A Computable General Equilibrium Approach to the Ex Post Evaluation of Regional Development Agency Policies*

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1. INTRODUCTION

Within the UK and other European economies, policies for regional economic regeneration have become increasingly fragmented, discretionary and supply-orientated. A particularly good example of such policies is the use of regional development agencies to provide flexible aid to local companies, attract inward investment and improve the working of the local labour market. The present official UK evaluations of regional policy adopt a hybrid procedure. The direct policy impact is calculated via some "industrial survey" method where recipient companies are asked, through interviews or questionnaires, to identify the extent of additionality and product-market displacement associated with the aided project.[i] However, the conventional assessment of the system-wide effects of such a policy takes a quite different form. The impact on local employment is assessed through a standard demand-determined multiplier of an Input-Output or Keynesian type, whilst at the UK level there is assumed to be 100% crowding out so that there is no net addition to national activity (Alexander and Whyte, 1995; HM Treasury, 1995, 1997, McVittie and Swales, 1999; PA Cambridge Economic Consultants Ltd. 1993).

Because of the nature of present regional policies, it is difficult to imagine an evaluation method which could capture the direct impact of individual policies without the use of "industrial survey" methods. First, typically there are numerous policies operating simultaneously in a given area and aided firms are often in receipt of assistance under a range of policies. It is therefore difficult to isolate statistically the impact of one individual policy. Second, the flexible and discretionary nature of the aid and, in the UK at least, the attendant problems of confidentiality, render the modelling of direct effects problematic. However, the shift to the use of industrial survey methods for the quantification of the direct impacts of policy has been accompanied by a relative neglect of system-wide effects. Essentially these are presently modelled in a very rudimentary fashion. In this paper we illustrating a theoretically and empirically more satisfactory approach. The system-wide impacts of regional development agency policy on both recipient region and the rest of the nation are calculated using a multi-regional Computable General Equilibrium (CGE) model.

Specifically, we present an attempt to measure the cost effectiveness of the Strategic Objective under which the goals of Scottish Enterprise are operationalised. Scottish Enterprise is a regional development agency located in Scotland.[ii] We focus specifically on one Strategic Objective, Business Competitiveness, but give some indication of how the method is adapted for other Strategic Objectives. We again use a hybrid model in which the direct impacts of the Strategic Objective are identified through microeconomic studies which have been either undertaken directly by SE or commissioned from outside consultants. These estimates of the direct effects then form the basis for the exogenous disturbance that is fed into our two-region Computable General Equilibrium model of the UK economy, AMOSRUK.[iii]

The subsequent model simulations provide the system-wide effects which are our primary concern: the approach is an extension of the single-region analysis in Gillespie *et al* (1998). In this case, we focus on the simulation values for a number of key economic variables which measure the impact on economic activity in both Scotland and the rest of the UK (RUK) and on the UK national budget and balance of payments positions. We concentrate on a limited set of variables solely to render the analysis more manageable and easily comprehended.[iv] Multiregional CGE models have been used extensively for policy evaluation, especially in the USA and Canada, but this is their first use in the UK (Buckley, 1992; Gazel *et al*., 1995; Harrigan and McGregor, 1989; Jones and Whalley, 1990; Kilkenny, 1998; Morgan *et al*, 1996; Muti *et al*, 1989; Rickman, 1992).[v]

We organise the paper in the following way. Section 2 gives a description of the AMOSRUK model. In Section 3 we detail: the expenditures made under the Business Competitiveness Strategic Objective; the estimated direct impacts, the way in which this disturbance is introduced into the AMOSRUK model and the simulation results for this Strategic Objective. Section 4 is a very brief account of our attempts to model the SE's other Strategic Objectives. Section 5 outlines the strengths of this evaluation approach. Section 6 presents extensions to this procedure: essentially ways in which the simulation accuracy could be improved. Section 7 is a short conclusion.

2. AMOSRUK

AMOSRUK is a computable general equilibrium model of the UK economy with two endogenous regions, Scotland and RUK, and one exogenous region, the Rest of the World (ROW). It is calibrated on a Scottish-RUK Social Accounting Matrix for 1989. This is the last year for which full-survey I-O tables are available for both Scotland and the UK. In terms of relative scale, Scotland makes up a little less than 9% of the UK population, employment and output.

We treat each endogenous region in a similar manner to that adopted in our single-region Scottish model, AMOS (Harrigan *et al*, 1991; McGregor *et al*, 1996a). However, in the interregional variant the individual regions are linked by trade and potential migration flows generally determined by endogenous changes in prices, wages and activity in both regions.[vi] The national economy is subject to certain macroeconomic constraints, though our treatment of these is at present extremely straightforward. We assume that interest rates are exogenous to the national economy and that the government operates a fixed exchange rate regime.[vii]

AMOSRUK is a flexible CGE model which offers the user a wide range of time-period and labour-market options. In this paper we concentrate on period-by-period simulations. In these simulations, in each individual time period the capital stock is fixed, both in aggregate and in its regional and sectoral composition, and the regional populations are constant. However, between periods capital stocks are updated by investment and the regional distribution of the national population is adjusted through interregional migration. (There are no natural changes in population or international migration.) Each regional labour market is characterised by endogenous participation and wage-setting functions. Whilst there are a number of regional wage-setting options available with AMOSRUK, in this paper we adopt regional bargaining, where the real wage in each region is solely a function of the tightness of the regional labour market.

A condensed representation of the version of AMOSRUK used in this paper is given in Table 1 (not available on the CDROM). In the equations presented in this table, the endogenous (UK) regions of the model are identified generically by superscripts X and Y and, where required, specifically by the superscript S for Scotland and R for RUK. The superscript W represents Rest of the World. In this summary depiction of the model many of the detailed income transfers between transactor groups are suppressed.

Equation (1) in Table 1 gives the determination of commodity value-added prices where $pv^X{}_i$ represents the value-added price in sector i in endogenous region X. We assume that in each region the three commodities in the model are all produced by perfectly competitive regional industries. These commodities/industries are: manufacturing, non-manufacturing traded and the sheltered sectors.[viii] Given linear homogeneity in the production of value added and the implied assumption of cost minimisation and zero profits, value-added prices are determined by the corresponding industry cost functions. This means that the value-added price is a linear homogeneous function of the two regional factor prices, $w^X{}_n$ and $w^X{}_k$, which are the wage rate and the capital rental rate respectively. Similarly, the regional commodity price, $p^X{}_i$, is a linear, homogeneous function of the value-added price and the vector of intermediate prices which comprises the vector of other commodity prices in the region, the vector of commodity prices in the second region, $\underline{p}^Y$, and the vector of the domestic currency prices of foreign imports, $\underline{\bar{p}}^W$. (A "bar" above a variable indicates that this variable is taken to be exogenous in the simulations that we conduct in this paper). This relationship is shown in equation (2). The regional consumer and capital price indices, cpi^X and kpi^X, are the weighted sums of all the commodity prices in the system. These are given by equations (3) and (4). Equations (5) and (6) are the cost-minimising factor demand functions. In each regional industry the demand for labour and capital, $N^X{}_i$ and $K^X{}_i$ is a function homogeneous of degree one in regional industry output $Q^X{}_i$ and degree zero in the regional factor, value-added and commodity price.

