. 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 (Figure 2). This confirms previous long-run simulation results 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[7]. 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 dictates supply restrictions. As output expands, prices rise in the short-run. Capital rental rates increase on average across all sectors by 1.41% and 1.3% relative to base in periods 2 and 3 respectively (Figure 10). 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.

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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. Therefore, imposing a 5% export shock on the traded sector does not equate to a 5% increase in whole-economy exports. A 5% increase in traded sector exports would, assuming no change in sheltered sector exports, translate to an approximate increase in total exports of 4.8%.

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

Traded sector commodity outputs are 0.5% higher than base values in Period 3, compared with 0.28% for the sheltered sector.

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 the end of the simulation period. 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), but only in response to the increase in the regional CPI in the shorter-run (Figure 2). These increases in nominal wages and CPI do result in a negative competitiveness effect in the short-run. The reverse is true in the long-run, however: as prices and nominal wages return towards their base values in the Quasi IO scenario, this labour market configuration results in the highest increase in ROW exports over base.

Table 2: Quasi IO Summary Results

	Period 3		Period 50	
	Scotland	RUK	Scotland	RUK
GDP	275,430	44,438	880,371	694,630
	0.44%	0.01%	1.41%	0.10%
Total employment	9,913	1,442	25,138	19,220
	0.52%	0.01%	1.33%	0.09%
Traded sector employment	0.68%	0.01%	1.69%	0.11%
Sheltered sector employment	0.18%	0.00%	0.53%	0.05%
CPI	0.31%	0.08%	0.01%	0.01%
Commodity output prices	0.47%	0.08%	0.02%	0.01%
Price of value added	0.69%	0.08%	0.02%	0.01%
Nominal wage	0.32%	0.08%	0.01%	0.01%
Real wage	0.00%	0.00%	0.00%	0.00%
Exports to the other region	-0.60%	1.17%	0.21%	1.49%
Exports to ROW	2.48%	-0.15%	3.41%	-0.02%

4.2 QUASI IO: RUK ECONOMY EFFECTS

In the Quasi IO case and for the RUK economy, the 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 14). This reflects the absence of RUK population constraints in this model set-up. As is apparent from Table 2, in this scenario the 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 17), so that, as output expands, the RUK economy does not experience negative competitiveness effects generated directly through the labour market. Nominal wages do increase in response to rising CPI in the short-run, but both variables move back towards their base values over time (Figures 18 and 15 respectively)

In the short-run, as RUK commodity outputs increase across all sectors, prices increase. There does, therefore, exist a negative external competitiveness effect at this stage; exports to the ROW fall by 0.16% relative to base in the period immediately following the shock (Figure 19). Nevertheless, exports to Scotland increase by 1.08% relative to base in the same period (Figure 20), contributing to an overall relative GDP stimulus (Figure 14). Over time, capacity constraints relax, prices move back towards their base year values and the negative external competitiveness effect is removed.

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 (Figure 4).

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 inter-regional migration, real wages rise, reflecting the tightness of the regional labour market (Figure 4). Commodity output prices therefore rise relative to base (Figure 8), as does the overall CPI (Figure 2). This represents a significant negative competitiveness effect: real wages are 0.56% higher than base by the end of the simulation period (compared with a 0% 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, the effect remains significant for the duration of the simulation period in this set-up, 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 much lower (ROW exports increase by 2.37% relative to base by the end of the simulation period in the Bargaining scenario, compared with 3.41% under the Quasi IO case). This is reflected in the weaker GDP stimulus under this market set-up, and accounts for a more subdued increase in total Scottish employment relative to base over the period (Figure 3)[8]. In particular, sheltered sector employment falls compared with its base value over the period (Figure 11), in line with a relative fall in sheltered sector exports to both the RUK and the ROW.

[8] These results are in line with 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.

Table 3: Bargaining Scenario Summary Results

	Period 3		Period 50	
	Scotland	RUK	Scotland	RUK
GDP	173,851	23,812	359,410	124,500
	0.28%	0.0%	0.57%	0.02%
Total employment	5,655	610	8,818	2,650
	0.3%	0.00%	0.47%	0.01%
Traded sector employment	0.44%	0.00%	0.7%	0.02%
Sheltered sector employment	-0.02%	-0.02%	-0.04%	0.00%
CPI	0.36%	0.08%	0.32%	0.07%
Commodity output prices	0.59%	0.08%	0.53%	0.08%
Price of value added	0.86%	0.08%	0.71%	0.08%
Nominal wage	0.69%	0.09%	0.88%	0.09%
Real wage	0.32%	0.00%	0.56%	0.02%
Exports to the other region	-0.76%	1.18%	-0.57%	1.36%
Exports to ROW	2.23%	-0.16%	2.37%	-0.15%

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 (Figure 14). Furthermore, the stimulus to RUK activity is small relative to the Scottish economy effects (Table 3), reflecting the indirect nature of the demand shock.

In this scenario, increased demand for RUK intermediate inputs and consumption and investment goods results in a rise in RUK exports to Scotland (Figure 20). In fact, the changes in Scottish exports to the RUK 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 19), 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 17). This reduces RUK competitiveness relative to the Quasi IO case, leading to a

larger fall in ROW exports (Figure 19) and increasing import penetration. This contributes to a significantly lower GDP stimulus in this case relative to the Quasi IO scenario. By the end of the simulation period, GDP is 0.02% higher relative to base in this scenario, compared with 0.1% in the Quasi IO case.

4.5 FLOW MIGRATION: SCOTTISH ECONOMY EFFECTS

As in the previous two scenarios, the demand shock also results in a relative increase in Scottish GDP when migration is introduced. The source of the long-run boost remains the same: 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, works to mitigate to some extent this negative effect in Scotland. This results in the flow migration case having the fourth largest long-run GDP increase: only the Bargaining scenario provides a lower increase in GDP over base, but significantly so.

Under this scenario, immediately following the demand shock, the prices of value-added and commodity outputs rise in the traded sectors, and economy-wide prices increase relative to base (Figure 2). As in the Bargaining scenario, the resultant increase in output and the reduction in unemployment mean that real wages are bid up (Figure 4). The effects on activity immediately following the shock are quantitatively very similar for the Flow Migration and Bargaining cases: total employment increases by 0.27%, output by 0.18% and real wages by 0.19% relative to base in the first period following the shock, for both scenarios. This is because the model set-ups are identical but for the inclusion of migration in the former, and population flows have no real impact until period two onwards. Only in the longer-run are migratory effects relatively large (Figure 13). Over time, unemployment and wage rates adjust in response to the shock, and the labour supply migrates accordingly.

The long-run effects for these two configurations are significantly different, however, owing to the different adjustment mechanisms that are in place for each set-up. By period 50, the relative increase in GDP is 1.29% for the Flow Migration case in Scotland, compared with 0.57% for the Bargaining scenario. In absolute terms, the increase in GDP in the Bargaining scenario is less than 50% of that of the Flow Migration increase.

In this set-up, as in the Bargaining scenario, the increase in real wages and consumer prices brings about a negative competitiveness effect, offsetting to some extent the demand shock (albeit that the overall increase in economic activity remains positive, with the negative supply-side effect from the wage increase being small relative to the demand injection). Whilst in the Bargaining scenario this 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, labour supply migrates away from the RUK economy into the Scottish economy, where unemployment is relatively lower and real wages relatively higher. 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 the RUK labour supply. Thus the presence of inter-regional migration, and the increase in labour supply in Scotland, works to reverse the increase in 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 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 generates a more competitive environment for trade. Scottish exports to the RUK are 0.01% higher than base values in period 50, compared with a relative fall of 0.57% for the Bargaining scenario, and Scottish exports to the ROW are 3.13% higher, compared with 2.37% 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 case, where the real wage increase is zero, the price increases more subdued and the negative competitiveness effect least prevalent (Figure 1).

Table 4: Flow Migration Summary Results

	Period 3		Period 50	
	Scotland	RUK	Scotland	RUK
GDP	200,066	-11,000	808,340	-446,687
	0.32%	0.00%	1.29%	-0.06%
Total employment	6,833	-886	22,968	-14,079
	0.36%	0.00%	1.21%	-0.07%
Traded sector employment	0.50%	0.00%	1.55%	-0.07%
Sheltered sector employment	0.04%	-0.01%	0.47%	-0.06%
CPI	0.36%	0.08%	0.12%	0.09%
Commodity output prices	0.56%	0.08%	0.15%	0.11%
Price of value added	0.82%	0.09%	0.18%	0.13%
Nominal wage	0.58%	0.10%	0.19%	0.16%
Real wage	0.23%	0.01%	0.07%	0.06%
Exports to the other region	-0.73%	1.19%	0.01%	1.46%
Exports to ROW	2.28%	-0.17%	3.13%	-0.22%

4.6 FLOW MIGRATION: RUK EFFECTS

In contrast to the effects on the Scottish economy, the introduction of inter-regional migration makes for an overall reduction in long-run GDP relative to base for the RUK (Figure 14). By the end of the simulation period, RUK GDP is 0.06% below its base value. 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 20). This is the source of the relative increase in economic activity in the Bargaining scenario, but the presence of 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 the labour supply flows into the Scottish economy (Figure 26), and the RUK economy experiences an adverse supply shock in the form of a loss of labour supply. In period 50, the RUK population is 59,025 lower relative to base[9].

The increase in demand for RUK goods from the Scottish economy, combined with labour supply shortages, means that there is still upward pressure on commodity output prices and overall CPI in the RUK economy (Figure 15). This causes a detrimental effect on RUK exports to the ROW (Figure 19). In the Scottish economy, the size and direct nature of the demand stimulus are sufficient to far outweigh the negative competitiveness effects that result from the responsiveness of wages in the Bargaining and Flow Migration scenarios. In contrast, this is not the case in the RUK economy, where the size of the stimulus is relatively small. For the Flow Migration closure, the negative competitiveness effect prevails, contributing to a fall in GDP relative to base over the simulation period (Figure 14).

4.7 WAGE SPILLOVER (1) AND MIGRATION WAGE SPILLOVER (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 around 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 the labour supply helps to reverse this in the long-

[9] Lisenkova et al (2007) 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.

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 is fairly limited, as are the effect on the RUK real wage and the Scottish nominal wage (Figures 17 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 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 inter-regional imports to Scotland, labour demand rises in the RUK in the Wage Spillover (1) set-up (Figure 16). 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 also remain fixed at the regional level. Furthermore, in this 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 a smaller increase in nominal wages compared with the other model scenarios, 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 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 and an increase in Scottish exports to the RUK. This explains the slightly lower long-run GDP increase over base relative to the Quasi IO configuration.

The introduction of migration has a limited affect 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 (Figure 13). Following the demand stimulus, as employment rises in Scotland, the population migrates inward from the RUK. Unlike in the Bargaining scenario, the

increase in the labour supply itself does not affect wages and therefore wider economic activity, since regional real wages are not directly linked to the tightness of the regional labour market in Scotland. Exports to the RUK do increase by less under the 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 50	
	Scotland	RUK	Scotland	RUK
GDP	347,113	30,875	844,571	181,437
	0.55%	0.00%	1.35%	0.03%
Total employment	12,784	840	24,010	4,099
	0.68%	0.00%	1.27%	0.02%
Traded sector employment	0.84%	0.00%	1.62%	0.03%
Sheltered sector employment	0.30%	0.00%	0.49%	0.00%
CPI	0.28%	0.08%	0.05%	0.10%
Commodity output prices	0.39%	0.07%	0.06%	0.06%
Price of value added	0.58%	0.08%	0.07%	0.07%
Nominal wage	0.08%	0.08%	0.08%	0.08%
Real wage	-0.20%	0.00%	0.03%	0.03%
Exports to the other region	-0.49%	1.17%	0.15%	1.42%
Exports to ROW	2.64%	-0.15%	3.32%	-0.11%

4.8 WAGE SPILLOVER (1) AND MIGRATION WAGE SPILLOVER (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 14). 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. Under both scenarios, the RUK economy experiences an increase in imports to Scotland, in response to an increase in

demand for RUK intermediate inputs. The direct effects of the shock in the Scottish economy, however, mean that labour market conditions are more favourable there, encouraging some of the labour supply to out-migrate from the RUK economy under the Wage Spillover (2) configuration (Figure 26). Serious labour market constraints account for the significantly lower GDP trajectory in this scenario.

