A Supply-Side Regional Econometric Model of Wales

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Abstract

This time series econometric model of Wales adopts a Hecksher-Ohlin specification with mobile skilled labour and capital, together with immobile unskilled labour and land. The model is linear and distinguishes three employment and output sectors, manufacturing industry, with prices set on world markets, non-manufacturing private industry and a public sector. Policy simulation exercises evaluate the impact of changes in actual and potential regional policy variables.

Keywords: Regional Economic Modelling

JEL Classification: R15, R58.

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1 Introduction*

Evaluations and appraisals of regional policy have conveniently been allied to purely demand- side regional models, whether based on Keynesian export multipliers or input-output models (as for example discussed in Harvey and Taylor, 2001). By neglecting supply-side constraints upon the expansion of economic activity this modelling approach has tended to encourage over-optimism about the effectiveness of traditional policy instruments such as Regional Selective Assistance (RSA) (National Audit Office 2003)[1]. To address this shortcoming regional policy modelling has begun to shift towards the computable general equilibrium (CGE) approach (most notably for the UK, AMOS, described in Harrigan et al 1991 and Gillespie et al., 2001). Apart from offering a more flexible modelling framework, CGE models can address both demand and supply-side issues and yield insights about the time path adjustments of the variables.

This paper therefore presents a CGE model of the Welsh economy. It is based on the Heckscher-Ohlin theory of international trade and draws on the models developed in Minford et al. (1991,1994,1995). Although the supply-side of the present model is similar, there are several differences in specifications. They include a richer range of policy options. At present the principal UK regional policy instrument is a capital subsidy to selected firms in order to boost employment – RSA. In addition the devolved Scottish government is allowed to impose up to 3 pence on Scottish income tax, while the Richard Commission (2004, ch10) has recommended a similar arrangement for Wales, if some taxation is devolved. The model allows an appraisal of both these and alternative regional policy instruments- for example a reduction in the employment (National Insurance) tax on export industries[2]. Because a public sector is distinguished, the impact of government expenditure and employment can be modelled. Variables that could help explain migration and working population effects are included and some of these, such as sickness benefits, are amenable to policy intervention. Inclusion of tax variables gives a more accurate picture of both gross labour costs and employees' take-home pay, and therefore permits an assessment of the consequences of changes in tax policy instruments, either at the UK or at the Welsh levels.

* We are grateful to Patrick Minford and David Meenagh for generous assistance with the model and data. Calvin Jones and Max Munday provided much appreciated advice on the Welsh economy. Remaining errors and omissions are ours alone.

[1] McGregor et al (1996) point out that with perfectly elastic supplies of labour through migration into the region and financial market integration, input–output models correspond closely with neoclassical models.

[2] Somewhat analogous to the Selective Employment Tax of the late 1960s but not increasing employment taxes on non-export industries.

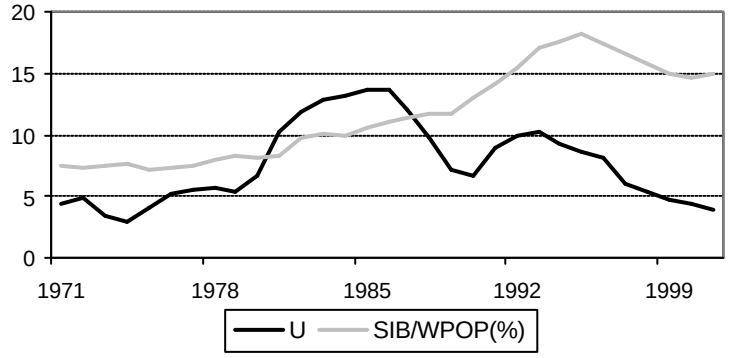
The following section presents a brief overview of the Welsh economy for the 1971-2001 period. Section 3 describes the theoretical framework underpinning the model. Some long run or comparative static properties of the model are discussed in section 4. The estimated equations are presented in section 5. Section 6 exhibits the policy and other simulation results and section 7 concludes.

2 An Overview of the Welsh Economy from 1971-2001

Between 1971 and 2001 total Welsh population grew by only six percent but changes in the age structure meant that working population rose by 14.5%. Real GDP per capita followed an upward trend and almost doubled over the 30-year period. Nonetheless, the performance of the Welsh economy is often considered poor because GDP per head is little more than 80% of the UK average.

At the same time the economy has been undergoing continuous restructuring. The coal and steel industries that once used to drive Welsh economic growth declined from the 1970s, while unemployment rose as high as 14% in mid 1980s (Figure 1). As unemployment declined sickness benefit claimants increased, attaining rates almost double the UK average. (Figure 1). The peak was reached in the mid 1990s and the subsequent decline might be attributed in part to the withdrawal of claimants over the retirement age. Disincentives to return to work for those claiming sickness benefits are powerful and changes in administrative regime may explain variations in the total number of claimants (Jones, 2000).