Equation (7) gives the generic form of the regional bargaining wage-setting option used in this exercise. In this labour-market closure, for each region, the value taken by the real consumption wage is negatively related to the regional unemployment rate, u^X . Essentially, wages are determined in accordance with a regional wage curve (Blanchflower and Oswald, 1994). The particular bargaining function adopted is the econometrically-parameterised relationship identified by Layard *et al* (1991) which takes the form

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

where β is a calibrated parameter. Equation (8) is the definition of the regional unemployment rate. The regional labour force is the product of the regional population, L^X and participation rate, T^X. The regional unemployment rate is the difference between the regional labour force, $L^X T^X$, and regional employment, ΣN^X_i , expressed as a proportion of the regional labour force. The participation rate is taken to be a function of regional population and aggregate labour demand. This is represented generically in equation (9). The particular expression used is:

$$T^X = f \quad + 0.25 \frac{\sum_i N_i^X}{L^X}$$

This expression embodies the Treasury assumption (Alexander and Whyte, 1995) that 25% of any increase in regional employment comes from increased local participation, rather than reduced registered unemployment and ϕ is a calibrated parameter. The capital rental rate in each regional sector is set by equating capital demand, K^x_i with the existing capital supply, $K^{\Sigma X}_i$, which is equation (10).

Equation (11) gives regional nominal household income, Y^X, as the shares, ψ^X_n and ψ^X_k respectively, of the labour and capital income generated in the region plus the welfare transfers associated with unemployment. These transfers are given by the number of unemployed $L^X T^X u^X$ in the region multiplied by the unemployment benefit f. Equation (12) determines the regional demand for commodity i, Q^X_i . This is the sum of consumption, intermediate, investment, government, interregional export demand and international export demand, C^X_i, J^X_i , I^X_i , G^X_i , X^{XY}_i and X^{XW}_i respectively. These individual elements of commodity demand are identified in equations (13)-(18).

Consumption demand (equation 13) is a function linear in regional real income. Intermediate demand (equation 14) is a linear function of regional outputs and homogeneous of degree zero in regional value-added and all commodity prices. The first step in deriving investment demand (equation 15) is to calculate the level of investment V^X_j undertaken in each regional industry j. This is discussed later in this section where we consider capital stock updating between periods. This is converted to the investment demand for the output of a sector i by a fixed-coefficient capital matrix whose elements are b^X_{ij} . The vectors of commodity prices are also included as an argument in the investment demand equation to determine the proportion of activity which goes to the region rather than interregional or international imports. Government demand (equation 16) is simply a fixed proportion a^X_i of the total national government expenditure $\bar{G}^N$ which is exogenous in these simulations. Interregional export demand for industry i (equation 17) depends upon the relevant price vectors and consumption, intermediate, investment and government demand for industry i in the other region Y. International export demand (equation 18) is a homogeneous function of degree one in foreign demand $\bar{D}^W$ and zero in regional and foreign prices. Again in the results presented here, foreign demand is taken to be exogenous.

The between-period updating of population and capital stocks is given by equations (19) - (23). In these equations, where appropriate, there is the addition of a time subscript. Equation (19) shows that the capital stock in regional industry i and time period t, $K^{\Sigma X}_{i,t}$, equals the capital stock in that industry in the time period t-1 minus depreciation and plus gross investment in period t-1. That is to say, investment implemented in time period t-1 augment capacity in time period t. The rate of depreciation is δ^X_i and the gross investment is $V^X_{i,t-1}$. Gross investment in industry i in time period t is a proportion, λ, of the difference between actual and desired capital stock plus the capital depreciation in the previous period. This is shown in the capital-stock-adjustment equation (20). To determine the desired capital stock, $K^{*\Sigma X}_{i,t}$, equation (21) shows that we use the capital demand equation (6) but substitute the risk-adjusted user cost of capital (ucc) for the actual capital rental rate. This implies that where the capital rental rate is above the risk-adjusted user cost of capital, the desired capital stock is above the actual capital stock. In these circumstances, capital accumulation will continue until the risk-adjusted user cost of capital and the capital rental rate are brought back into equality. Therefore, in long-run equilibrium the capital rental rate in all sectors equals the appropriate risk-adjusted user cost of capital. The value of the user cost of capital depends upon the interest rate, the depreciation rate, relevant tax and subsidy rates and the regional capital price index. In the simulations performed here we hold the interest, tax and subsidy rates constant so that changes in the regional capital rental rate are determined solely by changes in the regional capital price index (equation (22)..

We assume that there is no natural population increase and that international migration can be ignored. This is formally represented by equation (23), where $\bar{L}^N$ is the exogenous national labour force. In this specification of the model, the Scottish labour force is updated between periods by net inmigration, m^S. This is given by equation (24). Net inmigration is itself determined by a flow-equilibrium specification (equation 25) where the Scottish rate of net inmigration 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 equation (25) used in these simulations is again derived from the work of Layard *et al* (1991), in this case their interregional migration function:

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

where ζ is a calibrated parameter. From equation (23), net inmigration to RUK is simply net inmigration to Scotland with the sign changed. Given that the parameterisation of the updating equations are based on annual data, periods are interpreted as years.

For these simulations the AMOSUK model is parameterised in the following way. We impose constant elasticity of substitution (CES) production functions in all sectors with the elasticity of substitution taking the value 0.3 (Harris, 1989). This is relevant for the price setting functions (equations 1 and 2) and the factor demand equations (5 and 6). We use the Armington (1969) assumption for both interregional and international trade with the elasticity of substitution taking the value 2.0 (Gibson, 1990). This is required in the consumption, intermediate, investment and export demand functions (equations 13, 14, 15, 17 and 18). The rates of depreciation δ^X_i in equation (19) are calibrated on the original data set on the assumption that the economy is initially in long-run equilibrium. The speed of adjustment parameter λ in the investment equation (20) takes the value 0.5 following econometric work on the determination of investment in Scottish manufacturing. The model is run in a comparative static mode such that we assume that the regional economy is initially in long-run equilibrium at a zero growth rate. We therefore concentrate on comparative static adjustments to the policy innovations, ignoring any possible growth effects.

3. BUSINESS COMPETITIVENESS

The activities which are included under the Business Competitiveness involve business support and/or technology and product development (Scottish Enterprise, 1998). They include specific schemes to promote technological advance in Scottish plants and to aid technologically sophisticated Scottish firms. Other initiatives covered under this Strategic Objective are the supply of venture capital and support for the development of multi-discipline “clusters” of private sector companies and public sector service and infrastructure provision.

We model improved business competitiveness as an increase in company efficiency. This increase in efficiency simply means that the same output can be produced with less factor inputs. Therefore, with constant factor prices, profitability rises and/or commodity prices fall, so that Scotland becomes more competitive as a location for business activity and/or its products become more price competitive in extra-regional markets. There are various standard characterisations of efficiency improvement. We here adopt the “Hicks-neutral” form. This is where the efficiency of all factor inputs in the production of value added is increased equiproportionally. In this form of technical change there is no inherent capital or labour bias accompanying the improvement in technology so that, with factor prices constant, the cost-minimising capital/labour ratio remains unchanged. We also assume that there is a three-year build up of the direct effects. This is consistent with the views of SE staff concerning the direct impact of their policies. We have also had to make assumptions concerning the extent of policy decay. This is much more arbitrary. The central simulations are undertaken with an assumed linear 5-year decay. However simulations have also been undertaken where alternative patterns of policy decay are imposed..

A major problem here is calibrating the size of the assumed improvement in efficiency. For the Business Competitiveness Strategic Objective we do not have a direct estimate of the increase in business competitiveness (which, as indicated, we interpret as an increase in efficiency). Rather we have the estimated direct employment impact. This is taken from the Scottish Enterprise Operating Plan-Year End Report for 1997/8 which gives the direct employment under this Strategic Objective as 17,475. A report by Cambridge Policy Consultants identifies the relationship between gross and net jobs at the Scottish level for this Strategic Objective for the year 1997/8 as 0.4571. This implies that deadweight and displacement equals just over 54% of the direct employment claimed under this objective so that the direct net increase in employment equals 7,998. What we attempt to do is to calibrate the model so that the simulation results generate this figure.