Table 6: Wage Spillover (2) Summary Results

	Period 3		Period 50	
	Scotland	RUK	Scotland	RUK
GDP	346,269	-34,250	841,477	-483,678
	0.55%	-0.01%	1.34%	-0.07%
Total employment	12,784	-1,945	23,895	-15,043
	0.67%	-0.01%	1.26%	-0.07%
Traded sector employment	0.84%	-0.01%	1.61%	-0.08%
Sheltered sector employment	0.30%	-0.02%	0.50%	-0.06%
CPI	0.29%	0.08%	0.10%	0.10%
Commodity output prices	0.40%	0.08%	0.13%	0.11%
Price of value added	0.60%	0.08%	0.14%	0.13%
Nominal wage	0.09%	0.10%	0.16%	0.16%
Real wage	-0.19%	0.02%	0.06%	0.06%
Exports to the other region	-0.51%	1.19%	0.05%	1.46%
Exports to ROW	2.61%	-0.16%	3.19%	-0.23%

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 Scottish trade, which is the desired and anticipated response to some aspects of 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 model scenarios, the demand shock results in a positive stimulus for the Scottish economy, and the configuration of the regional labour market 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. Concern over the speed with which the regional economy adjusts is important: that the ordering of the magnitude of the effects under different labour market scenarios changes over time could prove to be misleading from a policy perspective. 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 regional labour market characteristics 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

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

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 GDP: Absolute Change from Base (£m)

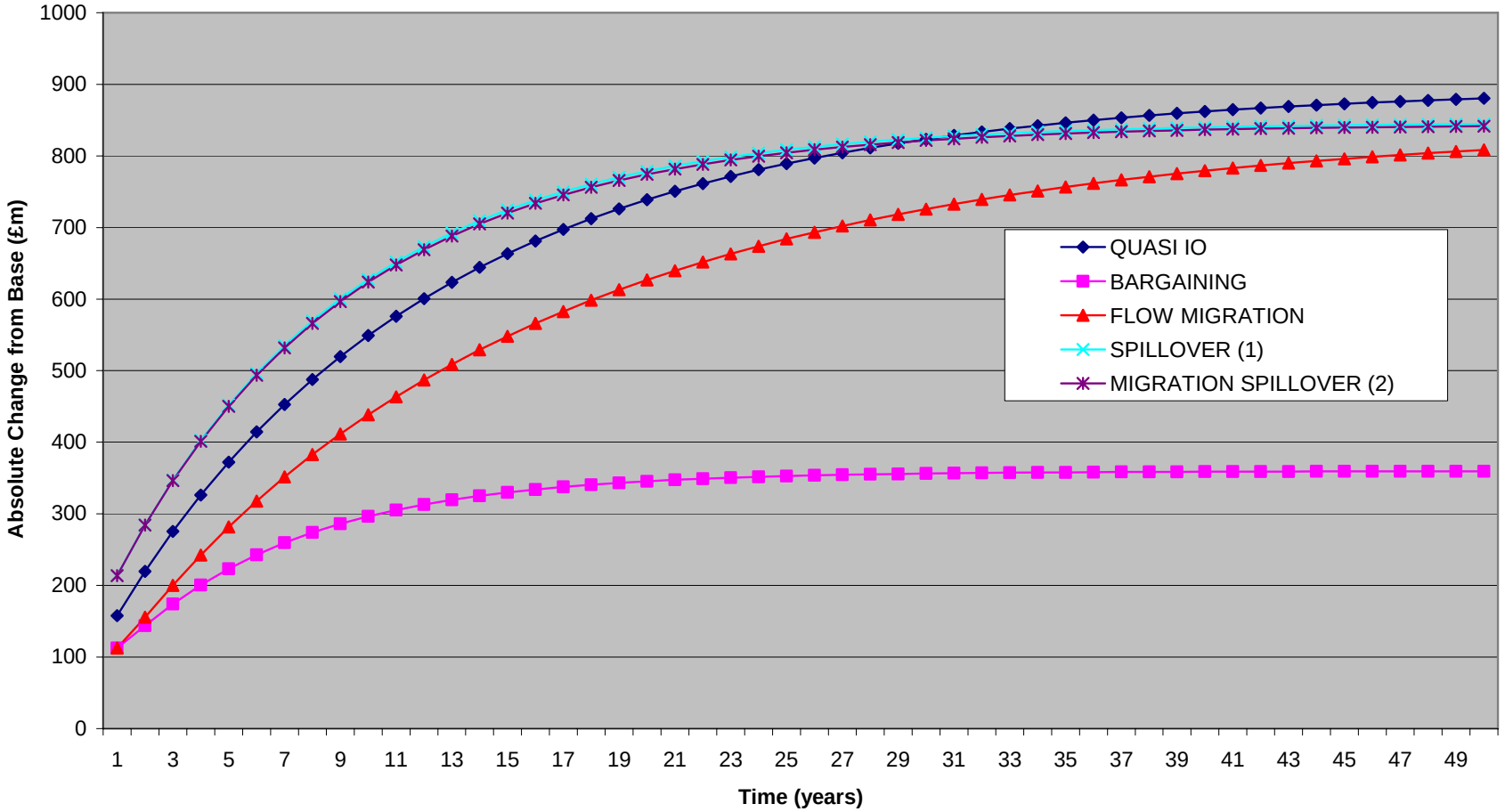


Figure 2
Scottish CPI: % Change from Base

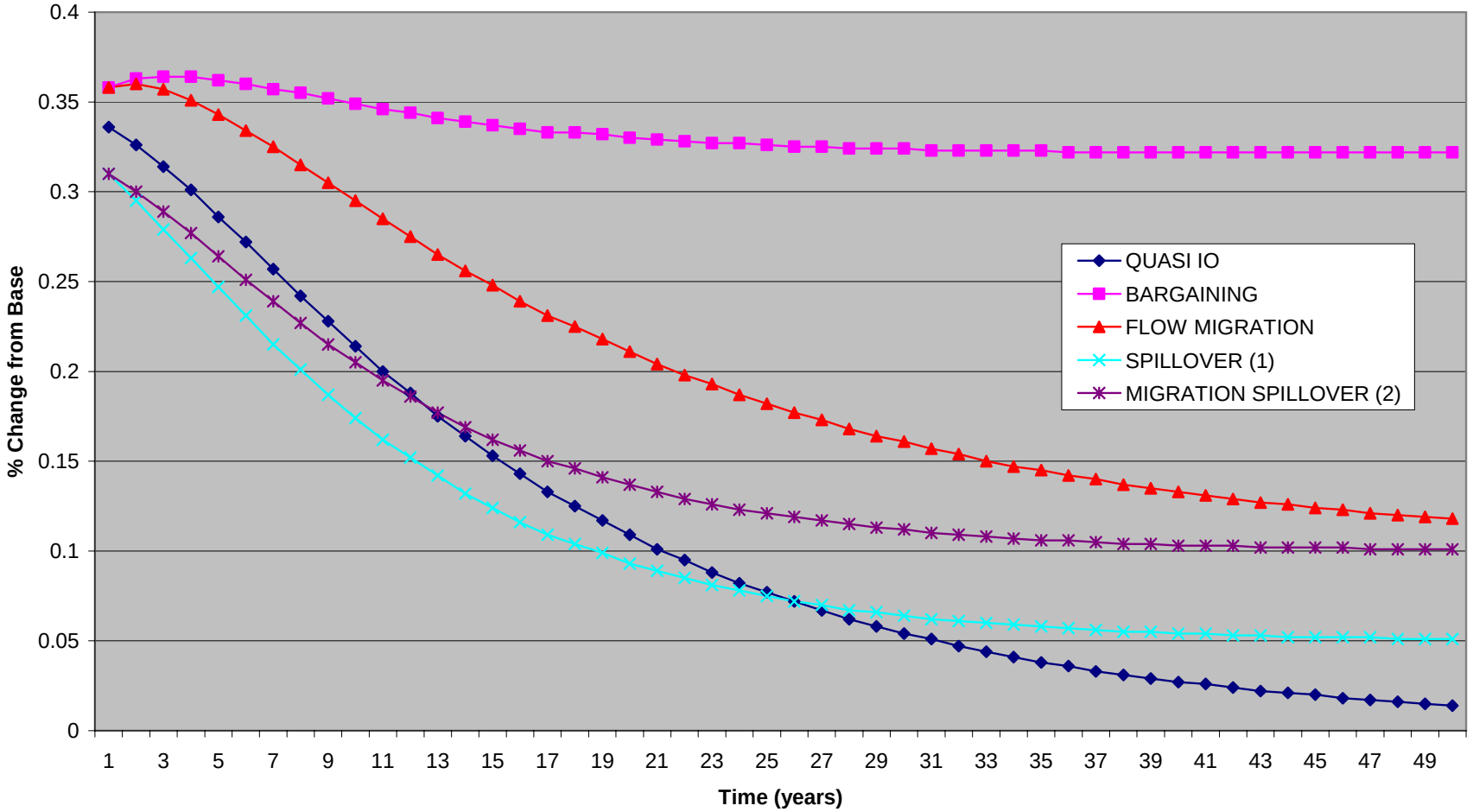


Figure 3
Scottish Total Employment: Absolute Change from Base (000s)