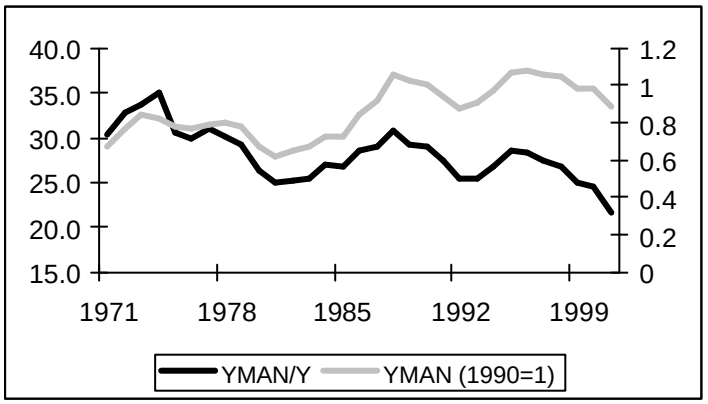
Figure 1 Unemployment Rate (U) and the Share of Sickness Benefits Claimants in Working Population (SIB/WPOP)



Welsh manufacturing industry experienced the general UK economic contraction and productivity increase of the early 1980s. Although recovering subsequently, recent data indicate that the downward trend in manufacturing output that started at the end of 1990s

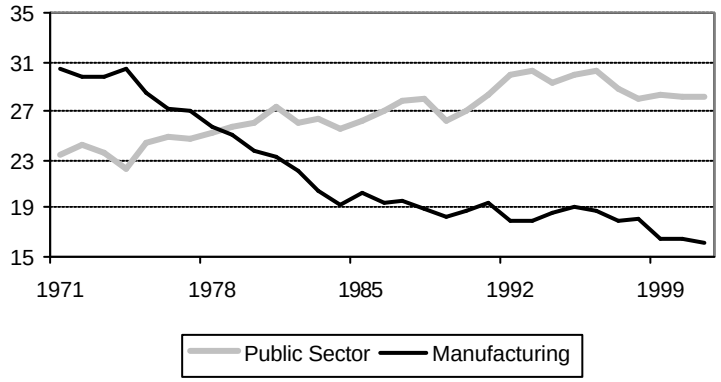
continues[3] (Figure 2). Incoming manufacturing investment, often supported by subsidies, helped maintain and enhance industrial production. European and Japanese manufacturing investment in Wales rose sharply after the 1970s and, even by 1974, foreign owned companies were employing almost 16% of the manufacturing employment (Munday, 2000). The share of manufacturing employment in foreign-owned subsidiaries seems to have risen, as apparent productivity growth declined from the later 1980s. Possibly this was a consequence of rising proportions of part-time female employees so that numbers of employees were an increasing inaccurate proxy for hours worked. Another hypothesis is that subsidiaries sold intermediate products to other plants overseas within the group at transfer prices that understated the true value, so that officially recorded output was also understated.

Figure 2 Real Manufacturing Output (YMAN) and Its Share in Total Output (YMAN/Y)



Changes in the Welsh economic structure redistributed employment. Contraction of manufacturing jobs was offset by an increase in public sector employment (Figure 3). The

Figure 3 Shares of Public Sector and Manufacturing Employment in Total Employment.



[3] Indeed the index of manufacturing output has been falling steeply after the sample period ends. Between 2001 and the end of the second quarter in 2003 it declined by 8.5%.

public sector now accounts for almost 30% of the Welsh employment, a direct consequence of increased government expenditures in sectors such as education and health, as well as public administration.

Rising public sector employment gains raise concerns as to how efficient the public sector has become. Public sector spending in Wales is not constrained by the taxes that can be raised. The Welsh budget is largely funded by a block grant from the UK Parliament. The total budget of the Welsh Assembly, which as yet lacks powers of taxation, is composed of two categories of public expenditure; Departmental Expenditure Limits (DELs) which set firm three-year spending limits and the Annually Managed Expenditure (AME) which cover items whose provision is reviewed and set annually. Changes to the block grant are generally determined by the so-called Barnett formula. The formula, which applies to each departmental programme in DEL, takes into consideration three variables, quantitative changes in the UK planned spending, the proportion of Wales population in UK, and a comparability factor that looks at the extent to which the relevant UK programme is comparable with the services for which the Welsh Assembly is responsible. Welsh tax revenues and similar receipts in general are passed to the UK Consolidated Fund, although the local authority property tax, Council Tax, does help finance local government spending.

The continuous rise in manufacturing real wages – in spite of the contractions in manufacturing output – suggests that the Welsh economy has been benefiting from higher productivity stemming from technological progress. Wages in the public sector have largely followed those in the manufacturing sector (Figure 4). Relative Welsh earnings outside manual manufacturing and the public sector however have tended to decline. In part this reflects compositional shifts, such as more part-time, female work, but even controlling for type and sector, Welsh wages in 1975 were generally below the UK average and deteriorated subsequently (Cameron et al 2002). Relative earnings fell in almost every sector but especially in construction, transport and distribution- all of which tend to be competitive.

The lower level of wages may in part stem from a lower cost of living. For the year 2000 the Office of National Statistics calculated that Welsh prices, exclusive of (critical) housing costs, were 3-4% lower than the UK average (Baran and Donoghue, 2001). A competitive market would be likely to adjust nominal wages downwards by this factor, other things being equal. However what evidence there is suggests no significant divergence between Welsh and UK prices over time (Fielding and Shields, 2001).

The proportion of part-timers in the workforce rose from 17% in 1975 to 29% in 1994 with four-fifths of these being women[4] (Cameron et al., 2002) (fig 5). Increasing participation rates for both males and females is one of the main priorities of the Welsh economic policy. In 1996 the economic activity rate in Wales was 4% below the UK average and this discrepancy accounts for between a third and a half of Wales' GDP per capita gap with the UK (Welsh Office, 1999).