It is difficult in practice to identify the employment gains associated with supply-side efficiency improvements. There are two aspects to this problem. The first is that with a sectoral increase in efficiency there are countervailing factors operating on employment within that sector. The increased competitiveness has an expansionary impact on sectoral output which, other things being equal, generates an increase in sectoral employment. On the other hand, the reduction in employment per unit of output simultaneously limits that increase in employment. The net result is that the employment change in the sector that receives the efficiency stimulus can be low or even negative, especially in the early periods following an efficiency gain (McGregor *et al*, 1996c). Therefore, if we try to measure the employment impacts by concentrating on the sector that received the increase in efficiency and using a procedure of "grossing up" using a simple employment multiplier, the results could be perverse.

The second problem is that whilst the employment impacts on the sector receiving the efficiency shock are less than for a demand-side expansion which would generate the same increase in output, the employment impacts on other sectors can be greater. This is because the increased competitiveness of one sector tends to have expansionary impacts on other sectors which use its inputs as intermediate goods. Specifically, the reduced price in the sector whose efficiency has increased improves the competitiveness of other sectors in the regional economy. Also, because the ratio of output to employment has risen in the sector receiving the efficiency increase, the standard I-O employment multiplier will rise. The crucial point here is that for efficiency gains the direct employment effects may well be small whilst the multiplier effects are likely to be large.

What we have done in the simulations reported here is to calibrate the size of the efficiency shock to the manufacturing and non-manufacturing traded sectors so that it generates the same number of additional Scottish manufacturing and non-manufacturing traded jobs by year three as given in the SE estimates (as adjusted by Cambridge Policy Consultants). That is to say, with a three-year build up of direct efficiency gains, in period three the total increase in Scottish manufacturing and non-manufacturing traded employment is 7,998. This represents a 0.58% increase in Scottish manufacturing and non-manufacturing traded employment.

We used trial and error to identify the appropriate size of the Hicks-neutral efficiency change in the manufacturing and non-manufacturing traded sectors. This turned out to be an increase of 2.87% which produces a combined increase in period-3 employment in Scottish manufacturing and non-manufacturing traded of 7,995. We are therefore simulating the initial employment increase in these sectors to within 0.04% accuracy. For the central set of simulation results, we also assume a 5-year policy decay, beginning in period 3. This implies that we model the direct impact of SE policy as a set of exogenous efficiency shocks to the manufacturing and non-manufacturing traded sectors that apply over periods 1 to 7. The particular pattern of these disturbances is given in Figure 1.

The exogenous efficiency disturbances identified in Figure 1 produce a time-path of simulated Scottish and UK total employment change which is given in Figure 2. Note first that there is increased employment in both Scotland and the whole of the UK over the full 10-year period. That is to say, the simulations do not reveal a situation where there is 100% crowding out in RUK of this policy-induced employment change in Scotland. Also, up to period 3, the increase in UK employment is greater than the increase in Scottish employment. This implies that in the early policy periods the RUK economy experiences a positive net stimulus from the increase in efficiency experienced by the Scottish manufacturing and non-manufacturing traded sectors. After period 3 Scottish employment change is greater than UK employment change, so that there is some reduction in employment in RUK, as against the base-year level, but this reduction in RUK employment is much less than the increase in Scottish employment.

The increase in efficiency in the manufacturing and non-manufacturing traded sectors enhances Scottish competitiveness in both RUK and ROW markets. The subsequent increase in output in these Scottish sectors has a positive impact on the derived demand for labour. This is greater than the reduction in labour demand resulting from the lower unit labour input associated with the efficiency improvement. Further, the increase in intermediate and consumption demand for the output of the Scottish sheltered sector produces an additional stimulus to labour demand within Scotland. The rationale for the expansion in Scottish employment is therefore rather straightforward.[ix] For the RUK, the Scottish efficiency gain initially leads to an increase in exports to both ROW and Scotland, with a corresponding expansionary impulse to RUK activity. RUK competitiveness with ROW is increased through lower nominal wages and intermediate prices. Exports to Scotland rise, even though RUK competitiveness falls, because the increase in activity in Scotland stimulates consumption, investment and intermediate demand. However, over time outmigration from RUK to Scotland puts upward pressure on RUK wages whilst easing wage pressure in Scotland adversely affecting RUK employment.

At the UK level, the underlying rationale for increased activity as a result of the Business Competitiveness Strategic Objective comes through the labour market. The improvement in Scottish manufacturing and non-manufacturing traded efficiency and the subsequent improvement in the terms of trade allows a fall in the nominal wage to be accompanied by a rise in the real consumption wage. Under these circumstances the quantity demanded and supplied of labour can rise simultaneously, increasing employment and economic activity. The Treasury 100% crowding-out assumption does not apply in this case.

This change in activity in both Scotland and UK also has impacts on GDP, tax receipts and benefit payments and the balance of payments.[x] The period-3 values of these variables are shown in Table 2. (The proportionate impact on a wider range of nominal and real variables over the full 10 years is given in Appendix 1). With the balance of payments, a negative change represents an improvement. We report figures for the GDP and employment changes for both Scotland and the UK. For changes in government revenue and benefit payments and balance of payments, we only give the UK figures.

The first point to make about the simulation results is that the implied improvement in efficiency is very large and generates substantial aggregate effects. Scottish GDP increases by £1,079,365,000 accompanied by an increase in total Scottish employment of 16,821. Secondly, note the sectoral distribution of employment change. The period-3 increase in Scottish sheltered employment is over 10% higher than the increase in manufacturing and non-manufacturing traded employment combined. The total UK impacts are similarly very large. UK GDP in period 3 is estimated to increase by £1,156,821,000. This implies that there is an increase in RUK GDP (calculated by subtracting the Scottish value from the UK value) of £77,456,000 which is 7% of the Scottish figure, and RUK period-3 employment increases by 1,324 which is 7.8% of the change in employment in Scotland. It is clear that, rather than crowding out occurring, RUK benefits from the expansion in the Scottish economy, at least in the initial periods. These RUK benefits are concentrated in manufacturing. There are small falls in activity in RUK non-manufacturing traded and the sheltered sector.

We observe very significant increases in UK government savings in these simulations. By period 3, increases in government tax revenue are £390,791,000 and unemployment benefit savings are calculated as £7,285,000. This has to be offset against an initial public expenditure of £90,472,000 identified in the 1997/98 Operating Plan-Year End Report for the Business Competitiveness Strategic Objective. Period-3 government savings are therefore over four times the initial public expenditure, and the expenditure in this Strategic Objective breaks even in the period 1. Accompanying the increase in government savings is an improvement in the UK balance of payments of £157,883,000 (balance of payments improvements are identified by negative changes here). This is not surprising given the period-3 2.65% and 3.75% expansion in Scottish manufacturing and non-manufacturing traded exports to ROW and the 0.07% and 0.10% increase in RUK exports to the ROW in the same two sectors. There is a reduction in Scottish ROW exports from the sheltered sector, but these are very small in absolute terms so that the manufacturing and non-manufacturing traded sectors dominate the aggregate results.

Table 3 presents the cumulative sums of the monetary variables discounted using the Treasury-recommended rate of 6% *per annum*. Calculations are made for a number of assumptions about decay. The size of these cumulated figures is large. Note especially that, even with the most rapid (sudden-death) decay after period 3, the discounted government revenue increase is just under eight times the value of the initial public expenditure. There are similarly substantial gains to the UK balance of payments.. Table 4 gives Scottish and UK employment changes over the whole 10-year time span, under the same set of assumptions concerning policy-effectiveness decay. Also shown in Table 4 is the cumulative discounted employment total for the ten year period. This is the estimated total discounted jobs, measured in present value years (PVYs). Again we observe substantial employment gains both at the Scottish and UK level. Moreover, if the relaxation of the national macroeconomic budget constraints identified in Table 3 led to a subsequent rise in Government expenditure (or reduction in taxation), there would be a further expansion in economic activity so that on this score, the results presented here for the increase in national employment are conservative.