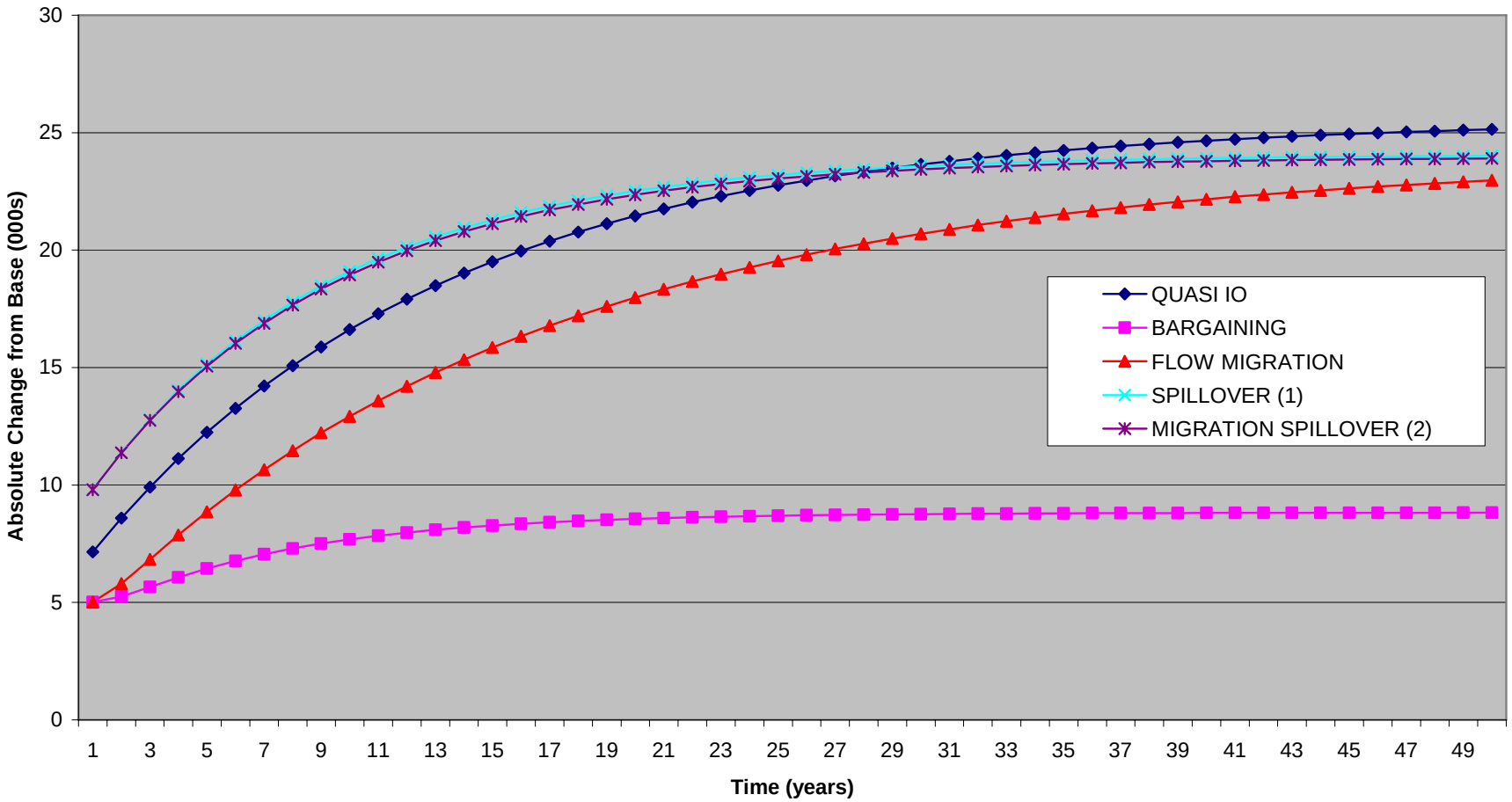


Figure 4
Scottish Real Wages: % Change from Base

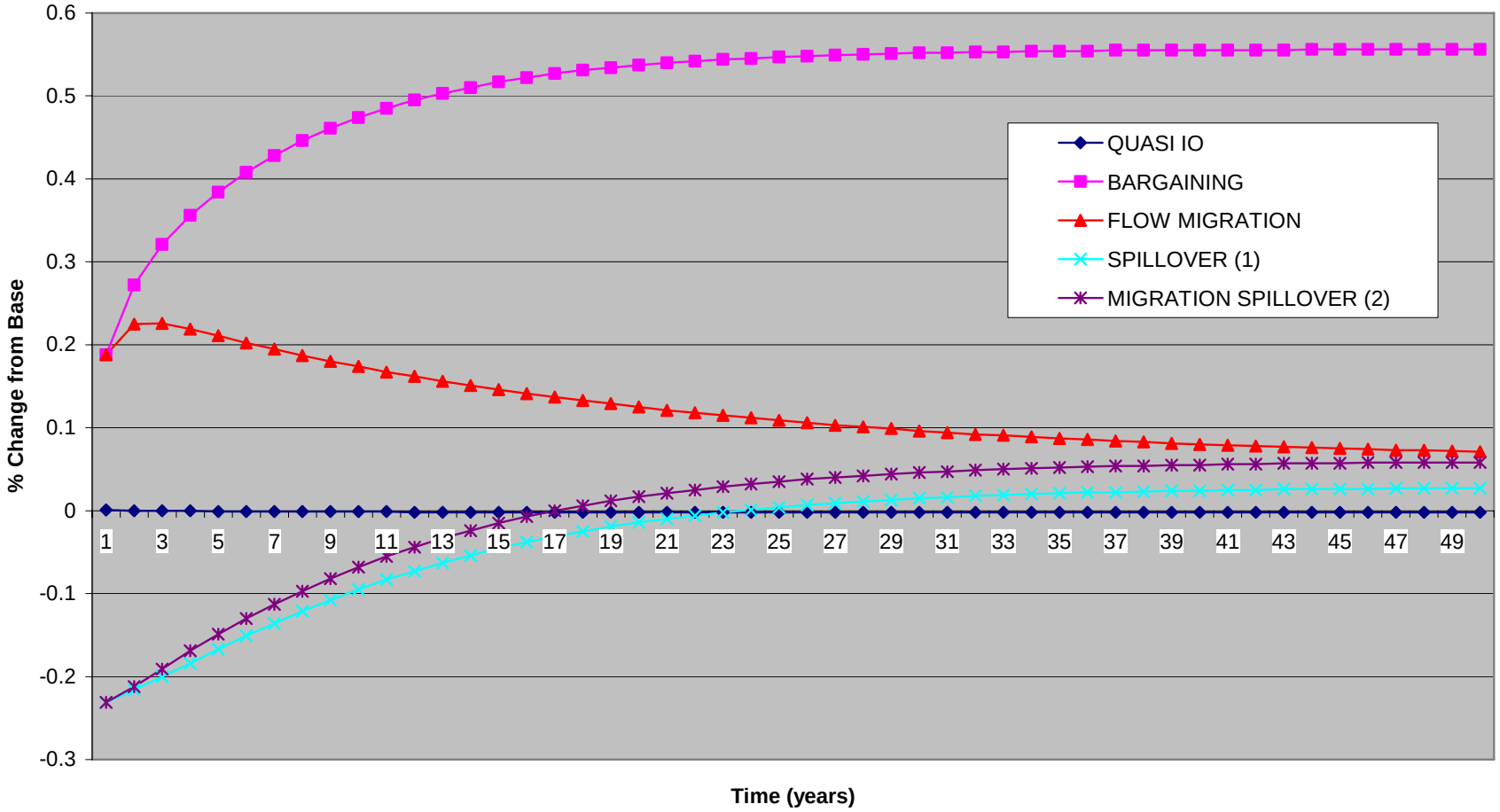


Figure 5
Scottish Nominal Wages: % Change from Base

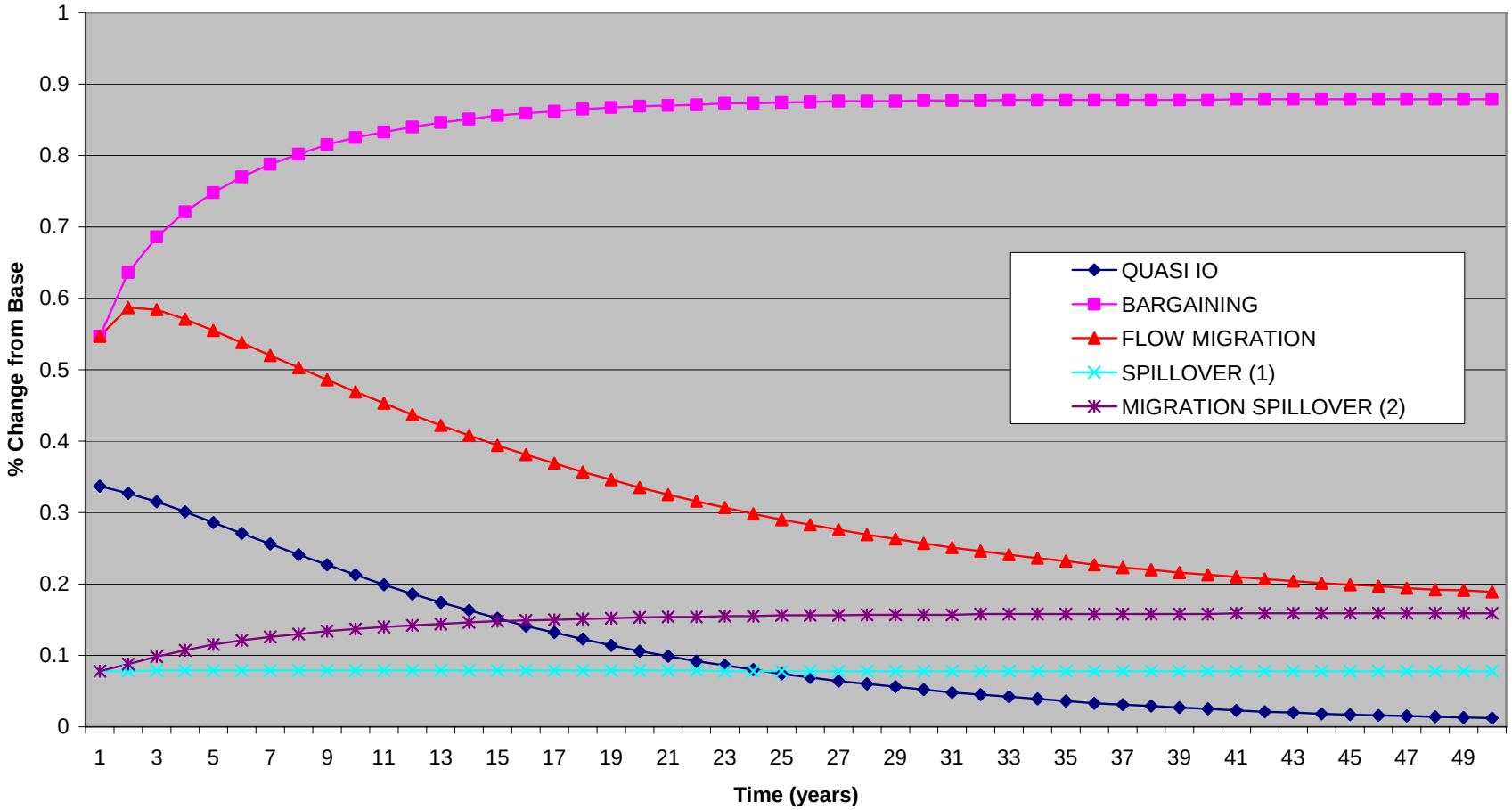


Figure 6
Scottish Exports to ROW: % Change from Base

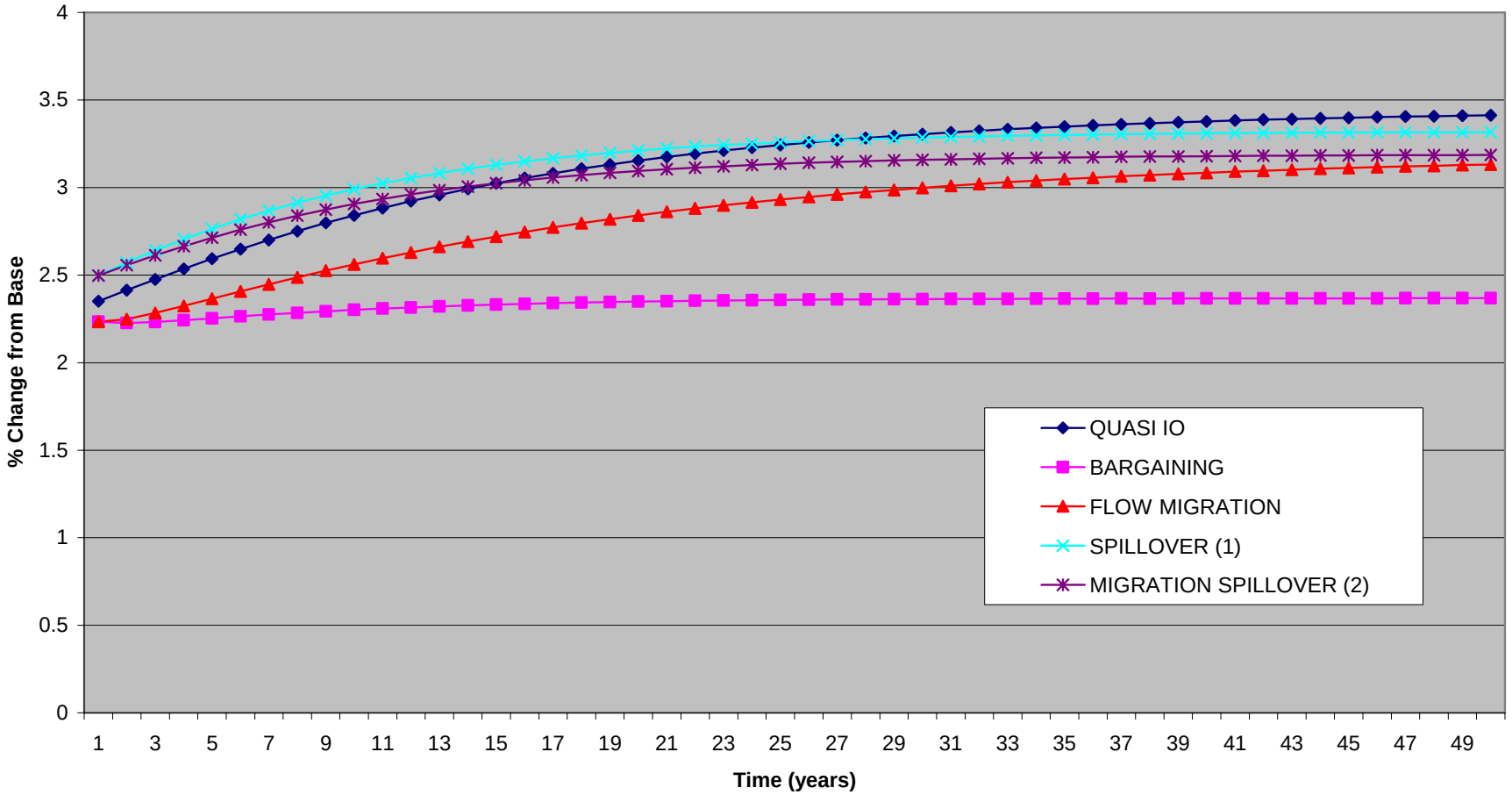


Figure 7
Scottish Exports to RUK: % Change from Base

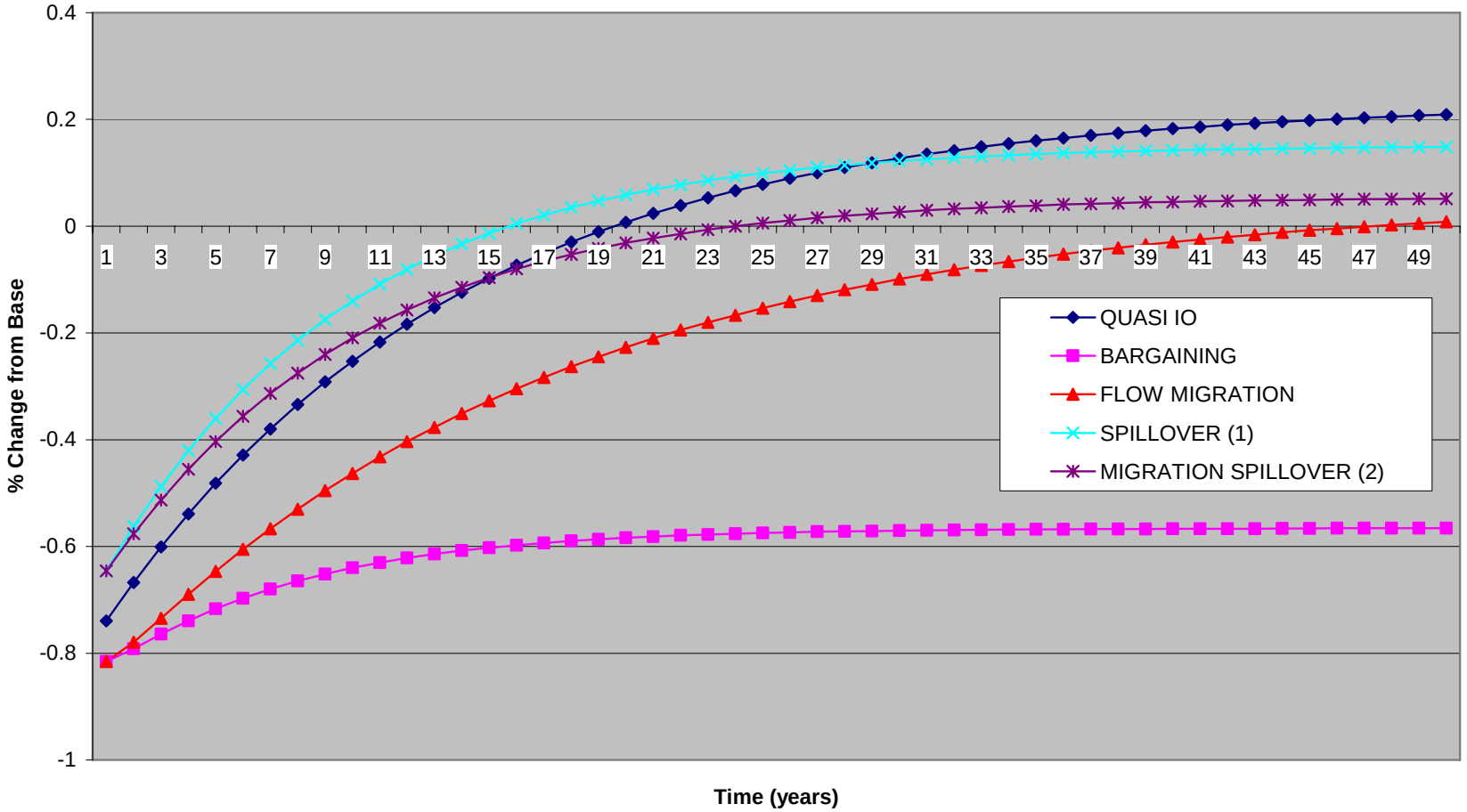


Figure 8