Figure 4 Welsh Real Wages in Manufacturing (Wman/RPI) and Apparent Manufacturing Labour Productivity (Yman/Empt)

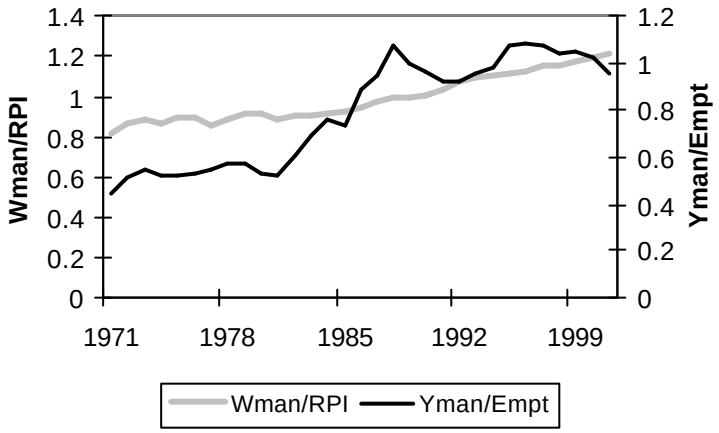
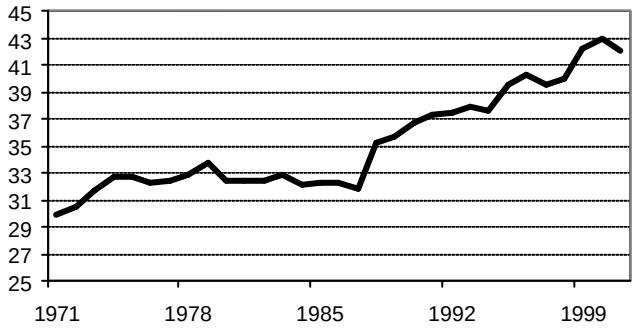


Figure 5 Female Part-Time Employees as Percentage of Total Employment



3 The Model Structure

A region's costs will be determined by those factors of production that are immobile, which in the present model are taken to be land and unskilled labour. Industrial land supply is

[4] OECD (1999) in a cross-national study attributed increasing female, part-time, employment to the weakening of employment protection legislation.

not a constraint and its price is exogenously set equal to the opportunity cost of farmland plus costs of obtaining planning permission and conversion for industrial use. Following Minford and associates (1991, 1994, 1995) the model then assumes there are two principal sectors producing traded goods (manufacturing) and non-traded goods (non-manufacturing including the public sector). These sectors respectively employ intensively unskilled and skilled labour. The unskilled labour is immobile and the skilled labour is mobile. There is a perfectly elastic capital supply at the world price, the rental '*r*', and a traded product price, P_T , also determined in the world market. CES production functions are assumed in both sectors.

The Traded Sector Wage

It follows that the gross wage or unit labour costs for traded sector (manufacturing) must also be fixed- so that traded sector employment is then determined by the supply of labour to this sector. Employment then fixes traded sector output and this determines non-traded sector output by creating the demand for it.

Suppressing subscripts the CRS CES manufacturing production function is:

$$Y = g\left[dK^{-r} + (1-d)L^{-r}\right]^{-1/r} \qquad (3.1)$$

where Y represents output and K and L are the factors of production, capital and labour respectively which are employed with relative factor shares d (0<d<1). Alternatively d indicates the degree to which technology is capital intensive. The parameter γ indicates the state of technology (γ>0) and denotes the efficiency of production. The elasticity of substitution is σ=1/1+ρ (-1<?).

The determinants of the exogenous traded sector wage can be demonstrated by substituting for capital in the production function with the marginal productivity condition:

$$r / P = dg^{-r}\left(Y / K\right)^{(1+r)} \qquad (3.2)$$

$$\left(Y / L\right)^{(1+r)} = 1 + \left[1 - g^{-r(1-rs)} d^{(1-ds)} \left(r / P\right)^{rs}\right] / \left[g^{-r}(1-d)\right] \qquad (3.3)$$

where *P* is the price level. Output per worker (Y/L) is fixed by the production function and the world price of capital.

Then the condition that unit cost of labour must be equal to the marginal revenue productivity of labour is imposed. If '*t*' denotes the tax on labour this implies:

$$w(1+t) / P = (1-d)g^{-r}\left(Y / L\right)^{(1+r)} \qquad (3.4)$$

Substituting for $\left(Y / L\right)^{(1+r)}$ from equation (3.3) into (3.4) the real unit labour costs in the traded sector become:

$$w(1+t) / P = (1-d)g^{-r} + \left[1 - g^{-r(1-rs)} d^{(1-ds)} \left(r / P\right)^{rs}\right] \qquad (3.5)$$

The lower the elasticity of substitution (σ<1) the smaller is the (inverse) change in the traded sector wage caused by a given change in the capital rental. When the elasticity of substitution is greater than unity, a reduction in the rental also reduces the wage, because the substitution effect dominates the output effect[5].