4. EVALUATION OF THE OTHER STRATEGIC OBJECTIVES

In the evaluation of the impact of the six other Strategic Objectives pursued by Scottish Enterprise, we use exactly the same general method as adopted for Business Competitiveness. That is to say, we introduce an exogenous disturbance to the AMOSRUK model which qualitatively replicates the direct impacts of the policy initiative. This disturbance is calibrated to generate a period-three change in simulated activity in the relevant Scottish sectors which hits the estimated direct impacts from SEN's independent evaluation methods. Again, typically we impose a three-year build up of effects. The model is then run forward under various assumptions concerning effectiveness decay. The key information provided by the model is the change in activity in those sectors not directly stimulated by the Strategic Objective, including RUK sectors.

For some Strategic Objectives the nature of the disturbance is very straightforward. For example, one of the Strategic Objectives involves encouraging export growth. The effect of this Strategic Objective can be simulated very easily: all that is required is an exogenous shock to Scottish exports to the rest of the world (McGregor *et al*, 1998). However, with other Strategic Objectives it is more difficult for the model to capture the direct policy stimulus. For some (e.g. Physical Business Infrastructure) considerable ingenuity is required to emulate the qualitative nature of the disturbance. For others (e.g. Skills and Knowledge) it is difficult to calibrate the model to achieve the appropriate scale of direct estimated effects. Finally, for Strategic Objectives where there is thought to be direct displacement in RUK activity (New Business, Inward Investment) the exogenous shock has elements which apply to RUK industries as well as Scottish industries.

5. STRENGTHS OF THE CGE APPROACH

The major advantage gained from using this CGE approach, as against the conventional Keynesian or Input-Output multiplier models, is the ability to deal with supply-side disturbances and constraints. In terms of disturbances, many of the Strategic Objectives pursued by Scottish Enterprise have a supply-side orientation. That is to say, they aim to improve the efficiency and/or reduce the costs facing specific sectors of the Scottish economy. Such supply-side changes affect relative prices and competitiveness in other Scottish and RUK sectors. They also generally change the relationship between employment, value-added and gross output in the policy-targeted sectors. In these circumstances, the ratio of the change in activity in the sectors which are the focus of SE policy initiatives and the change in total activity is more complex than the standard Keynesian and I-O analyses allow. In short, traditional multiplier values may provide wildly inaccurate measures of the impact on other sectors.

In the evaluation of regional regeneration policies, a key issue is the nature of the national effects. At present, the UK Treasury view is that such policies have no overall expansionary impact on the national economy (HM Treasury, 1997). This rule applies specifically to employment. Such a position implies that an increase in employment in the region where policy is in operation will be fully offset by an equal and opposite reduction in employment in the rest of the UK: there is assumed to be 100% displacement at the national level. This carries the implication that regional policy only has spatially redistributive effects. Also in calculating the exchequer cost of regional policy, HM Treasury argue that it is inappropriate to offset any of the subsidy cost with reduced payment of unemployment benefit or an increased tax take.

However, we have never seen an explicit defence of the Treasury position on complete national displacement.[xi] Further, AMOSRUK clearly identifies national effects which accompany effective supply-side policies. Where such national impacts occur, regional policy potentially has positive efficiency and redistributive implications. Also the reduced welfare payments and the increased tax receipts should be set against the subsidy payments (and ideally also other public and private sector costs (Swales, 1997)) in the evaluation of regional policy. AMOSRUK presents a much more sophisticated representation of the supply side of the national economy than that adopted by HM Treasury in their rules for the evaluation of spatial regeneration policy. As such it might offer a means to engage in a more appropriate debate about the national implications of spatial policy.

Even where a Strategic Objective has direct impacts which are captured by an expansion in demand, CGE analysis, unlike I-O and Keynesian models, incorporates supply-side constraints in the subsequent regional and national adjustments.[xii] One central constraint is represented by the operation of the labour market. Here there are two key considerations: the wage setting mechanism and the regional migration function. If one believes that regional wages are sensitive to the tightness of the local labour market, any expansion in regional demand for labour will be partially offset by increased wages. This sensitivity to local labour market conditions can be motivated by wage curve, regional bargaining or competitive labour market arguments (Blanchflower and Oswald, 1994; Layard *et al*, 1991; Minford *et al*, 1994). Conventional demand-orientated multipliers fail to capture the substitution of capital for labour and the fall in regional competitiveness that accompanies such a wage increase.

The second important labour-market issue is interregional migration. The population movements that result from changing economic conditions have an impact both on the extent and the time path of adjustment to economic disturbances. In general, migration eases labour market pressure in the aided region (Scotland), so that the positive impacts on this region tend to rise over time. However, the opposite occurs in the non-aided region (RUK) where outmigration tightens the local labour market and leads to reduction in labour demand. These considerations are ignored in the conventional UK evaluation procedures.

A further supply-side constraint is posed by the short-run fixity of the capital stock. Here we expect capacity constraints to bind before they are eased through net investment. Again such capacity constraints have price and competitiveness implications which are neglected in the standard demand-driven approach. Also the relaxing of both short-run capital- and labour-supply constraints through investment and regional migration takes time.

Our CGE analysis maps out not just the extent, but also time-path, of adjustment of the regional and national economies to the policy disturbance.

A final advantage of the CGE analysis is that it provides an additional, indirect check on the accuracy of the estimate of the direct policy effect. That is to say, the size of the disturbance required to hit the estimated direct employment target might add support to, or cast doubt upon, the validity of this estimate. In the example which is the focus of this paper, the Business Competitiveness Strategic Objective, we require a 2.87% Hicks-neutral increase in efficiency in the manufacturing and non-manufacturing traded sectors in order to produce the period-3 direct employment effects. On the face of it, this increase seems too large and suggests that some iterative procedure, using both microeconomic and system-wide CGE results, would be desirable in determining the size of the direct impacts.

6. POTENTIAL EXTENSIONS

Our view is that the simulation results given in this paper present a more accurate account of the regional and national operation of regional supply-side policy than the present official UK evaluation procedures. However, the validity and accuracy of these CGE results could be improved. There are three main sources for such improvement. These can be classified under the following headings: model calibration and parameterisation; identifying and modelling the direct effect; and model characteristics.

6.1 Model calibration and parameterisation

At present the model is calibrated to a 1989 data set. The core of this data set is an interregional Social Accounting Matrix (SAM), which is built around an interregional Input-Output table. This interregional I-O table is itself constructed from two separate tables, one for Scotland and the other for the UK economy as a whole. The simulation results would be improved if we had a more up to date and reliable interregional SAM. One key requirement for interregional CGE analysis is the timely construction of interregional I-O tables. The availability of such information is not problematic for some countries but is for the UK, where no official interregional I-O tables have ever been constructed.