Scottish Price of Commodity Outputs: % Change from Base

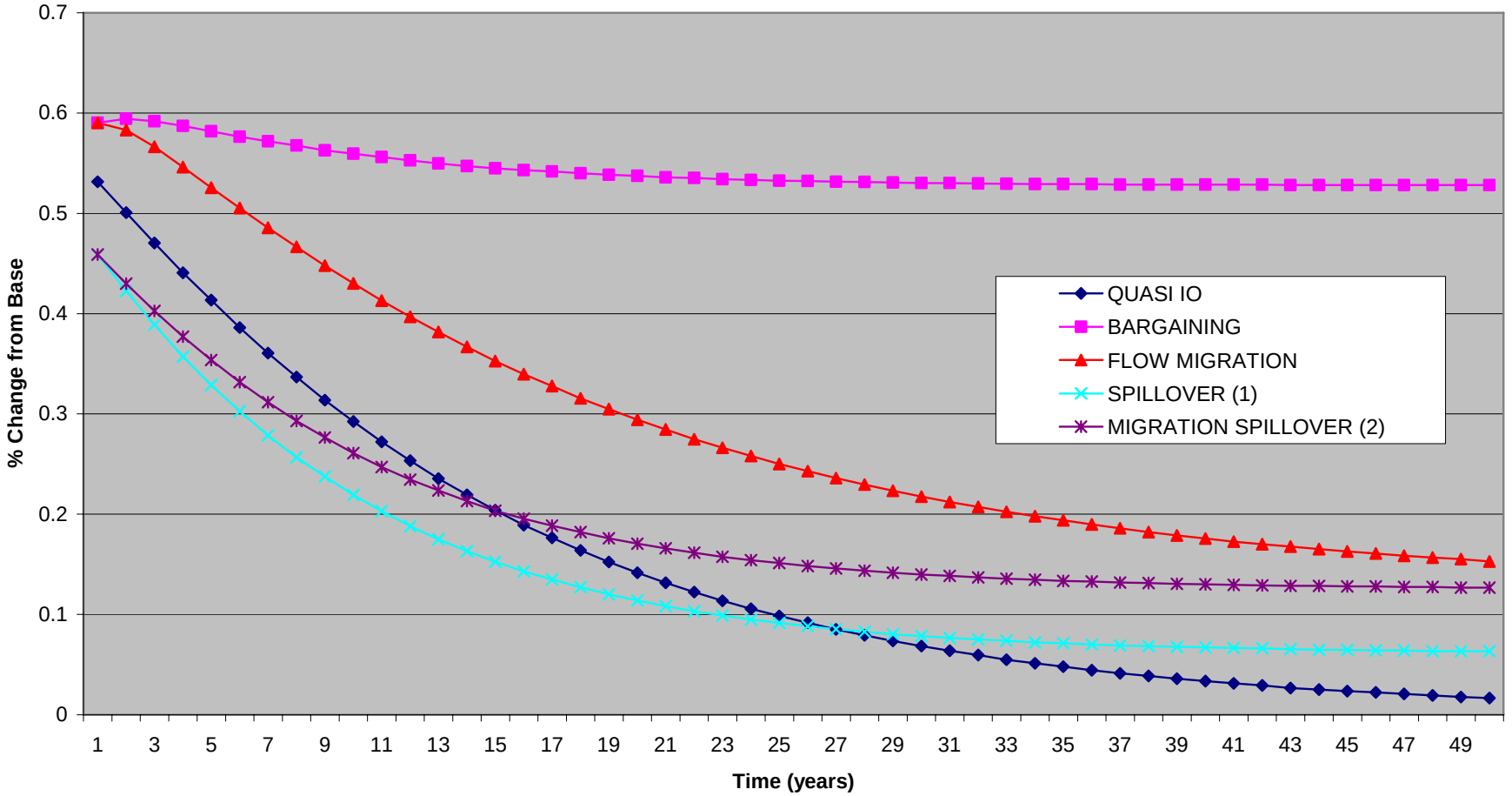


Figure 9
Scottish Price of Value Added: % Change from Base

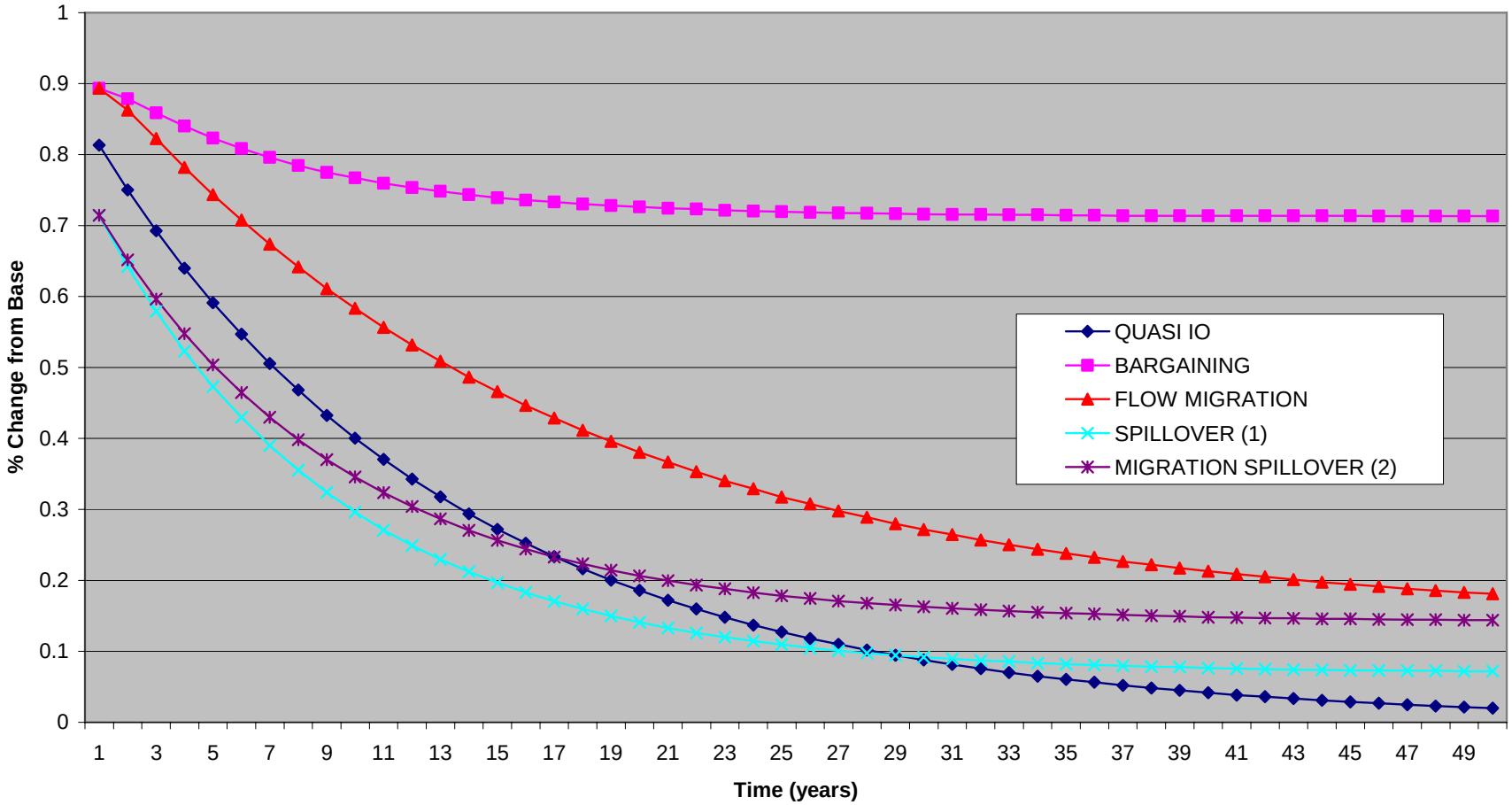


Figure 10
Scottish Capital Rental Rates: % Change from Base

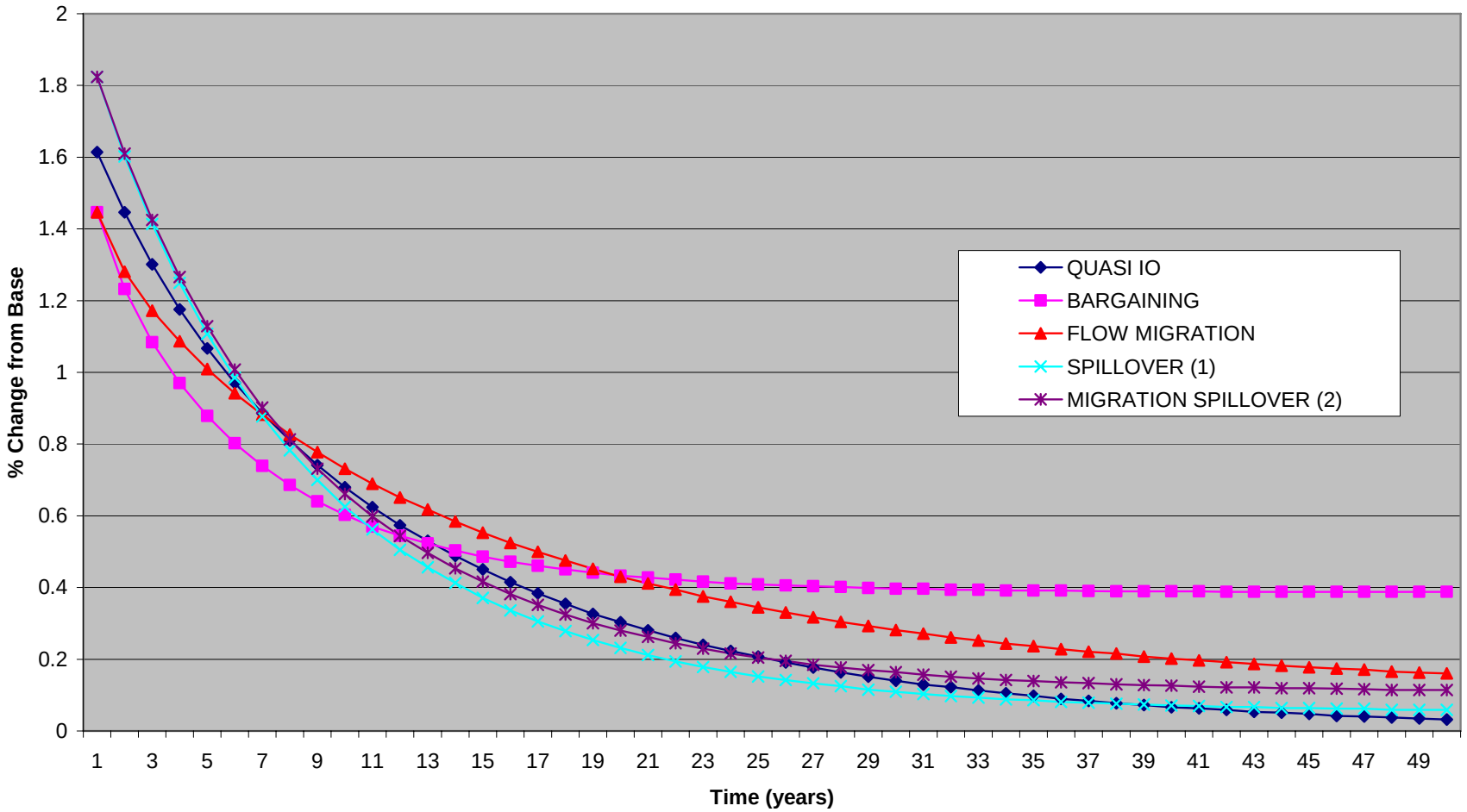


Figure 11
Scottish Sheltered Sector Employment: % Change from Base

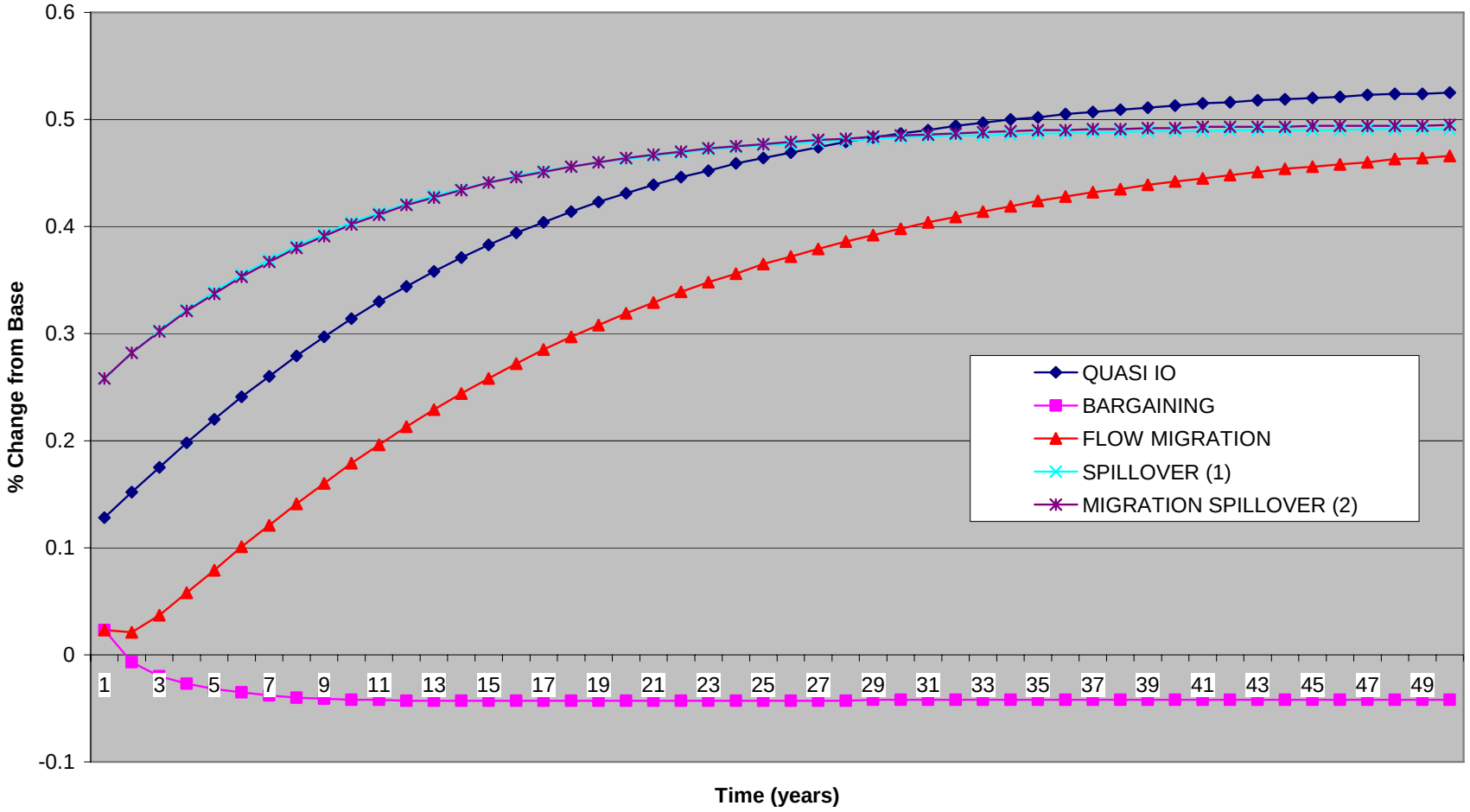


Figure 12