Labour Supply to the Traded Sector

The second critical relationship of the model is labour supply to the traded sector. This is assumed to be based on household utility maximisation, where the after-tax real wage relative to unemployment benefits determines the trade-off between work and leisure.

Marginal Productivity of Labour in the Traded Sector

Employment in the traded sector is fixed by exogenous unit wage costs and the supply of labour to the sector. Output is then determined by the marginal productivity of labour. In logs the marginal productivity equation is:

$$Ln(Y/L) = Ln\left[(1-d)g^{r}\right] + \left[1/(1+r)\right]Ln\left[w(1+t)/P_{T}\right] \qquad (3.6)$$

Thus, average traded productivity depends on the real wages and the state of technology.

Traded output corresponds with Welsh exports by assumption, while consumption, investment and imports depend upon the level of income, which in turn is determined by traded output. In the long run the Welsh balance of payments must be balanced with output equalling demand, unless there are continuing government transfers. For otherwise a deficit stemming from demand exceeding output could only be financed by a reduction in Welsh financial assets (for example house sales) and an eventual contraction of the money supply that would reduce non-traded prices. This would put downward pressure on non-traded employment and wages, cutting spending until it was aligned with output.

Non-traded Non-public Sector Output and Demand

Non-traded sector output Y_{NT} depends upon demand (DMD) from the traded or export sector plus components financed by government and by savings. Employees in exporting spend money in shops and on local services and send their children to school. In turn this gives rise to other rounds of spending. Demand may also respond to relative prices- traded products have become cheaper relative to services over the period of interest. While traded

[5] Simply subsidising the rental of capital encourages the substitution of capital for labour, so that, with a Cobb-Douglas production function, combined with the output effect the net employment effect is zero. A one percent reduction in the (marginal) price of capital lowers employment by 1-a percent, where 1-a is the output elasticity of capital (say 0.25%). But profit-maximising output will be higher to offset this reduction exactly. For the CES, the elasticity of the cost minimising demand for labour with respect to the capital rental, $\eta_{LK}=(1-s_L)\sigma$, so that with an elasticity of substitution of 0.5 and a labour share of 0.75 the adverse employment effect is smaller, 0.125%. Here the output effect can more than offset the substitution effect. Conversely with an elasticity of substitution greater than unity labour displacement will not be offset by the output effect.

prices are exogenous, non-traded good prices P_{NT} depend upon non-traded wages and output in the sector supply function; in principle they are endogenous. Assuming that demand for non-traded output is given by,

$$Y_{NT} = a + bDMD + f(P_{NT} / P_T) \quad (3.7)$$

and supply of non-traded output by:

$$P_{NT} = h + j\,Y_{NT} + l\,w_{NT} \quad (3.8)$$

where a, ß, ? are parameters, then the reduced form equation for non-traded output is:

$$Y_{NT} = [(a + fh)/(1 - fj)] + [b/((1 - fj)]DMD + [fl/(1 - fj)]w_{NT} + f/(1 - fj)P_T \quad (3.9)$$

Non-traded output depends upon demand, non-traded wages and on traded prices.

Non-Traded Sector Employment

The demand for employment in non-traded sector is derived from the demand for output. Non-traded wages are endogenous and there is an elastic supply of such workers at the going wage because of migration. The demand for non-traded labour is (CES), in logs:

$$L_{NT} = mY_{NT} + qw_{NT} / P_{NT} \quad (3.10)$$

and the supply of non-traded labour is given by:

$$w_{NT} = wL_{NT} + yZ \quad (3.11)$$

with µ, ?, ? and ? parameters.

Both non-traded wages and prices can be substituted out in the demand equation so that non-traded employment depends upon non-traded output and the set of exogenous factors Z that influence the supply of labour to the sector. These are the determinants of that part of working population that consists of skilled labour. Equations (3.8), (3.10) and (3.11) can be solved in terms of non-traded output, Y_{NT}, and the exogenous factors that determine the supply of labour to the non-traded sector.

Working Population

Working population depends upon natural increase, net migration and influences upon labour force participation such as administrative regimes for sickness benefit. Possibly housing tenure may affect mobility within Wales; state rented housing provides a subsidy that may not be transferable to another area if the job conditions require a move.

Only skilled labour migrates into and out of Wales in the present model. Net migration is often supposed to depend upon relative wages and or relative unemployment rates (for example Gillespie et al 2001). There also appears to be a relative house price effect. Typical UK house price cycles begin in London and the Thames valley, spilling out to the South East

and most of the rest of the England and Wales with lags of between one and two years, depending on the strength of regional connections. The ensuing widening of house price differentials creates opportunities for greater capital gains by owner occupiers relocating to lower house price areas. Wales has been a net recipient of migrants throughout the period according to the National Health GP registration data (available from 1975). These do not distinguish worker migration from, say, retirement moves. But between 2000 and 2002 there was a net inflow of working age migrants into Wales averaging 7000 a year and of this net inflow 2,200 a year had post-school qualifications (Table 6 Dixon 2003)[6]. The numbers are broadly comparable with the NH migration data which may therefore be assumed to include a high proportion of persons of working age.

The Government

The impact of public sector employment (public administration, health, education) depends on whether the appointments are from the immobile or mobile labour forces. If from the second, an expansion of the public sector reduces output in the non-traded sector and perhaps increases the working population by migration. Possibly also there are multiplier effects as if public sector employees were exporting, because government spending (from the block grant) allows more importing. On the other hand, rising state employment of unskilled labour crowds out genuine export industry jobs. The magnitude can be estimated by including government employment as an independent variable in the export employment supply function and the working population equation.