A standard criticism of CGE analysis is that simulation results can be sensitive to the values of key parameters which are sometimes at best “guess estimates”. There is validity in this argument though our view is that CGE modelling is not very different from other modelling approaches on this score. After all, I-O analysis adopts particular (and extreme) parameter values in the use of fixed coefficients in production and consumption. Further, regional econometric modelling often imposes parameter restrictions (Minford *et al*., 1994). In our approach, wherever possible we use econometrically estimated parameter values, examples being in the wage-setting and migration functions. However, it is true to say that a lack of data makes reliable regional econometric work difficult in the UK. An improvement in UK regional data would again improve the accuracy of CGE simulations.[xiii]

6.2 Identifying and modelling the direct effects

The veracity of the regional and national impacts of SE’s policies identified by AMOSRUK depends crucially on the accuracy of the estimates of the direct effects. Within a UK context such effects are conventionally measured through some sort of “industrial survey” method (Armstrong and Taylor, 1993; Foley, 1992). In this paper we do not question the validity of the estimates of the direct effects: the simulation results given here are presented as conditional on the accuracy of the estimates of the direct effects. However, it would be desirable to integrate more closely the processes involved in both the estimation of the direct effects and the simulation of the system-wide impacts. Crucially, the assumptions made in the calculation of the direct effects must be consistent with the assumptions implied in the parameterisation of the CGE model. Also, as argued in the previous section, attempts to model the estimated direct effect produce indirect evidence concerning the plausibility of the size of these effects.

A closely related issue is the propriety of the exogenous shocks chosen to emulate SE’s policies. Close consideration of this topic can bring gains both to the policy maker and the economic modeller. The operation of the CGE model requires a precise specification of the way in which policy is expected to operate. Such a discipline can be useful for policy makers. But attempting appropriately to capture these supply-side policy effects also has major benefits for the modeller as it tests the policy-relevance of the model. Our view is that the interaction between the modeller and the policy maker should be a two-way process. The model provides information to the policy maker on the constraints imposed by system-wide effects operating in the economy. The policy maker provides information on the relevance of the model to current policy concerns.

6.3 Model characteristics

We have used the two-region AMOSRUK model to investigate the impact of a supply-side disturbance in one region. The results are both quantitatively plausible and qualitatively consistent with standard economic theory. However, it would be useful to investigate more systematically the national characteristics of the model. That is to say, where we introduce an exogenous disturbance which does not vary across regions, how do the results from AMOSRUK compare with those derived from other econometric UK national models? It must be stressed here that we would not expect, nor necessarily want, the national behaviour of AMOSRUK to replicate the behaviour of national econometric models. AMOSRUK has a more fully-developed supply side which is explicitly regionally-disaggregated.. However, major discrepancies should be investigated and explained.

In a similar vein, we have yet to fully investigate the regional characteristics of the model. That is to say, we have not compared the impact of the same disturbance when targeted on each of the two regions of the UK. The work presented in this paper suggests that supply side policies have national impacts and that those impacts are geographically concentrated in the areas where the supply disturbance occurred. However, it does not show that such policies should necessarily be focused on development areas. Moreover, we have yet to think closely about what the model implies about the nature of the underlying regional problem.

7. CONCLUSIONS

In the past decade the “industrial survey” method has dominated the evaluation of UK regional regeneration policy (Foley, 1992. HM Treasury, 1995, 1997). This method relies on interview and questionnaire techniques to identify policy effectiveness. The prevalence of discretionary policy instruments, such as those operated by Scottish Enterprise, is at least part of the explanation of the popularity of this approach. It is difficult to know how government could quantify the effectiveness of certain elements of such a policy without a direct approach to firms (Swales, 1997). However, the focus on the "industrial survey" method has been accompanied by a severe neglect of spatially disaggregated system-wide modelling. We believe that this is a mistake. "Industrial survey" and modelling approaches can play complementary roles in the identification of policy impacts, at least in the context of models that possess a fully-specified supply side (Gillespie *et al*. 1998). This paper hopefully lays some of the groundwork for such a marrying of techniques. Moreover the explicit modelling of national effects opens up the debate on the efficiency effects of spatial policy.

REFERENCES

Alexander, J.M. and Whyte, T.R. (1995)."Output, Income and Employment Multipliers for Scotland", *Scottish Economic Bulletin*, vol. 50, Winter 1994/95.

Armington, P. (1969). “A Theory of Demand for Products Distinguished by Place of Production”, *IMF Staff Papers*, vol. 16, 157-178.

Armstrong, H. and Taylor, J. (1993). *Regional Economics and Policy (2nd edition)*, Harvester Wheatsheaf, Brighton.

Blanchflower, D.G. and Oswald, A.J. (1994). *The Wage Curve*, M.I.T. Press.

Buckley, P.H. (1992). “A Transport-Orientated Interregional Computable general Equilibrium Model of the United States”, *The Annals of Regional Science*, vol. 26, pp. 331-348.

Foley, P. (1992). "Local Economic Policy and Job Creation", *Urban Studies*, vol. 29, pp.557-598.

Gazel, R., Hewings, G.J.D. and Sonis, M. (1995). “Trade, Sensitivity and Feedbacks: Interregional Impacts of the US-Canada Free Trade Agreement” in J.C.J.M. van den Bergh, P. Nijkamp and P. Rietveld, eds. *Recent Advances in Spatial Equilibrium Modelling*, Springer, New York.

Gibson, H. (1990). “Export Competitiveness and UK Sales of Scottish Manufactures”, Paper delivered to the Scottish Economists’ Conference, The Burn, 1990.

Gillespie, G., McGregor, P.G., Swales, J.K. and Yin, Y.P. (1998). "The Displacement and Multiplier Effects of Regional Selective Assistance: A Computable General Equilibrium Analysis", Strathclyde Papers in Economics, No. 98/3, Department of Economics, University of Strathclyde.

Harrigan, F.. and McGregor, P.G. (1989). “Neoclassical and Keynesian Perspectives on the Regional Macroeconomy: A Computable General Equilibrium Approach”, *Journal of Regional Science*, vol. 29, pp. 555-573.

Harrigan, F., McGregor, P.G., Dourmashkin, N., Perman, R., Swales, J.K. and Yin, Y.P. (1991). ”AMOS: A Macro-Micro Model of Scotland”, *Economic Modelling*, vol. 10, pp. 424-479.

Harris, R.I.D. (1989). *The Growth and Structure of the UK Regional Economy 1963-85*, Avebury, Aldershot.

H M Treasury (1995). *A Framework for the Evaluation of Regeneration Projects and Programmes*, HMSO, London.

H M Treasury (1997). *Appraisal and Evaluation in Central Government: Treasury Guidance*, The Stationary Office, London.

Jones, R. and Whalley, J. (1990). "Regional Balance Sheets of Gains and Losses from National Policies", *Regional Science and Urban Economics*, vol. 20, pp. 421-435.

Kilkenny, M. (1998). "Transport Costs and Rural Development", *Journal of Regional Science*, vol. 38, pp. 293-312.

Layard, R., Nickell, S. and Jackman, R. (1991). *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford University Press, Oxford.

McGregor, P.G., Swales, J.K. and Yin, Y.P., (1996a), "The System-Wide Impact on the Recipient Region of a Regional Labour Subsidy", *Oxford Economic Papers*, vol. 48, pp. 105-133.

McGregor, P.G., Swales, J.K. and Yin, Y.P., (1996b), "AMOS-RUK: An Interregional Computable General Equilibrium Model of Scotland and Rest of the UK", Paper presented at the 5th World Congress of the Regional Science Association, Tokyo, May, 1996.

McGregor, P.G., Swales, J.K. and Yin, Y.P., (1996c), "The Impact of an Increase in Regional Efficiency", paper presented at the ESRC Urban and Regional Study Group, Queen's University, Belfast, December, 1996.

McGregor, P.G., Swales, J.K. and Yin, Y.P., (1998), "The Scottish and UK Effects of the Promotion of Scottish Exports: An Inter-Regional CGE Analysis", paper presented at the Regional Science Association International, British and Irish Section, York, September, 1998.