Scottish Traded Sector Employment: % Change from Base

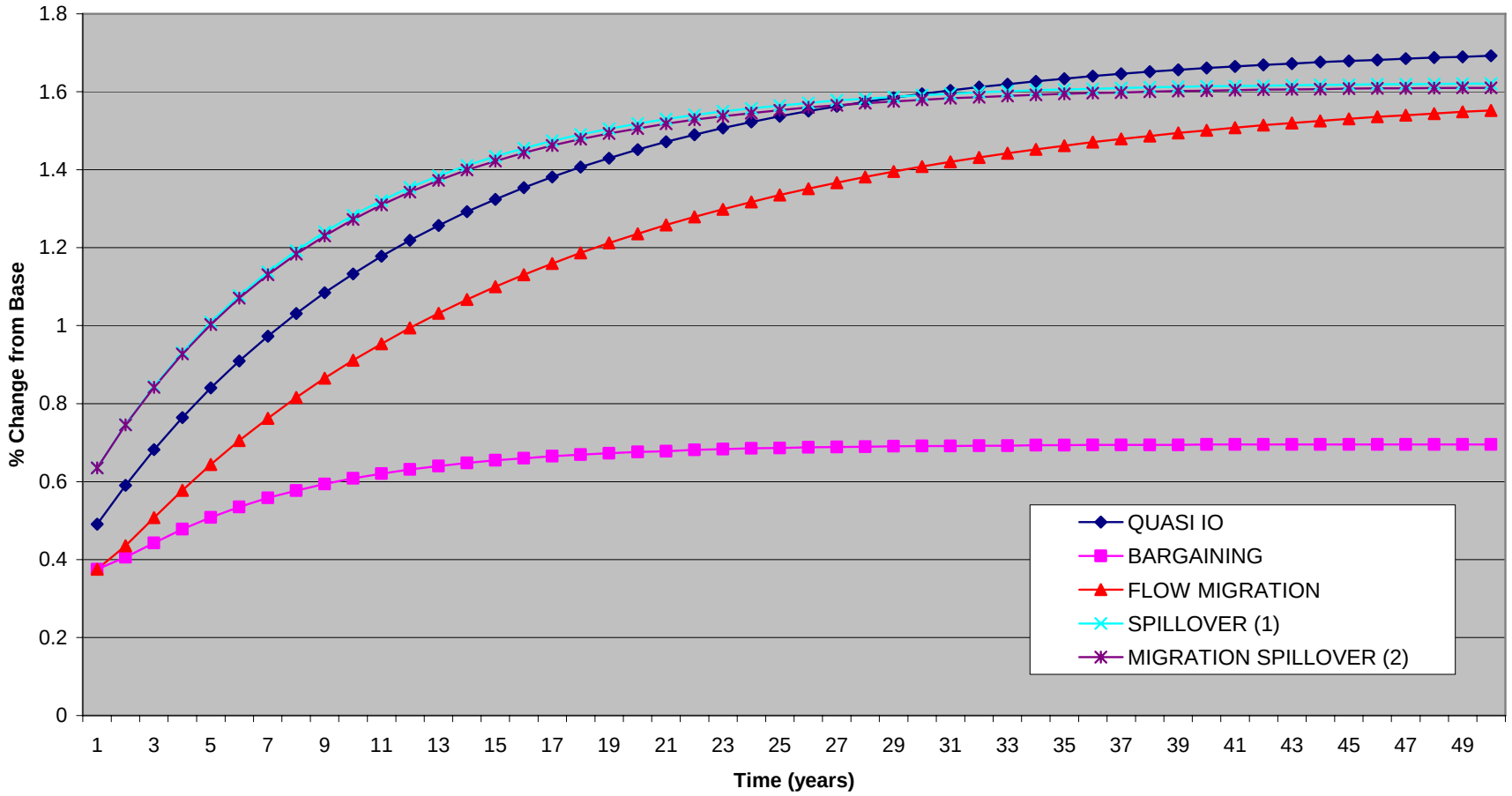


Figure 13
Scottish Population: Absolute Change from Base (000s)

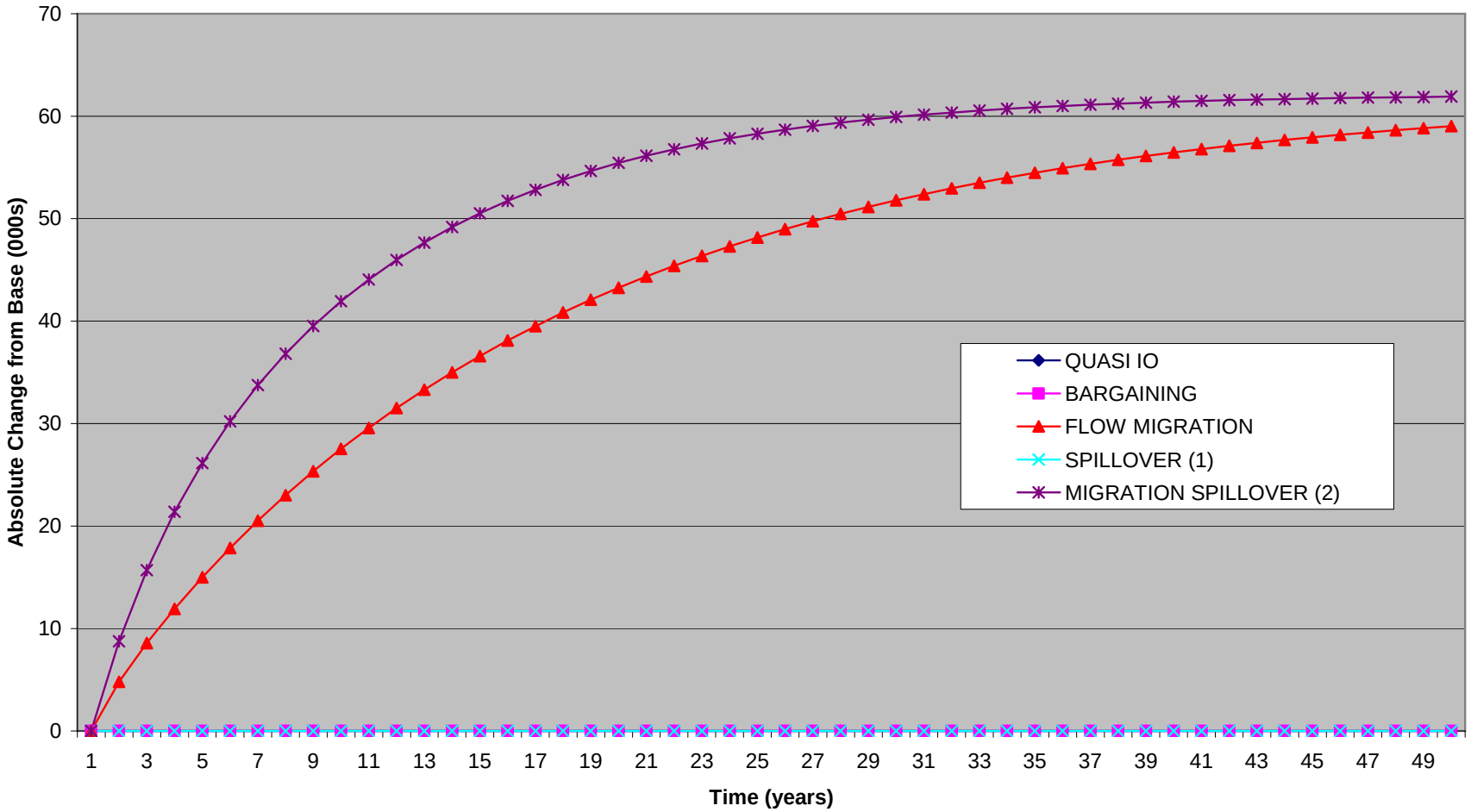


Figure 14
RUK GDP: Absolute Change from Base (£m)

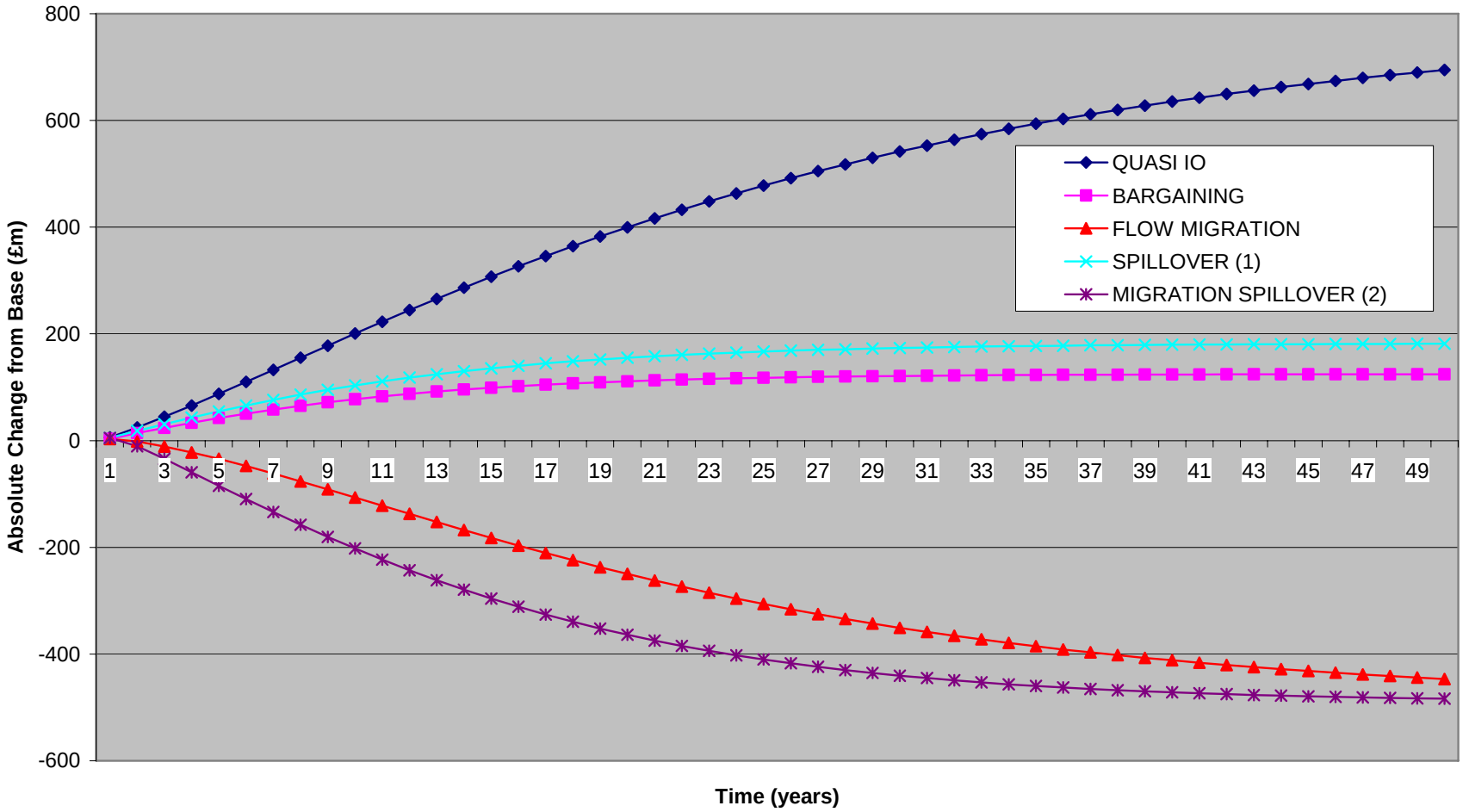


Figure 15
RUK CPI: % Change from Base

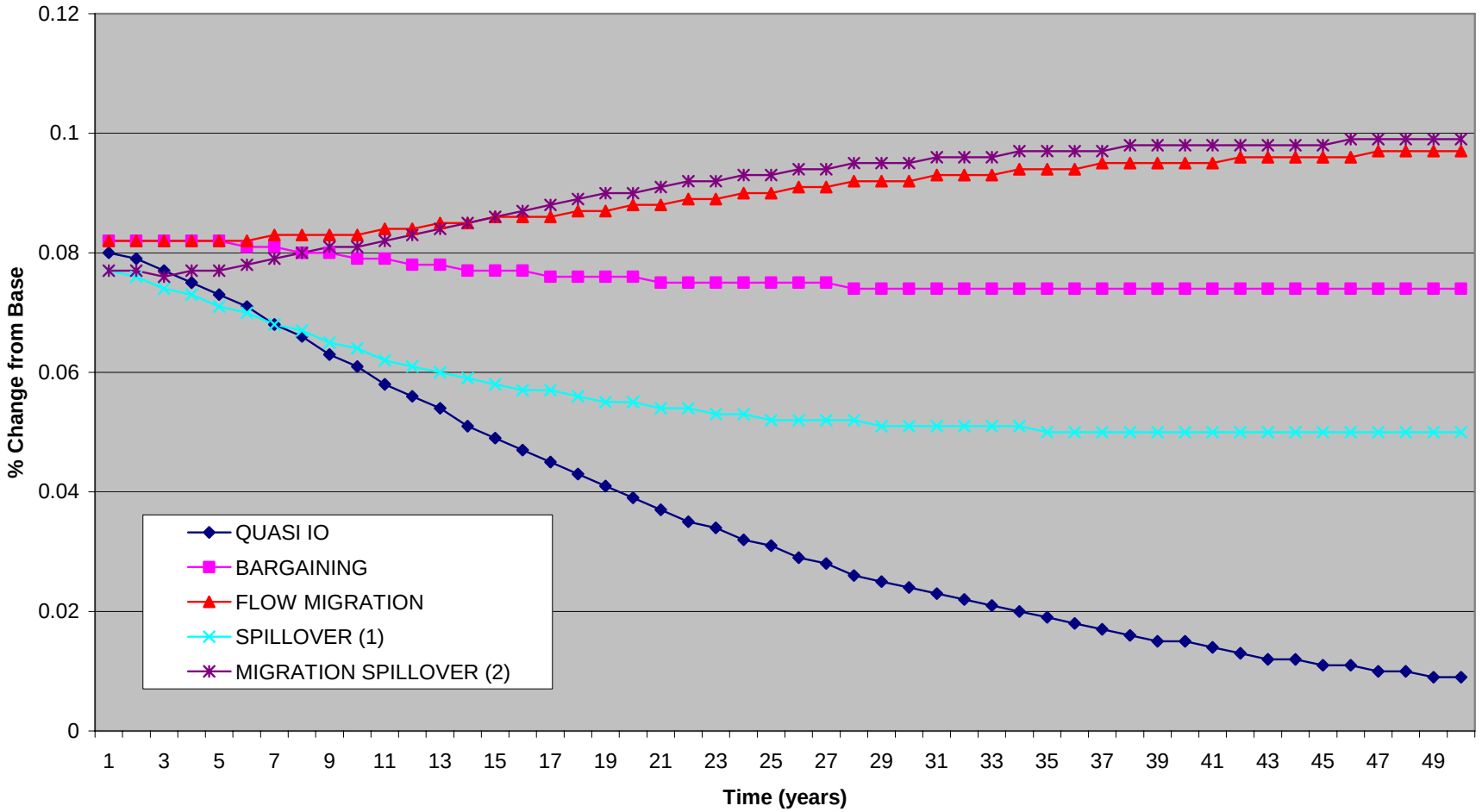


Figure 16
RUK Total Employment: Absolute Change from Base (000s)