There is evidence of public sector crowding out in a similar model to the present one but with wages that are rigid in the public sector and flexible in the private sector. Henley and Thomas (2001) consider whether the relocation of central government office employment, an implicit or explicit regional policy in the last thirty years, displaced private sector employment. Nationally negotiated public sector wages widen pay differentials in lower demand regions where there is also less likelihood of crowding out private sector employment. What is different about this arrangement is that the basis of the postulated market segmentation is not clear. If there is no general distinction between public and private sector workers – such as skill or Welsh language facility - then there must be one for one crowding out in the labour market. The region can still be better off because of transfers from

[6] This was an unusual period for London and the South East so comparison can be misleading. However London lost an average of 29,100 working age migrants and absorbed 200 fewer than Wales of net migrants with post school qualifications.

central government and possibly their multiplier impact. Employment can rise- because of more immigration or greater participation - but unemployment will not change[7].

Unemployment

Unemployment is determined by the difference between working population and total employment, both public and private sector. By assumption it consists only of unskilled labour. In principle it is possible for a change both to increase employment and the percentage of unemployment, if working population is also raised sufficiently.

4. Some Comparative Static Properties of the Model

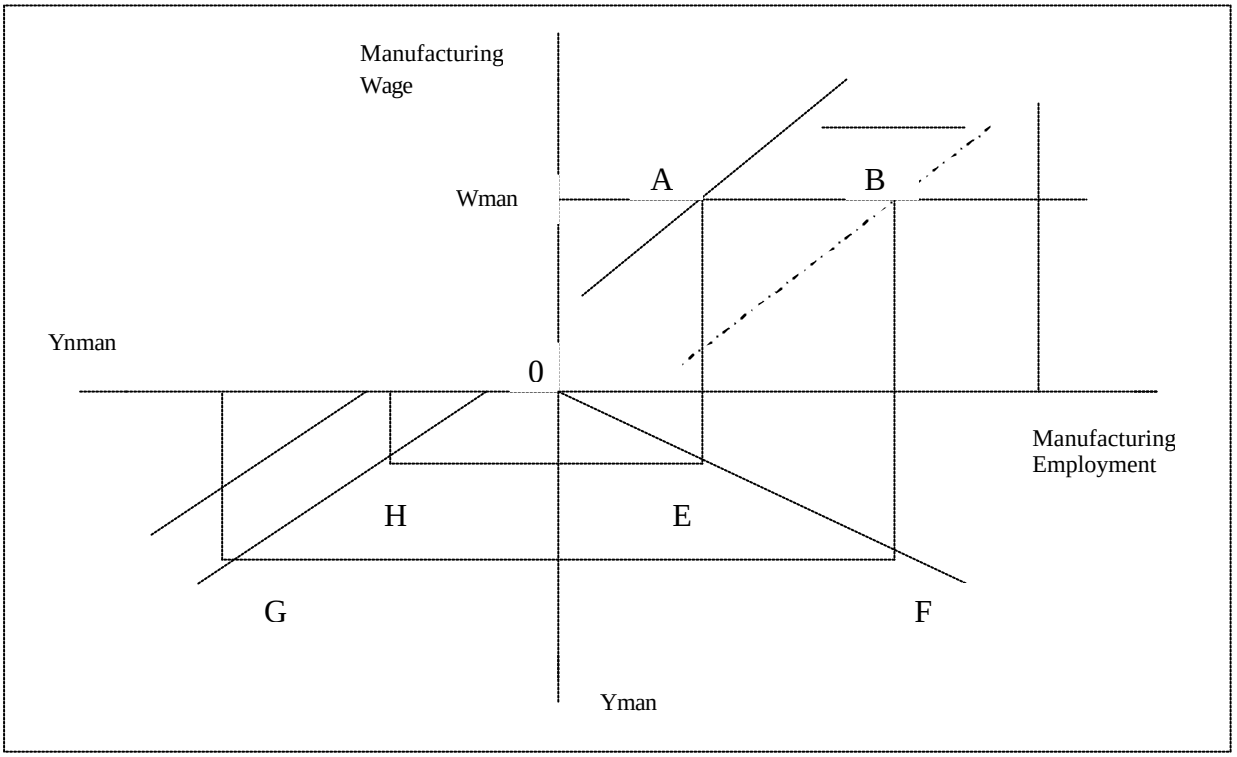
Figure 6 illustrates the consequences of various influences on traded sector unit wage costs. In the top right hand panel, technical progress would shift upwards the real wage line. This increases the labour supply in the same panel and reduces unemployment (because traded labour is assumed immobile). The export sector working population is represented by the vertical line on the right hand side of the panel. Non-traded labour is assumed never to become unemployed either because of migration or withdrawal from the working population. An increase in the labour tax rate on export labour, t, can only be accommodated by a fall in the nominal and real wage, w, which lowers employment. If the elasticity of substitution is less than unity, increasing exchange rate risk raises r, lowers w, and reduces employment. Regional Selective Assistance (RSA), a capital subsidy, pushes down r (to selected firms) and, on the same assumption, raises employment[8]. On the other hand, if the elasticity of substitution exceeds one, RSA reduces the wage paid to the employees, *w*.