McVittie, E. and Swales, J.K. (1999), "Sector-Specific Factor Subsidies and Employment in a Regional Price-Endogenous Export-Base Model", *Environment and Planning A*, forthcoming

Minford, P., Stoney, P., Riley, R. and Webb, B. (1994), "An Econometric Model of Merseyside: Validation and Policy Simulations", *Regional Studies*, vol. 28, pp. 563-575.

Morgan, W., Mutti, J. and Rickman, D. (1996), "Tax Exporting, Regional Economic Growth and Welfare", *Journal of Urban Economics*, vol. 39, pp. 131-159.

Moore, B., Rhodes, J. and Tyler, P. (1987), *The Effects of Government Regional Economic Policy*, HMSO, London.

Mutti, J., Morgan, W. and Partridge, M. (1989). "The Incidence of regional taxes in a General Equilibrium Framework", *Journal of Public Economics*, vol. 39, pp. 83-107.

Office of National Statistics (1997), *United Kingdom National Accounts: The Blue Book*, London, The Stationery Office.

PA Cambridge Economic Consultants Ltd. (1993), *Regional Selective Assistance 1985-88*, HMSO, London.

Partridge M.D. and Rickman, D.S. (1998), “Regional Computable General Equilibrium Modelling: A Survey and Critical Appraisal”, *International Regional Science Review*, vol. 21, pp. 205-248.

Rickman, D.S. (1992), “Estimating the Impacts of Regional Business Assistance Programs: Alternative Closures in a Computable General Equilibrium Model”, *Papers in Regional Science*, vol. 71, pp. 421-435.
:
Scottish Enterprise (1998), *Annual Report, 1997-98*, Scottish Enterprise, Glasgow.

Scottish Office Industry Department (1994). *Scottish Input-Output Tables for 1989*, HMSO, Edinburgh.

Swales, J.K. (1997). "The *Ex Post* Evaluation of Regional Selective Assistance", *Regional Studies*, vol. 31, pp. 857-863.

Treyz, G.I., Rickman, D.S. and Greenwood, M.J. (1993). “ The Dynamics of U.S. Internal Migration”, *Review of Economic and Statistics*, vol. 75, pp. 209-214.

FOOTNOTES

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[i] Additionality is the extent to which the project would have gone ahead in the target area had the regional aid not been available. Displacement is reduction in activity in unaided companies as a result of the expansion in activity in aided companies (HM Treasury, 1997).

[ii] Scottish Enterprise is a regional development agency located in Scotland but funded at the UK (national) level. Its broad aims are to create jobs and prosperity for the people of Scotland. These aims have been operationalised through seven Strategic Objectives: Business Competitiveness, New Business, Inward Investment, Exports, Skills and Knowledge, Physical Business Infrastructure and Access to Opportunity (Scottish Enterprise, 1998). The paper is based on work undertaken by the present authors for Scottish Enterprise on the evaluation of the impact of all seven Strategic Objectives.

[iii] AMOSRUK is an acronym for *A M*acro-micro model *O*f *S*cotland and the *R*est of the *UK*.

[iv] One cost of such a parsimonious approach is that it does not do full justice to the whole range of outputs of SE. This observation holds particularly for those Strategic Objectives where goals such as social inclusion and environmental improvement are important

[v] For a review of regional CGE modelling see Partridge and Rickman (1998).

[vi] In the single-region version Scottish prices, wages and activity are endogenous, but prices, wages and activity in the rest of the UK are exogenous.

[vii] Numerous other macroeconomic options are possible for interest rate and exchange rate determination in a national CGE context. Some of these are discussed in McGregor *et al* (1996b).

[viii] The sheltered sector is made up of service sectors which undertake very low levels of extra-regional trade. Manufacturing comprises sectors 12-89; non-manufacturing traded sectors 1-10, 91-97, 99, 109-111; sheltered sectors 11, 90, 98, 103-108 and 112-114 in the 1989 Scottish I-O tables (Scottish Office Industry Department, 1994).

[ix] However, it is important to note that if the elasticity of labour demand is low, employment can fall with an increase in labour productivity (McGregor *et al*, 1996c).

[x] AMOSRUK is calibrated on a 1989 data set. We have converted nominal values to 1997 prices using the UK GDP deflator (Office of National Statistics, 1997).

[xi] It might be that this rule has been adopted for evaluation convenience in order to reduce influence costs from areas seeking assistance or as a convenient assumption under circumstances where up to now it has been difficult to accurately identify the national effects of local regeneration policies.

[xii] An example would be the Exports Strategic Objective. However, even here in our inter-regional CGE approach the primary way in which an expansion in exports operates is through the improvement in the terms of trade that it generates. This allows the real

consumption wage to rise, thereby expanding labour supply, and the real product wage to simultaneously fall, expanding labour demand.

[xiii] It is unlikely that appropriate econometric estimation and testing of regional CGEs will prove feasible in the foreseeable future. Accordingly, it is inevitable that some degree of uncertainty will attend the values of key parameters and some aspects of market structure. Where this is true, sensitivity analysis can shed light on the likely policy significance of this uncertainty.

Figures and Tables.

Figure 1: The Time Pattern of Exogenous Hicks-Neutral Efficiency Shocks to the Manufacturing and Non-Manufacturing Traded Sectors, with an Assumed with 5 Year Decay.

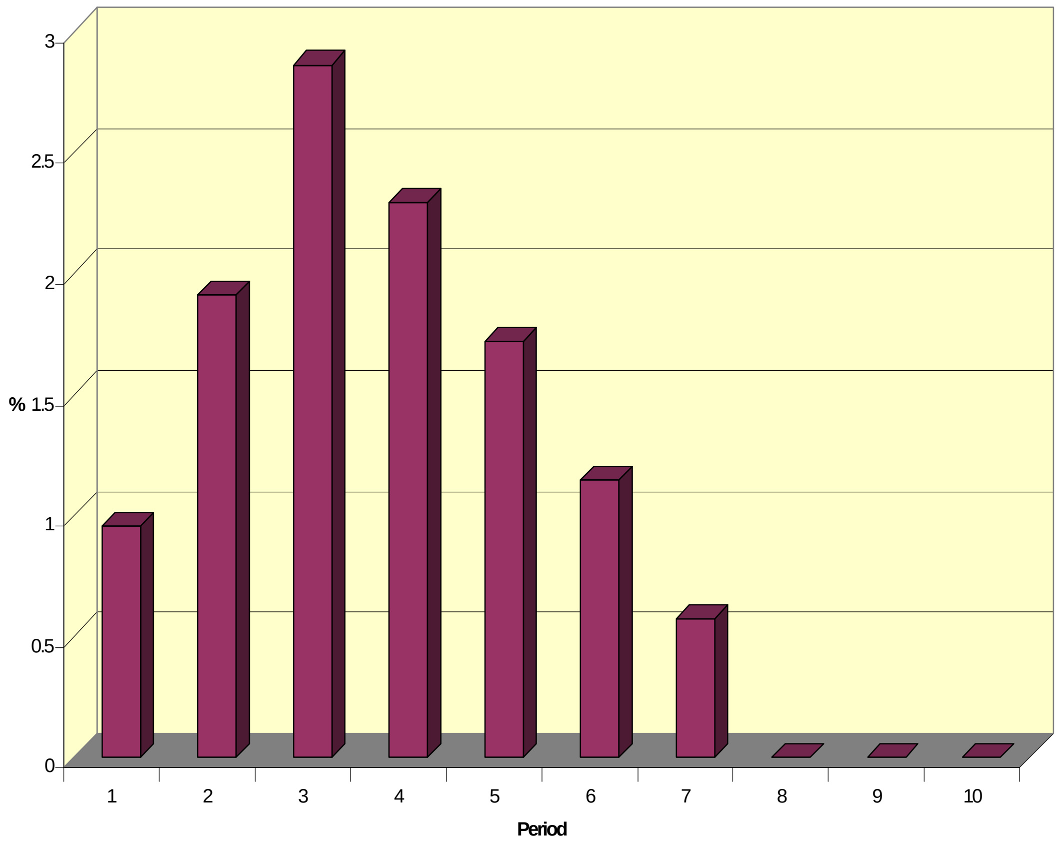

Figure 2: The Estimated Change in Total Employment in Scotland and UK as a result of SE's Business Competitiveness Strategic Objective.