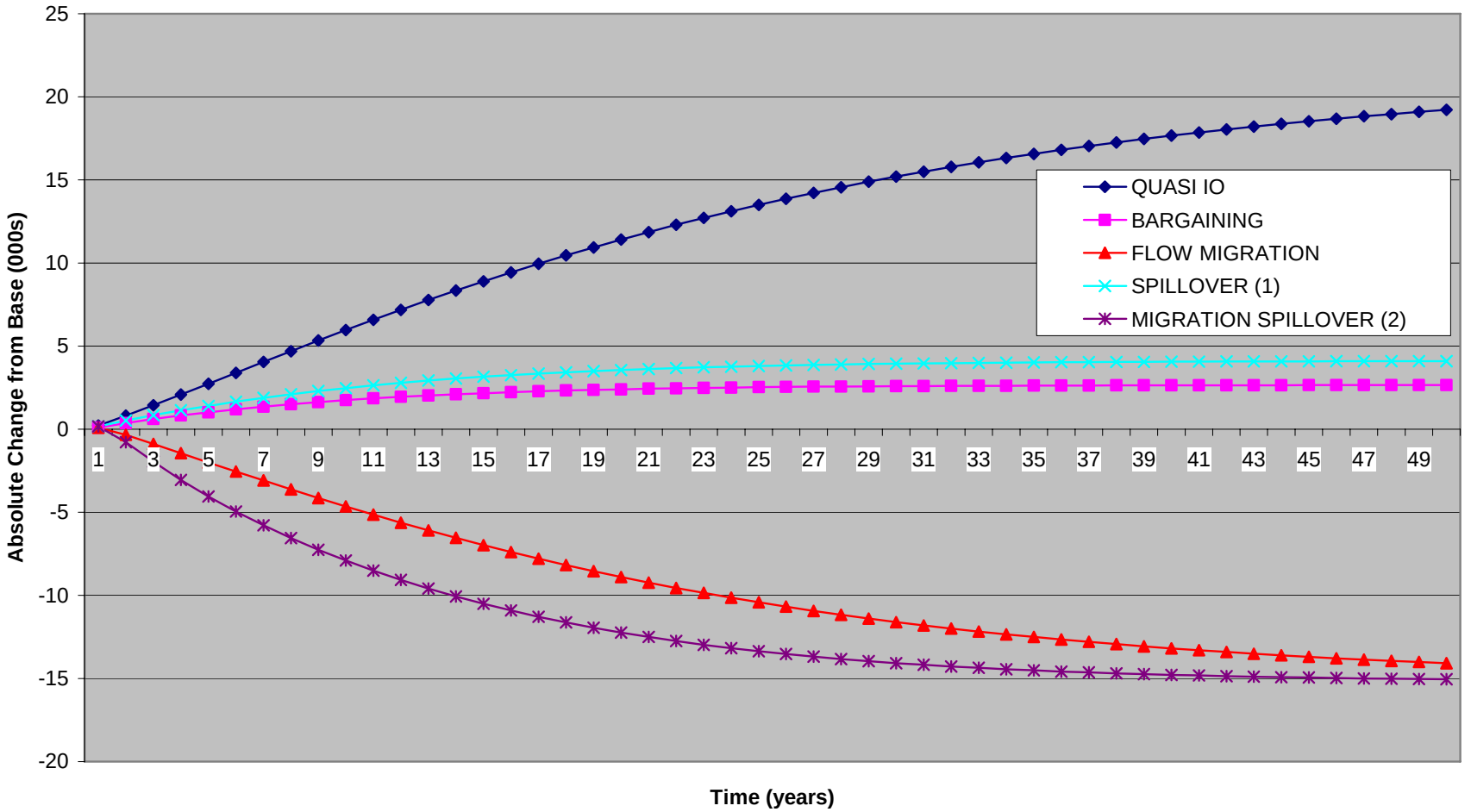


Figure 17
RUK Real Wage: % Change from Base

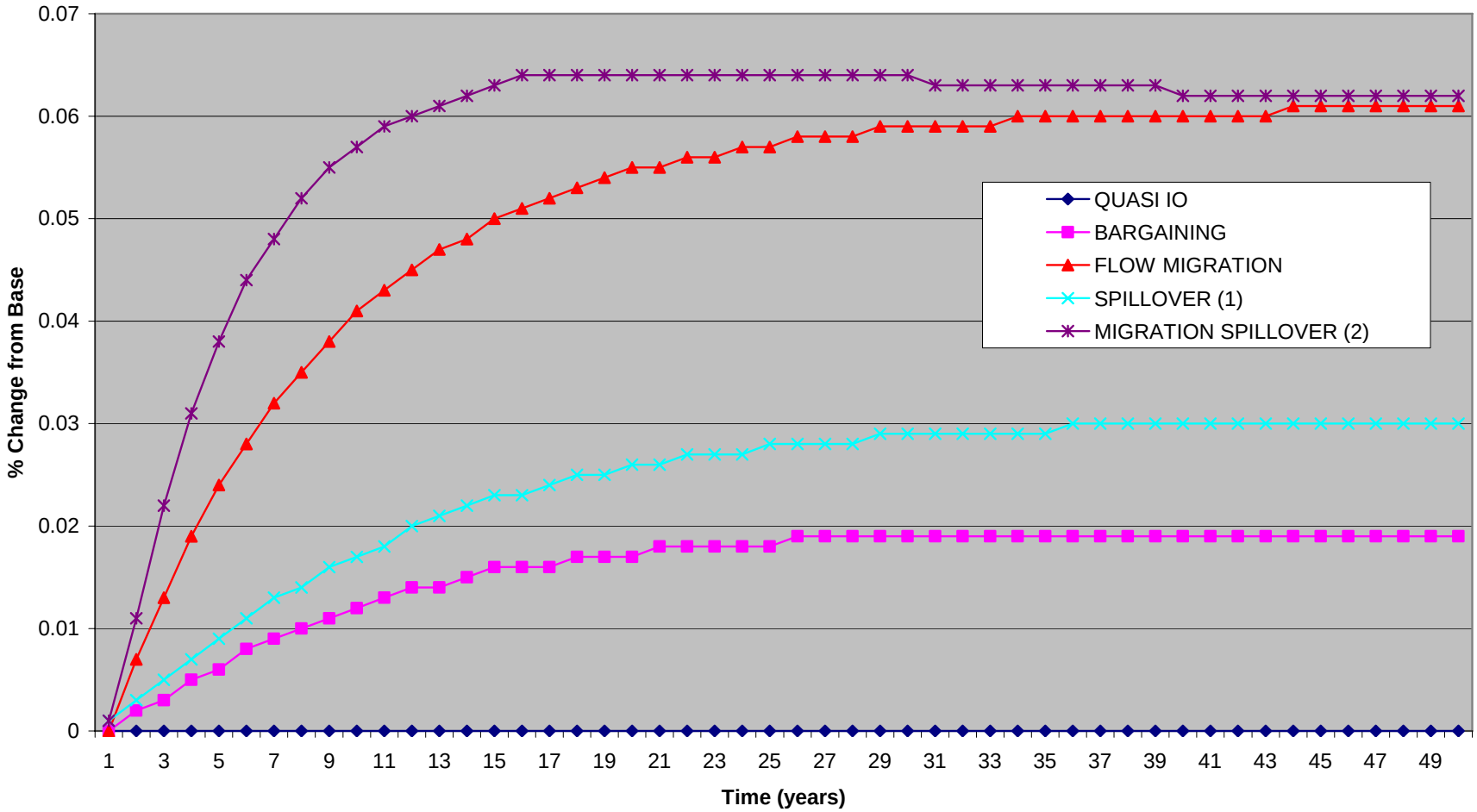


Figure 18
RUK Nominal Wage: % Change from Base

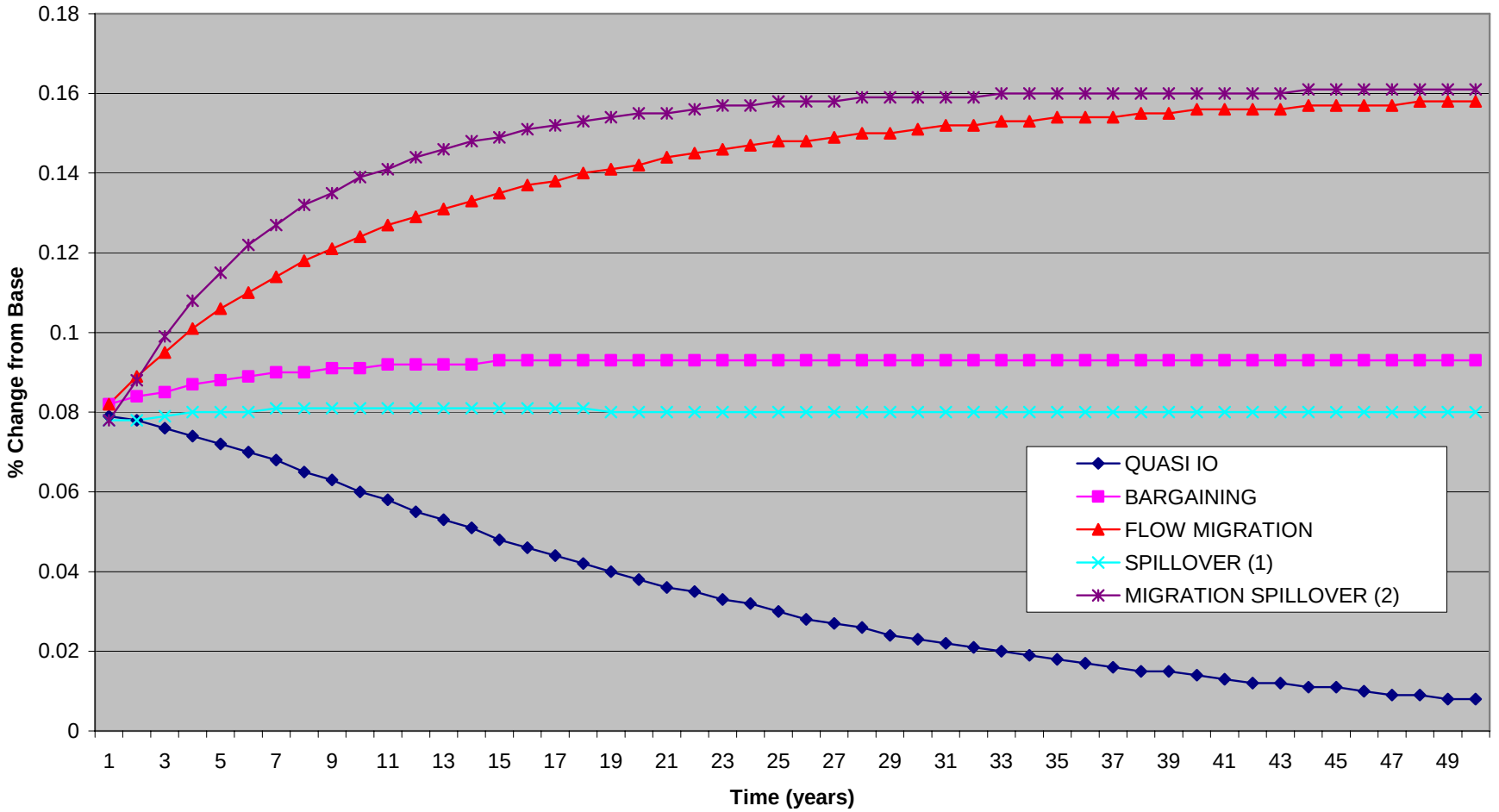


Figure 19
RUK Exports to ROW: % Change from Base

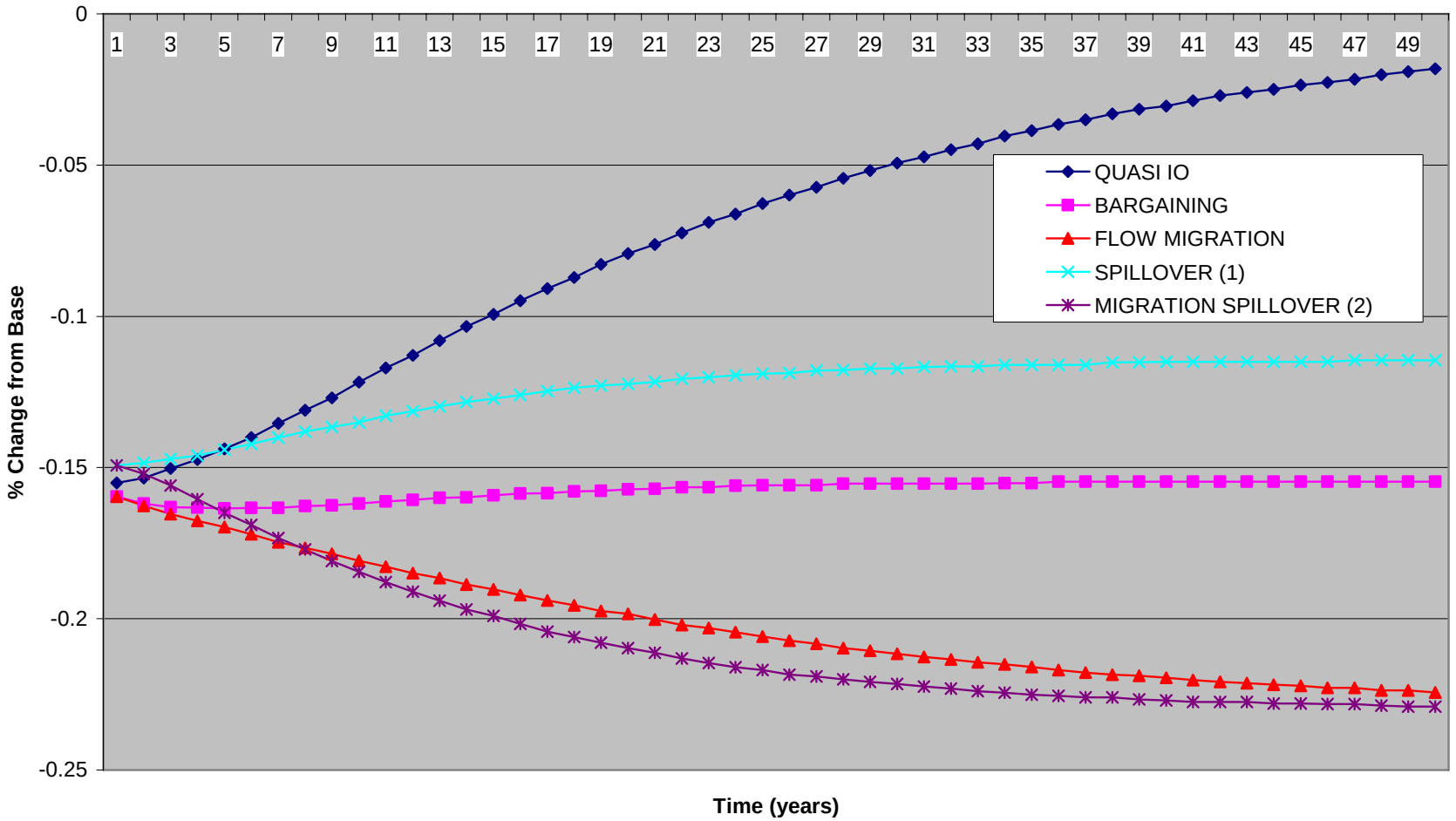


Figure 20
RUK Exports to Scotland: % Change from Base