The wider consequences in the panel below of Figure 6 include the induced changes in output through the marginal productivity condition in the export sector. The bottom left hand panel illustrates the impact on non-traded output of traded demand. As the export sector expands employees demand more non-traded products such as retailing, garage services and entertainment. The gradient of the relationship in the panel is what is often termed the 'export

[7] To test for crowding out versus multiplier effects, Henley and Thomas (2001) estimate private sector employment functions determined by lagged GDP and current and lagged public sector employment (all in differences). They find negative first period effects (crowding) (-0.318 se 0.057) and smaller positive second period effects (multiplier) (0.242 se 0.078) from a panel 1981-1995 (BHPS). This suggests net crowding out. They go on to estimate an earnings function from NES data, explaining earnings with variables such as age and education as well as public sector employment. Wales shows a 12-25% public sector premium in 1990s, averaging 20%. The likely explanations for this excess seem to be national bargaining and trade union power. Non-manual public sector pay has fallen relatively over last 30 years whereas manual workers instead experienced employment reduction. This is consistent with rigid manual worker wages but not non-manual.

[8] £359 million was paid as RSA out in the ten years ending 31 March 2003 in Wales.

Figure 6. Comparative Static Properties of the Model



multiplier' in demand side regional models. Taken together these three panels show how changes in export unit wage costs are amplified through demand effects to impact upon the whole economy.

Reductions in unemployment benefit, income tax, or the cost of living shift unskilled labour supply (from A to B in figure 6) and increase employment and output (from E to F and from H to G). Tightening conditions for claiming sickness benefit increases working population and raises unemployment. Expansion of government increases non-traded output, holding traded output constant (no crowding out), raises working population (through migration) and does not alter the 'export multiplier' (the leftward shift in the function in the bottom left panel of figure 6).

The model does not allow product market displacement effects from Regional Selective Assistance (RSA) because regional export prices are fixed by assumption; they cannot be raised by greater economic activity induced by RSA. Additionality, what extra happens as a result of the subsidy, is measured by the extent to which the post-subsidy rental

of capital is lower to the selected firms and the elasticity of unskilled labour supply. The investment, employment and output effects flow simply from profit maximisation in an assumed competitive environment and the firms' production functions. Alternatively the impact can be averaged across the region.

The diagrammatic exposition of the present model has treated working population entirely as given. But to the extent that working population responds to unemployment differentials, RSA could also increase the total size of the workforce as well as reducing numbers of unemployed. However immobile or unskilled labour is a relatively small proportion of the workforce. The increase in the size of the workforce is therefore unlikely to offset the reduction in unemployment[9].

5 Specification and Estimation of the Model

The estimated model is set out in Table 1 below. It is log-linear and distinguishes three employment and output sectors; manufacturing industry with prices set on world markets, non-manufacturing private industry and a public sector. The correspondence with the theoretical sectors is not exact since there is some traded output produced in the 'non-traded sector' (for example mining at the beginning of the period and tourism at the end[10]).

[9] Suppose the coefficient (elasticity) on Welsh unemployment is 0.015 and a fall of 2,000 persons in unemployment amounts to a 4% reduction, then the rise in working population is roughly 0.015*4%*1,000,000=650. In this case the final fall in percentage unemployment is very slightly lower because the denominator is higher; instead of 4.8% it becomes (48,000/1,000,650) *100 % =4.797%.

[10] Historically coal exports have been of major significance for the Welsh economy. On the one hand relatively little employment and output (11 percent in the Industrial Production index of 1970) was accounted for by mining even at the beginning of the period. On the other, it was more erratic than manufacturing- employment and output fell earlier (between 1971 and 1974 output declined 40 percent). So there is an overstatement of buoyancy of export sector in the early years.

Table1

Short Run Model Equations

A1.1 $\log(EMPT) = \underset{(5.08)}{85.726} - \underset{(-15.27)}{0.042}*TIME + \underset{(2.23)}{0.495}*\log[WMAN*(1-TAX\_INC)/RPI] - 0.495*\log(BEN) + \underset{(8.92)}{0.052}*FWPOP$

A1.2 $\log(WPOP) = \underset{(20.81)}{4.154} + \underset{(6.69)}{0.259}*LEMPNT - \underset{(-3.08)}{0.037}\log(SIB) - \underset{(-2.32)}{0.087}*\log(LOW_{-1}) + \underset{(2.15)}{0.106}*\log(SEW_{-1}) + \underset{(4.29)}{0.003}*u\_UK + \underset{(6.85)}{0.258}*LEMPPS$

A1.3 $\log(YNMAN) = \underset{(-2.32)}{-16.531} + \underset{(2.17)}{0.508}*\log(DD) + \underset{(2.52)}{0.760}*\log(RPIPM) + \underset{(2.18)}{0.009}*TIME$

A1.4 $\log(EMPNT) = \underset{(5.95)}{3.564} - \underset{(-2.05)}{0.451}*\log[WNMAN*(1+TAXFIRM)/PM] + \underset{(3.96)}{0.752}*\log(YNMAN)$