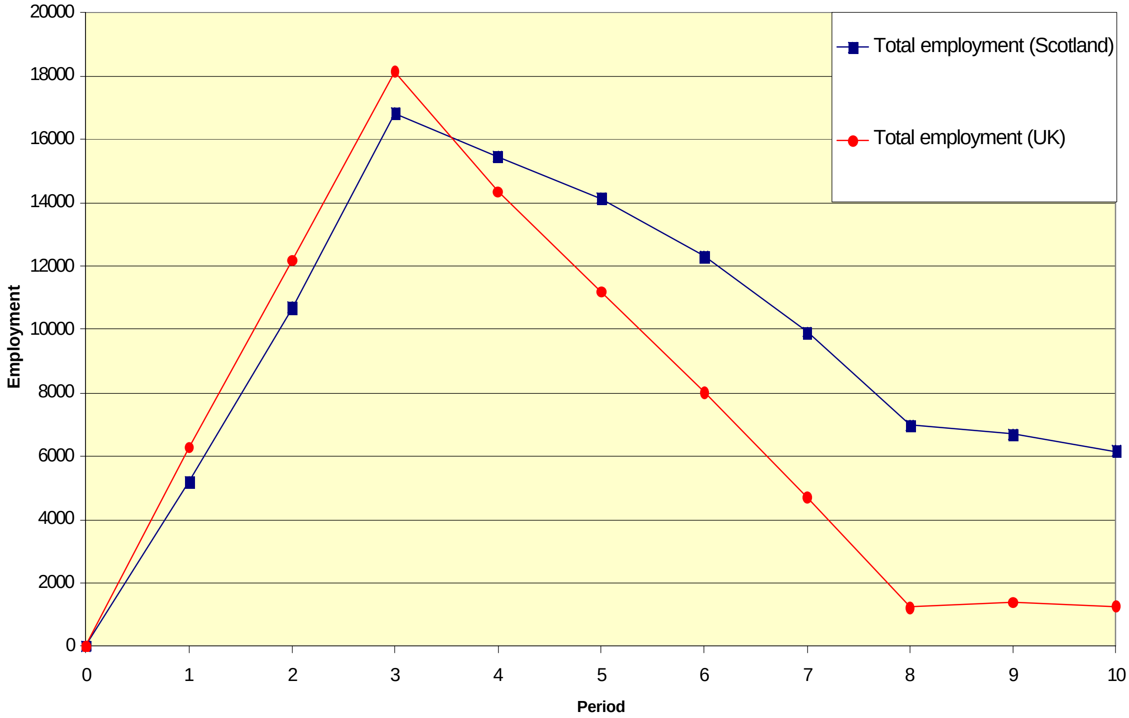

Table 2: Scottish and UK Effects in period 3 of SE's Business Competitiveness Strategic Objective.

Table 2 - Period 3 Results

	Scotland Period 3	UK Period 3
GDP (real), £million	1079.365	1156.821
Total employment (000's)	16.821	18.145
Manufacturing:	2.167	3.870
Non-Manu traded:	5.828	5.697
Sheltered:	8.826	8.579
Government tax revenue, £million	-	390.791
Expenditure on benefits, £million	-	-7.285
Balance of Payments, £million	-	-157.883

Table 3: The Cumulative Discounted Scottish and UK Financial Effects of SE's Business Competitiveness Strategic Objective.

	Scot GDP	UK GDP	UK Tax Revenue	UK Expend. On Benefits	UK Balance Of Payments
Periods 1 to 3	1973.691	2134.584	720.367	-13.838	-264.855
Periods 1 to 10:					
5 Year Decay	4297.213	4168.752	1402.652	-23.203	-891.462
10 Year Decay	6018.799	5945.095	2005.855	-33.830	-1192.271
No Decay	8120.200	8135.425	2749.210	-47.284	-1531.891

Table 4: Period by Period Employment Results for SE's Business Competitiveness Strategic Objective for a Range of Assumptions Concerning Policy Decay.

	Period 1	Period 2	Period 3	Period 4	Period 5
Scotland:					
5 Year Decay	5.188	10.686	16.821	15.452	14.128
10 Year Decay	5.188	10.686	16.821	16.994	17.335
No Decay	5.188	10.686	16.821	18.532	20.529
UK:					
5 Year Decay	6.294	12.188	18.145	14.359	11.183
10 Year Decay	6.294	12.188	18.145	16.219	14.827
No Decay	6.294	12.188	18.145	18.075	18.459

Table 4 Continued.

	Period 6	Period 7	Period 8	Period 9	Period 10	Cumulative Discounted Employment Total
Scotland:						
5 Year Decay	12.313	9.923	6.983	6.698	6.171	83.100
10 Year Decay	17.395	17.093	16.438	15.458	14.182	112.313
No Decay	22.452	24.225	25.843	27.317	28.660	147.205
UK:						
5 Year Decay	8.014	4.699	1.222	1.392	1.261	66.589
10 Year Decay	13.469	12.015	10.446	8.773	7.012	94.440
No Decay	18.900	19.296	19.623	19.890	20.100	128.891

Appendix 1: Percentage Changes in Key Scotland and RUK Variables as a result of SE's Business Competitiveness Strategic Objective.

SCOTLAND	Period 1	Period 2	Period 3	Period 4	Period 5
GDP (real)	0.751	1.526	2.334	1.981	1.614
Consumption (real)	0.383	0.792	1.223	1.059	0.872
Nominal before tax wage	-0.108	-0.207	-0.321	-0.294	-0.297
Real take-home wage	0.120	0.261	0.397	0.328	0.221
Total employment (000's)	0.230	0.475	0.747	0.687	0.628
Manufacturing:	0.122	0.254	0.411	0.409	0.413
Non-Manu traded:	0.202	0.428	0.690	0.673	0.651
Sheltered:	0.322	0.652	1.003	0.866	0.735
Total labour supply (000's)	0.052	0.162	0.319	0.436	0.495
Unemployment rate	-1.751	-3.078	-4.221	-2.459	-1.305
Population (000's)	0.000	0.070	0.194	0.362	0.455
Price of value added:					
Manufacturing	-0.957	-1.905	-2.852	-2.350	-1.848
Non-Manu traded	-0.835	-1.681	-2.539	-2.144	-1.728
Sheltered	0.065	0.096	0.083	-0.080	-0.214
Price of commodity output:					
Manufacturing	-0.434	-0.867	-1.301	-1.072	-0.842
Non-Manu traded	-0.599	-1.207	-1.826	-1.540	-1.241
Sheltered	0.059	0.085	0.073	-0.075	-0.196
Consumer price index	-0.229	-0.465	-0.715	-0.620	-0.516
Value-added:					
Manufacturing	1.049	2.116	3.211	2.654	2.098
Non-Manu Traded	1.093	2.223	3.397	2.859	2.302
Sheltered	0.269	0.560	0.881	0.801	0.710
Exports to the other region:					
Manufacturing	0.768	1.548	2.349	1.954	1.556
Non-Manu Traded	0.843	1.716	2.627	2.230	1.816
Sheltered	0.189	0.405	0.654	0.644	0.615
Exports to ROW:					
Manufacturing	0.875	1.756	2.653	2.179	1.706
Non-Manu Traded	1.210	2.459	3.753	3.152	2.528
Sheltered	-0.117	-0.170	-0.146	0.150	0.393
Real income (CPI deflator):					
Households disposable	0.384	0.792	1.222	1.058	0.872
Firms disposable	0.706	1.376	2.042	1.580	1.181