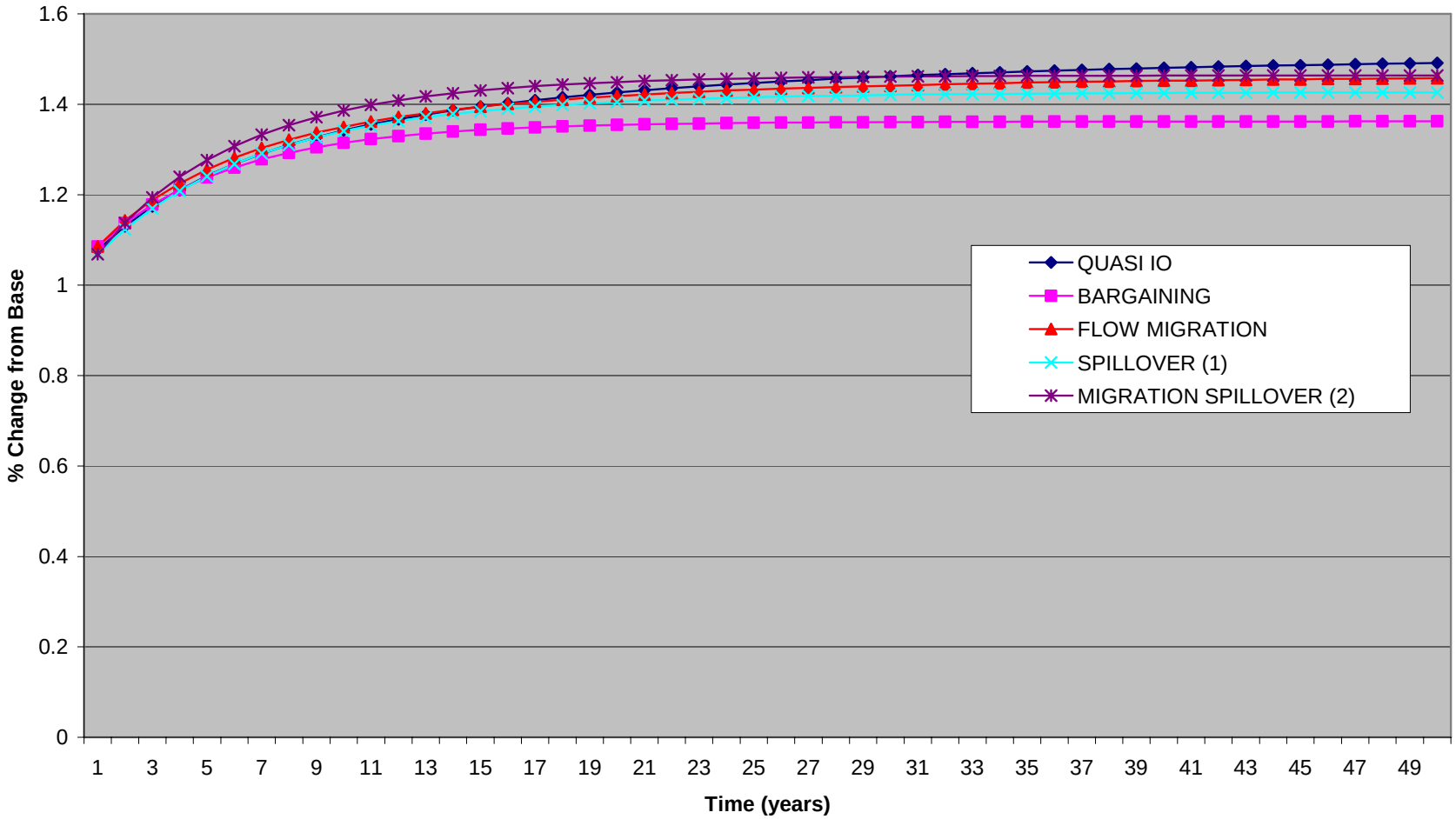


Figure 21
RUK Price of Commodity Outputs: % Change from Base

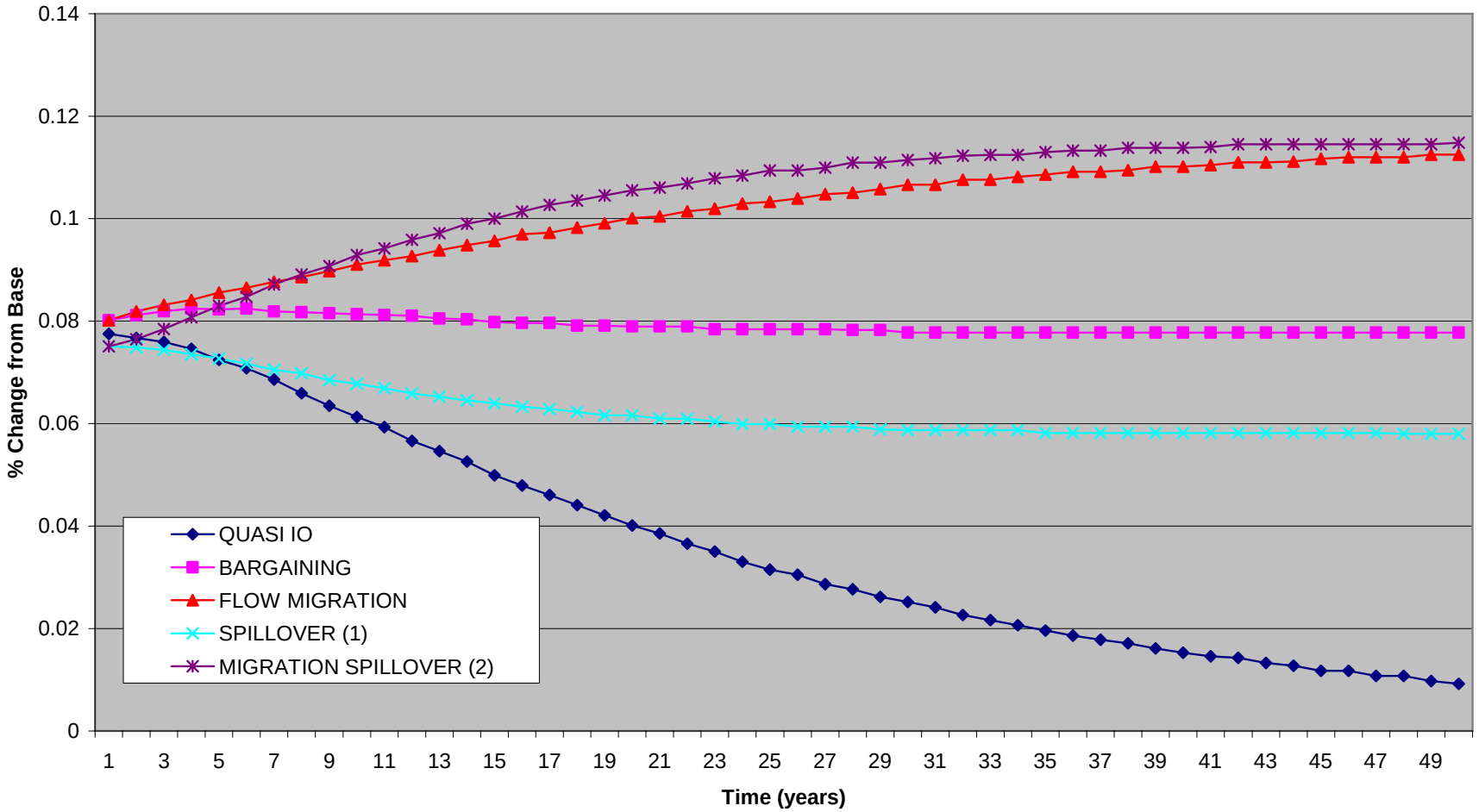


Figure 22
Price of RUK Value Added: % Change from Base

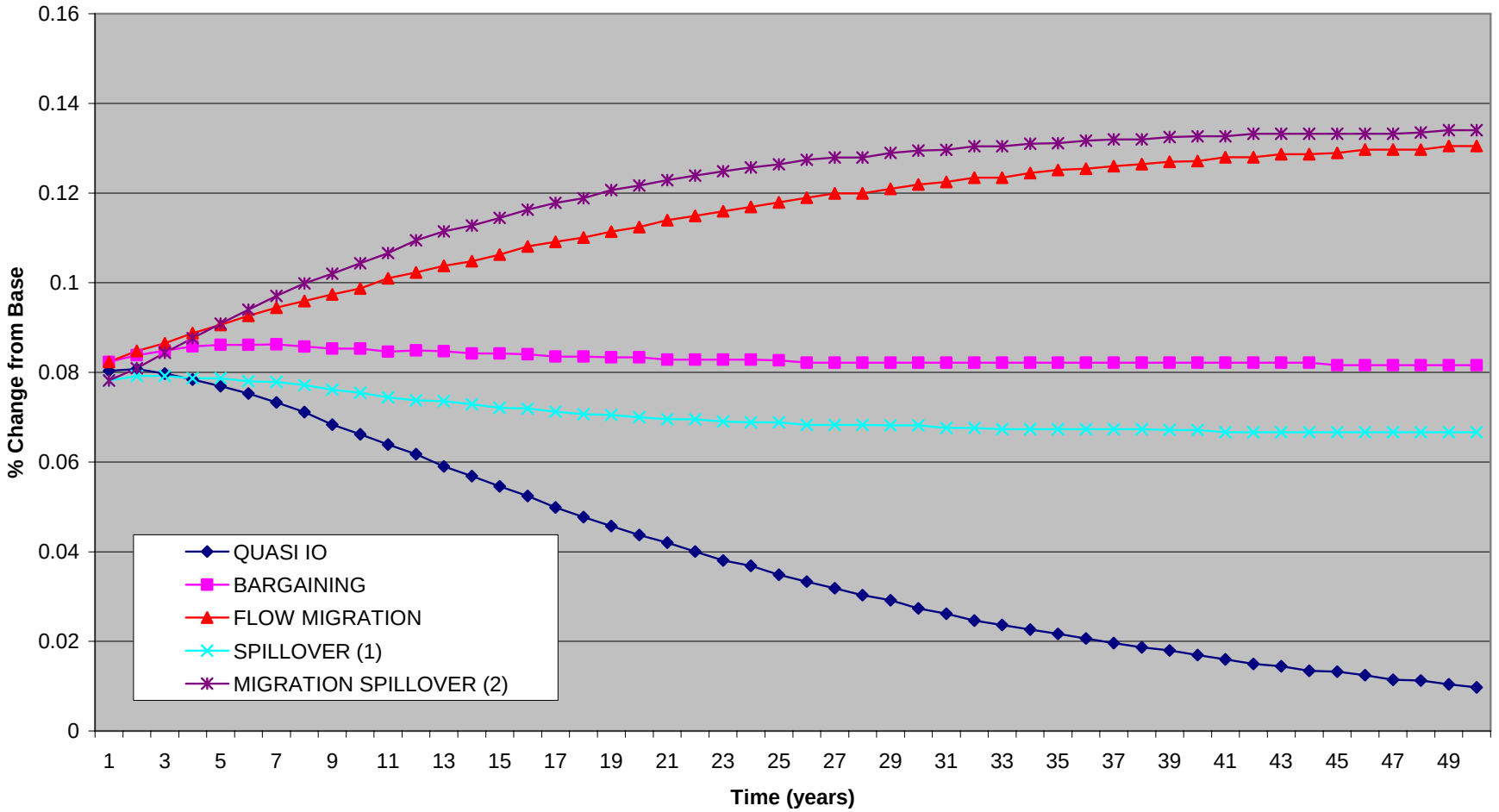


Figure 23
RUK Capital Rental Rates: % Change from Base

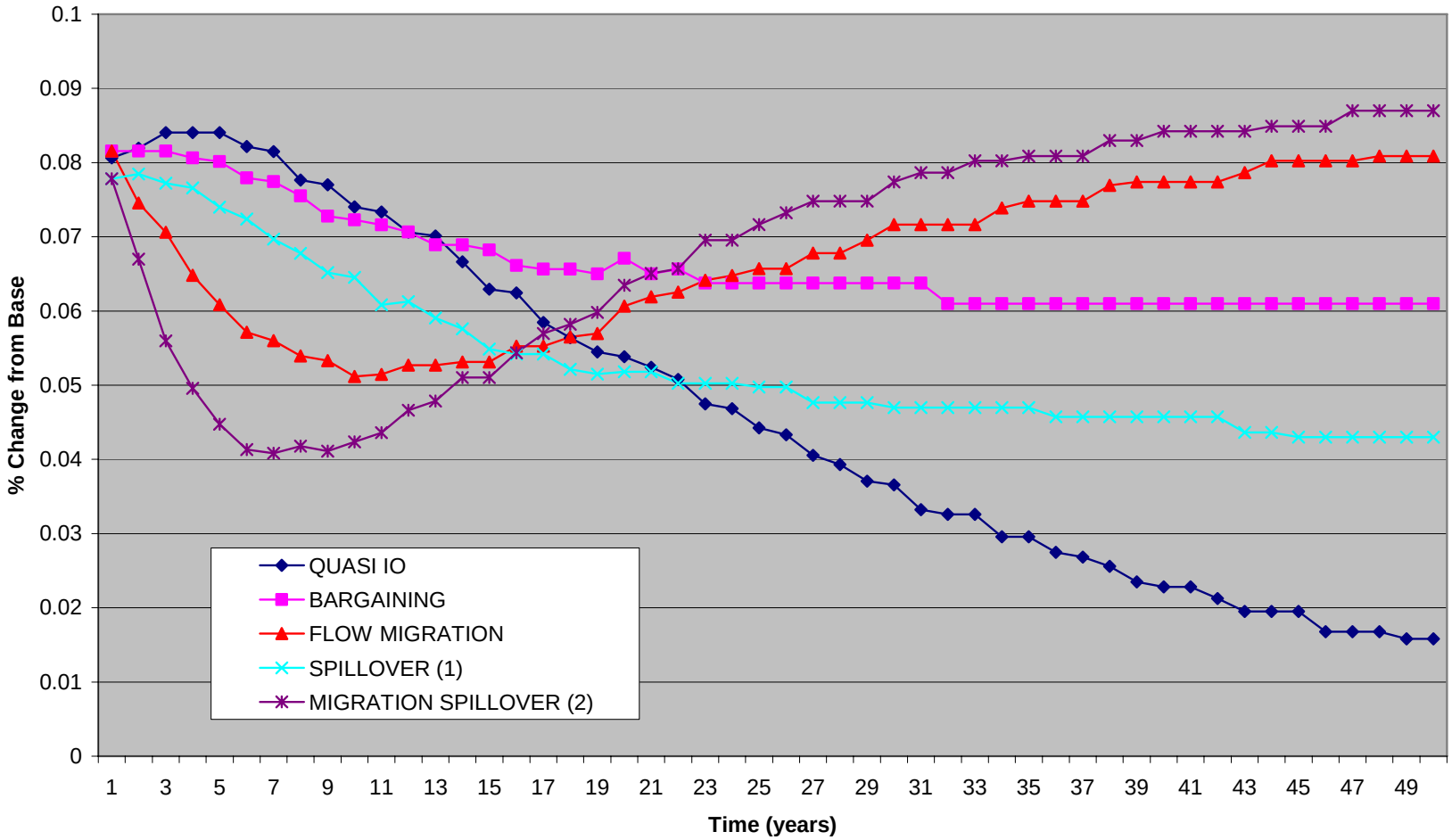