A1.5 $\log(YMAN) = \underset{(-0.38)}{-0.146} + \log(EMPT) + \underset{(7.90)}{0.828}*[\log(YMAN_{-1}) - \log(EMPT_{-1})] + \underset{(2.56)}{0.772}*\log[WMAN*(1+TAX\_FIRM)/PM] - \underset{(-2.75)}{0.025}*(FWPOP)$

A1.6 $\log(DD) = \underset{(2.57)}{0.010} + \log(DD_{-1}) + \underset{(3.13)}{0.369}*\Delta[\log(uk\_DD)] - \underset{(-2.16)}{0.322}*[\log(DD_{-2}) - \log(DD^{*}_{-2})]$

A1.7 $Y = YMAN + YNMAN + YG$

A1.8 $EMP = EMPT + EMPNT + EMPPS$

A1.9 $u\_W = [1 - EMP/WPOP]*100$

A1.10 $\log[WNMAN*(1-TAXINC)/RPI] = \underset{-2.82}{-14.363} - \underset{-2.20}{0.844}*\log(WPOP) + \underset{3.47}{0.593}*\log[WMAN*(1-TAXINC)/RPI] + \underset{3.22}{0.01}*TIME$

(t – statistics in paranthesis, ? is the difference operator)

EMPT – Welsh manufacturing employment (thousands)
WMAN – Welsh manufacturing wage (weekly, gross in £)
TAX_INC – Income tax
RPI – Retail Price Index (1990=100)
BEN – Unemployment benefits
FWPOP – Welsh ratio of females in working population
SIB – Welsh claimants of sickness benefits (thousands)
LOW – London-Wales relative house prices
DD – Welsh demand (billion £)
RPIPM – ratio of non-traded to traded prices
WNMAN – Welsh non-traded sector wage (weekly, £)
EMPNT – Welsh non-manufacturing employment (ths.)

WPOP = Welsh working population (thousands)
TAX_FIRM – Income tax for the firms
SEW – South-East – Wales relative house prices
u_UK – UK unemployment rate (%)
u_W – Welsh unemployment rate (%)
YNMAN – Non-manufacturing output (billions £)
PM – Manufactures prices (1990=100)
uk_DD – UK demand (billions £)
Y – Welsh output (billions £)
YG – Welsh government spending (billions £)
G – Welsh government spending, including transfer payments (billions £)

EMP – Welsh Employment (thousands)
EMPPS – Public sector employment (thousands)

Equation number	DW	R squared
A1.1	1.61	0.95
A1.2	1.97	0.97
A1.3	1.42	0.97
A1.4	1.44	0.78
A1.5	2.13	0.97
A1.6	1.90	0.58
A1.10	1.62	0.96

Equilibrium Values:

A1.11 $\log(EMPT^{*}) = 85.726 - 0.042 * TIME + 0.495 * \log[WMAN * (1 - TAX\_INC) / RPI] - 0.495 * \log(BEN) + 0.052 * FWPOP$

A1.12 $\log(WPOP^{*}) = 4.154 + 0.259 * LEMPNT^{*} - 0.037 * \log(SIB) - 0.087 * \log(LOW_{-1}) + 0.106 * \log(SEW_{-1}) + 0.003 * u\_UK + 0.258 * LEMPPS$

A1.13 $\log(YNMAN^{*}) = -16.531 + 0.508 * \log(DD^{*}) + 0.760 * \log(RPIPM) + 0.009 * TIME$

A1.14 $\log(EMPNT^{*}) = 3.564 - 0.451 * \log[WNMAN^{*} * (1 + TAXFIRM) / PM] + 0.752 * \log(YNMAN^{*})$

A1.15 $\log(YMAN^{*}) = \log(EMPT^{*}) + [1/(1 - 0.828]] * \{-0.146 - 0.025 * (FWPOP) + 0.772 * \log[WMAN * (1 + TAX\_FIRM) / PM]\}$

A1.16 $\log(DD^{*}) = 0.95 + 0.9 * \log(YMAN^{*}) + 0.35 * \log(G - YG)$

A1.17 $Y^{*} = YMAN^{*} + YNMAN^{*} + YG$

A1.18 $EMP^{*} = EMPT^{*} + EMPNT^{*} + EMPPS$

A1.19 $u\_W^{*} = [1 - EMP^{*} / WPOP^{*}] * 100$

A1.20 $\log[WNMAN^{*} * (1 - TAXINC) / RPI] = -14.363 - 0.844 * \log(WPOP^{*}) + 0.593 * \log[WMAN * (1 - TAXINC) / RPI] + 0.01 * TIME$

The data series and definitions are described in Appendix 3. Regional demand uses a proxy for gross domestic fixed capital formation. Data are available only for selected industries, in particular agriculture, energy and water supply, manufacturing, transport and communications, and dwellings[11]. Also for lack of data, Welsh demand excludes any measure of net exports.

Table 2 presents unit root tests for the variables using the ADF procedure. The maintained regressions for I(1) included either an intercept and a deterministic trend or an intercept only, depending on whether the data series was trended or not. The tests show that the unit root hypothesis cannot be rejected at the 5% significance level for all variables.