Appendix 1 Continued

SCOTLAND	Period 6	Period 7	Period 8	Period 9	Period 10
GDP (real)	1.220	0.796	0.346	0.325	0.297
Consumption (real)	0.667	0.447	0.211	0.194	0.178
Nominal before tax wage	-0.288	-0.259	-0.211	-0.212	-0.195
Real take-home wage	0.113	0.013	-0.079	-0.092	-0.086
Total employment (000's)	0.548	0.442	0.311	0.299	0.275
Manufacturing:	0.399	0.361	0.299	0.290	0.269
Non-Manu traded:	0.600	0.517	0.403	0.384	0.355
Sheltered:	0.586	0.418	0.230	0.221	0.203
Total labour supply (000's)	0.511	0.490	0.438	0.389	0.350
Unemployment rate	-0.359	0.479	1.251	0.892	0.729
Population (000's)	0.500	0.504	0.475	0.416	0.372
Price of value added:					
Manufacturing	-1.328	-0.787	-0.225	-0.222	-0.210
Non-Manu traded	-1.285	-0.814	-0.314	-0.296	-0.274
Sheltered	-0.305	-0.357	-0.375	-0.327	-0.280
Price of commodity output:					
Manufacturing	-0.605	-0.359	-0.102	-0.100	-0.094
Non-Manu traded	-0.922	-0.583	-0.224	-0.211	-0.195
Sheltered	-0.278	-0.323	-0.340	-0.297	-0.254
Consumer price index	-0.400	-0.272	-0.132	-0.120	-0.108
Value-added:					
Manufacturing	1.522	0.924	0.303	0.293	0.274
Non-Manu Traded	1.712	1.089	0.434	0.409	0.379
Sheltered	0.591	0.447	0.280	0.256	0.228
Exports to the other region:					
Manufacturing	1.140	0.705	0.249	0.239	0.222
Non-Manu Traded	1.370	0.893	0.385	0.360	0.329
Sheltered	0.551	0.454	0.328	0.295	0.258
Exports to ROW:					
Manufacturing	1.222	0.721	0.205	0.201	0.189
Non-Manu Traded	1.869	1.175	0.449	0.423	0.391
Sheltered	0.558	0.651	0.682	0.596	0.509
Real income (CPI deflator):					
Households disposable	0.667	0.447	0.212	0.194	0.178
Firms disposable	0.795	0.409	0.020	0.052	0.059

Appendix 1 – RUK

RUK	Period 1	Period 2	Period 3	Period 4	Period 5
GDP (real)	0.006	0.010	0.013	0.005	-0.002
Consumption (real)	0.010	0.019	0.027	0.017	0.008
Nominal before tax wage	-0.014	-0.026	-0.033	-0.016	-0.003
Real take-home wage	0.004	0.012	0.023	0.032	0.035
Total employment (000's)	0.005	0.006	0.005	-0.005	-0.014
Manufacturing:	0.013	0.024	0.032	0.018	0.006
Non-Manu traded:	0.002	0.002	-0.002	-0.011	-0.019
Sheltered:	0.002	0.000	-0.004	-0.013	-0.020
Total labour supply (000's)	0.001	-0.003	-0.012	-0.026	-0.034
Unemployment rate	-0.051	-0.152	-0.270	-0.321	-0.321
Population (000's)	0.000	-0.006	-0.017	-0.032	-0.041
Price of value added:					
Manufacturing	-0.003	-0.008	-0.014	-0.016	-0.015
Non-Manu traded	-0.012	-0.024	-0.036	-0.028	-0.019
Sheltered	-0.013	-0.026	-0.038	-0.029	-0.019
Price of commodity output:					
Manufacturing	-0.011	-0.022	-0.034	-0.031	-0.026
Non-Manu traded	-0.016	-0.032	-0.048	-0.038	-0.028
Sheltered	-0.012	-0.024	-0.035	-0.029	-0.020
Consumer price index	-0.019	-0.037	-0.057	-0.048	-0.038
Value-added:					
Manufacturing	0.009	0.018	0.026	0.018	0.010
Non-Manu Traded	0.002	0.002	-0.001	-0.008	-0.014
Sheltered	0.001	0.000	-0.002	-0.009	-0.015
Exports to the other region:					
Manufacturing	0.238	0.471	0.703	0.558	0.420
Non-Manu Traded	0.137	0.276	0.416	0.339	0.259
Sheltered	0.092	0.184	0.273	0.207	0.139
Exports to ROW:					
Manufacturing	0.021	0.044	0.069	0.062	0.052
Non-Manu Traded	0.032	0.064	0.096	0.076	0.056
Sheltered	0.023	0.047	0.070	0.057	0.041
Real income (CPI deflator):					
Households disposable	0.010	0.019	0.026	0.017	0.008
Firms disposable	0.021	0.038	0.053	0.032	0.015

Appendix 1 Continued RUK

RUK	Period 6	Period 7	Period 8	Period 9	Period 10
GDP (real)	-0.009	-0.014	-0.019	-0.018	-0.018
Consumption (real)	0.001	-0.007	-0.013	-0.013	-0.013
Nominal before tax wage	0.008	0.017	0.024	0.021	0.018
Real take-home wage	0.034	0.031	0.026	0.021	0.017
Total employment (000's)	-0.020	-0.024	-0.026	-0.024	-0.023
Manufacturing:	-0.004	-0.014	-0.021	-0.020	-0.019
Non-Manu traded:	-0.024	-0.028	-0.029	-0.027	-0.026
Sheltered:	-0.024	-0.026	-0.026	-0.023	-0.021
Total labour supply (000's)	-0.039	-0.040	-0.039	-0.034	-0.031
Unemployment rate	-0.304	-0.253	-0.202	-0.152	-0.135
Population (000's)	-0.044	-0.045	-0.042	-0.037	-0.033
Price of value added:					
Manufacturing	-0.012	-0.008	-0.002	0.002	0.004
Non-Manu traded	-0.010	-0.001	0.008	0.009	0.010
Sheltered	-0.010	0.000	0.010	0.011	0.012
Price of commodity output:					
Manufacturing	-0.019	-0.012	-0.003	-0.001	0.001
Non-Manu traded	-0.018	-0.007	0.005	0.006	0.007
Sheltered	-0.012	-0.003	0.006	0.008	0.009
Consumer price index	-0.027	-0.015	-0.002	0.000	0.002
Value-added:					
Manufacturing	0.002	-0.006	-0.013	-0.014	-0.015
Non-Manu Traded	-0.019	-0.022	-0.024	-0.024	-0.023
Sheltered	-0.019	-0.021	-0.022	-0.021	-0.019
Exports to the other region:					
Manufacturing	0.285	0.150	0.015	0.021	0.023
Non-Manu Traded	0.179	0.099	0.017	0.017	0.017
Sheltered	0.076	0.018	-0.036	-0.032	-0.027
Exports to ROW:					
Manufacturing	0.039	0.024	0.007	0.002	-0.002
Non-Manu Traded	0.035	0.013	-0.009	-0.011	-0.013
Sheltered	0.024	0.006	-0.012	-0.016	-0.018
Real income (CPI deflator):					
Households disposable	0.000	-0.007	-0.013	-0.013	-0.013
Firms disposable	0.002	-0.010	-0.020	-0.017	-0.014