Figure 24
RUK Sheltered Sector Employment: % Change from Base

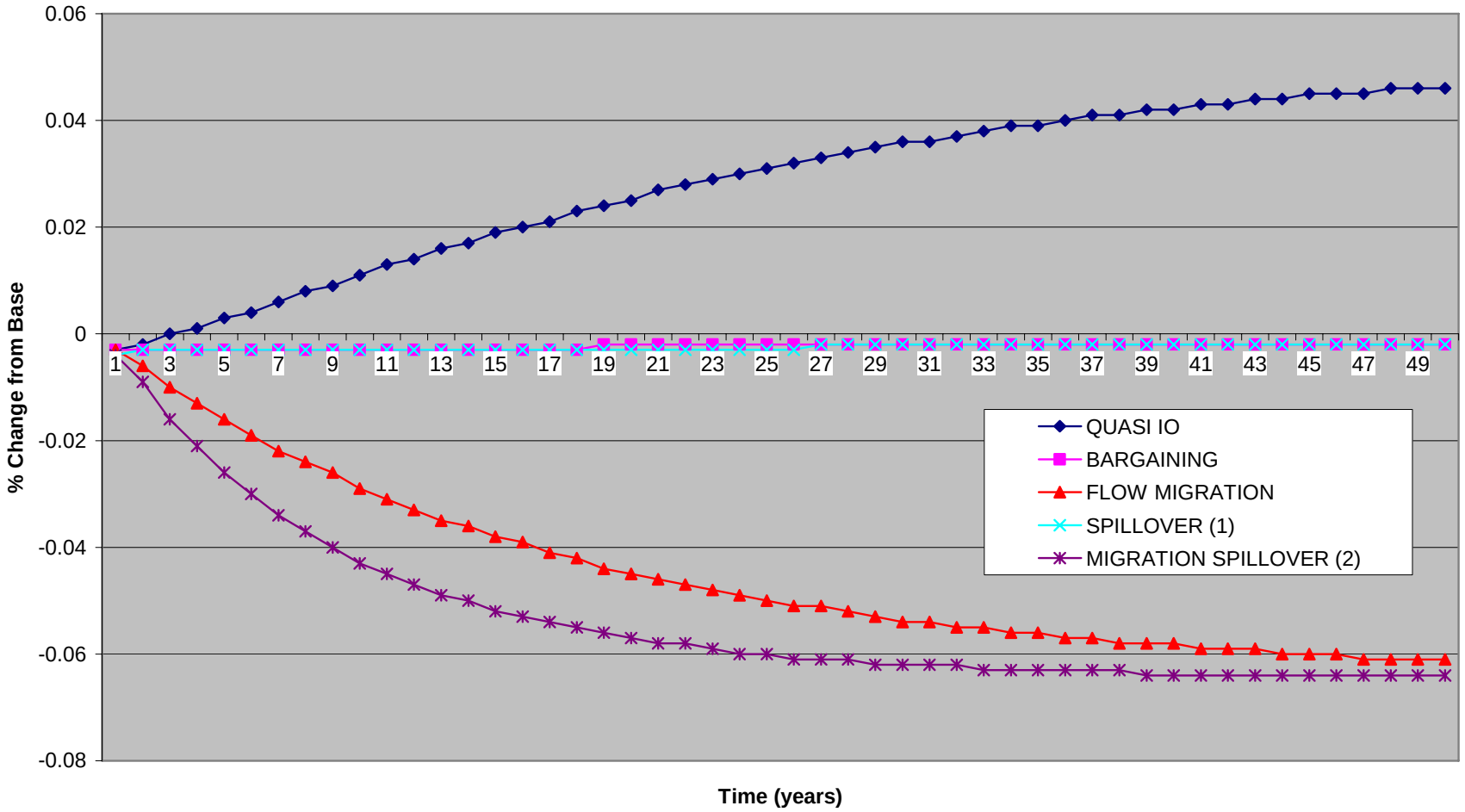


Figure 25
RUK Traded Sector Employment: % Change from Base

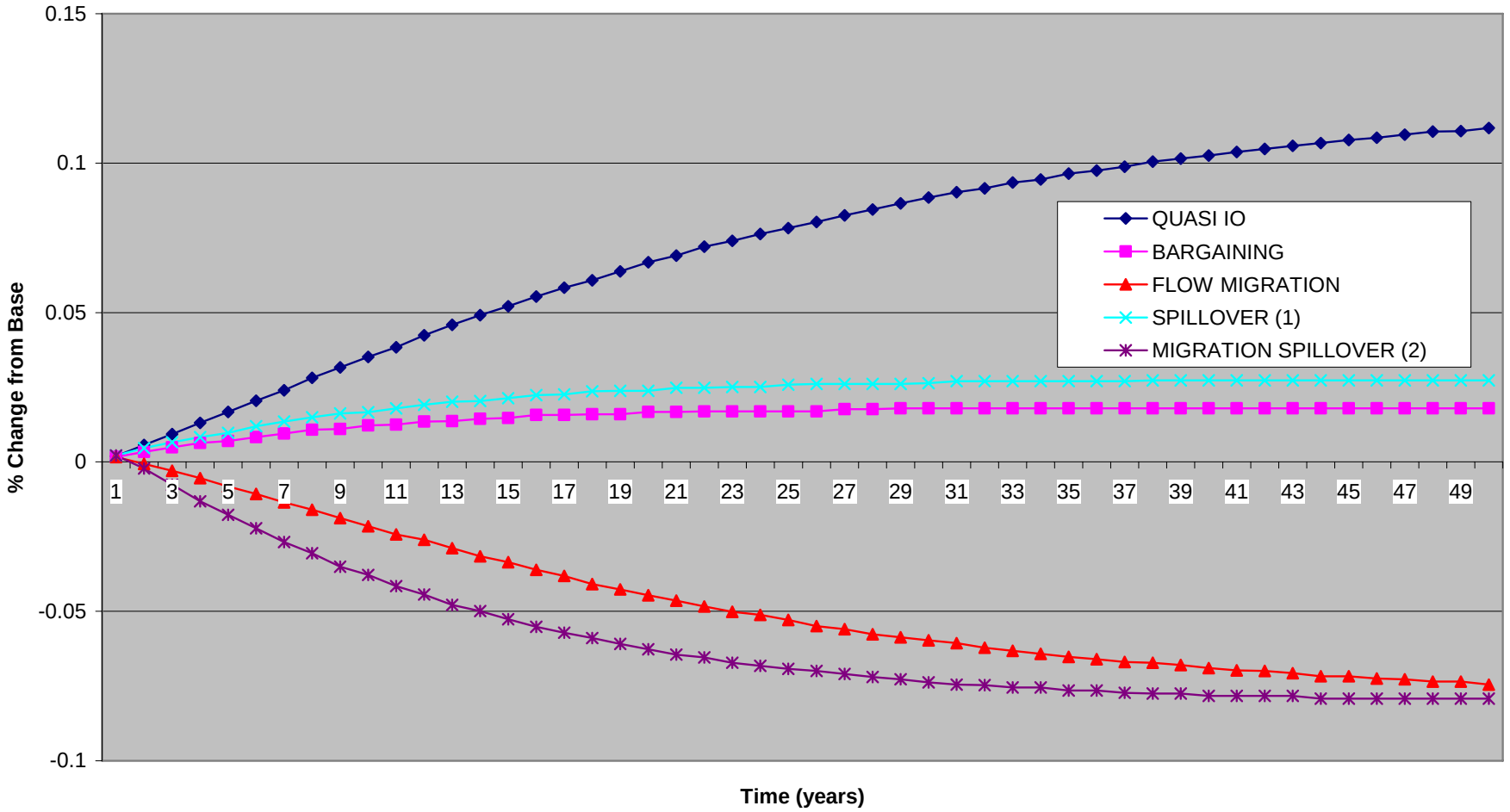
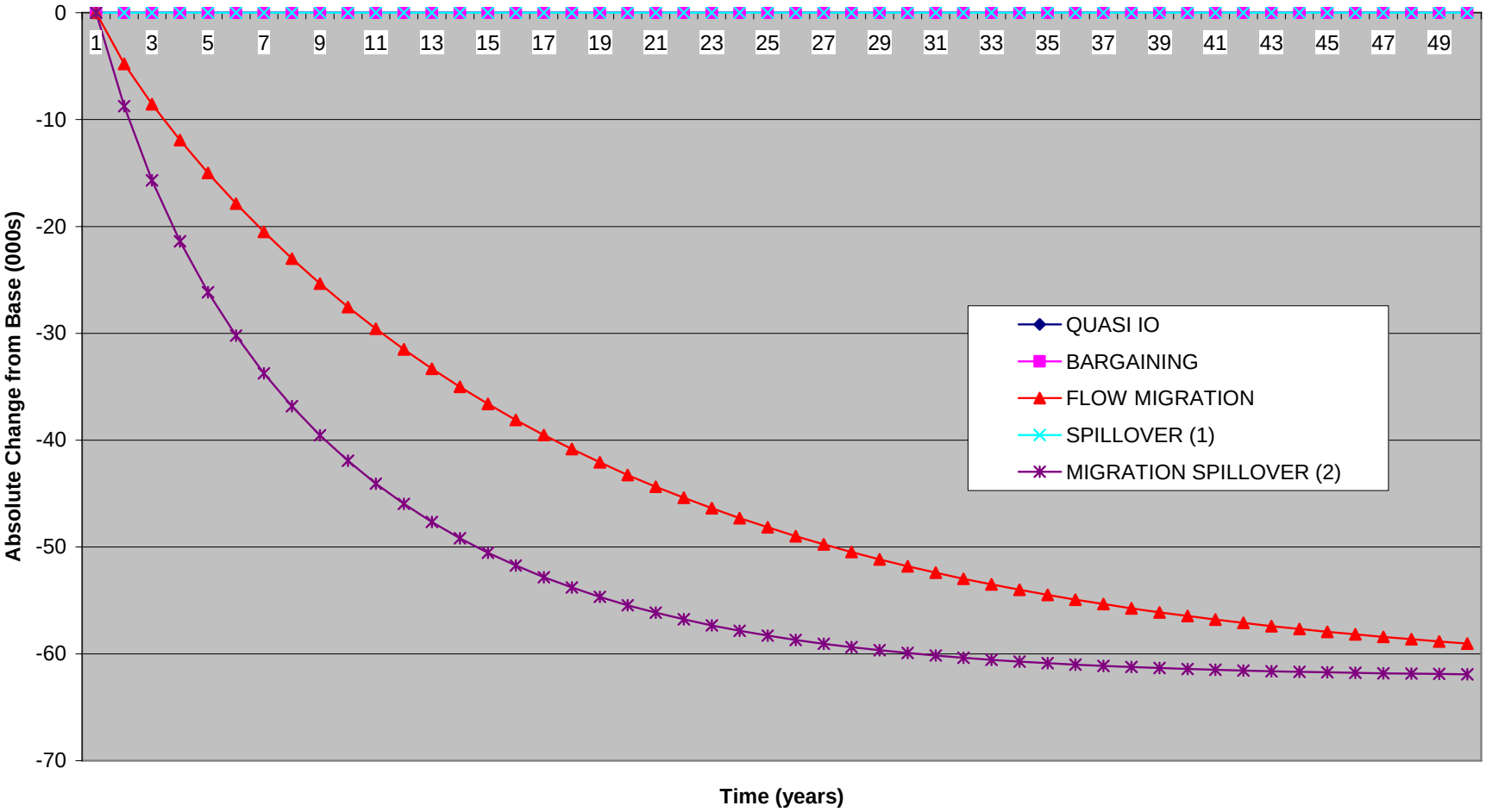


Figure 26
RUK Population: Absolute Change from Base (000s)



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