Table 2. Unit Root Tests

Variable[#]	**ADF Value for I (1)**
EMPT[*]	-1.730881
EMPNT[*]	-2.890787
WPOP[*]	-2.751787
Real net manufacturing wage[*]	-2.671702
Y[*]	-2.199194
YNMAN[*]	-2.032721
DD[*]	-2.795821
YMAN[*]	-2.653456
FWPOP[*]	-1.273380
EMPPS[*]	-2.178411
SIB[*]	-1.371440
u_UK[**]	-2.096756
u_W[**]	-1.905140
EMP[*]	-2.256045
uk_DD[*]	-2.619434
G[*]	-1.901133
LOW[**]	-1.683851
SEW[**]	-2.010703
Firms Unit Labour Costs[*] (WMAN)	-3.445898

Notes:

[#]Unemployment rates, un_W and un_Uk, and the share of female employees in working population, FWPOP are in percentages. All other variables are in logs.

*MacKinnon critical values for rejection of hypothesis of a unit root (intercept and a trend, 2 lags included).

1% Critical Value* -4.3226
5% Critical Value -3.5796
10% Critical Value -3.2239

**MacKinnon critical values for rejection of hypothesis of a unit root (only intercept, 2 lags included).

1% Critical Value** -3.6852
5% Critical Value -2.9705
10% Critical Value -2.6242

All the model equations have been estimated by instrumental variables (IV). Equation (A1.1) is a manufacturing labour supply function that relates workers' decisions to their real net take-home pay. Since working is assumed to confer disutility, unemployment benefits, an alternative source of income to manufacturing wages, play an important role. Labour supply would ideally be measured in hours, rather than persons, in view of the rise in part-time, primarily female, employment. The proportion of part-time workers in Welsh manufacturing, is not available and therefore the ratio of female employees in Welsh working population (FWPOP) is a proxy. Other time-dependent factors, such as demographic changes, are approximated by a time trend.

The productivity equation (A1.5) is derived from the marginal labour productivity given by equation (3.6). The effect of tax-adjusted wages relative to manufacturing prices on manufacturing output is statistically significant. Also highly significant is the lagged productivity term, the coefficient of which implies a strong persistence of productivity effects. Constant returns to scale are assumed, implying that any increase in labour input will have a corresponding similar effect on output. If, as expected, the spread of female part-time employment in manufacturing follows the same pattern as in non-manufacturing, a negative coefficient on the female part-time participation rate would imply that the manufacturing labour productivity measured simply as a ratio of manufacturing output to the number of employees in manufacturing could be misleading because the part-time workers may displace full time employees[12]. The coefficient of the ratio of female employees in Welsh working population (FWPOP) has a negative sign.

Turning to the non-traded sector, equation (A1.3) defines output as a function of Welsh demand and a ratio between non-traded and traded prices. Firms' demand for labour to produce this output is given by equation (A1.4). Thus, non-traded employment is a function of non-traded output and the gross wage firms pay to hire the required labour. Because employment in the non-traded sector is mobile it is the attractiveness of pay in this sector that drives this mobility. Equation (A1.10) specifies real net non-traded wage as a function of working population (WPOP), intended to capture migration effects, and the wage in the traded sector, taken as a proxy for the UK average earnings.

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[11] Even these investment data were subject to several re-classifications of industries over the time period which render this series not wholly consistent.

[12] Explaining productivity in UK manufacturing as a whole has proved problematic, partly because apparent productivity slowdown in the 1970s stemmed from incorrect measurement of output and from structural change (Cameron, 2000).

Equation (A1.6) determines Welsh demand. In the short run this depends on the UK demand because of the close integration of the Wales and the rest of the UK. But in the long run domestic demand should equal output; as in the long run, an independent economy cannot run indefinitely a balance of payments deficit/surplus on current account. In the case of Wales, however, this condition is slightly modified by UK transfer payments into the principality that permit an equilibrium demand higher than equilibrium output. This is indeed what the long run demand equation (A1.16) shows; excess demand is about a third of output. By way of comparison, devolved expenditure per head in Wales 1997-2000 is estimated to be 18-20 percent higher than in England (Mackay 2000)[13]. In addition, Annually Managed Expenditure must involve further net transfers to Wales. The calculations here imply that Wales benefits by £10 billion a year from UK transfers.

Equation (A1.2) explains the working population. Apart from demographic effects, which are captured by a time trend, the inclusion of house prices determines the migrant component of working population; higher relative house prices elsewhere discourage migration from Wales but encourage migration to Wales. The net effect on migration may well depend on the region, whether it is a net importer or net exporter of people to or from Wales. Those relative house price terms included are proxies for the whole regional pattern of house price change. Adding in other region house prices does not change the overall impact, even though they are often statistically significant.

Recent data show that the sickness benefits claimant rate in Wales is almost twice as high as the UK average. The inclusion of sickness benefits (SIB) in the equation is designed to capture this characteristic. The coefficient has a negative sign and the impact on working population is rather moderate; a 1% increase in numbers on sickness benefits would, ceteris paribus, lead to a 0.04% fall in working population. The public sector and non-traded employment variables are included in the equation in order to capture displacement effects.

The model is closed with the identities (A1.7)-(A1.9) in which government spending (YG) and public sector wages (EMPPS) are treated as exogenous, while long-run equilibrium values of endogenous variables are given by equations (A1.11)-(A1.20).

6 Model Simulations

A measure of the performance of the model is the 'fit' over the period of estimation. Both static and dynamic in-sample forecasts show that the model explains to a large extent the

[13] However the distribution of military expenditure entails net transfers to England (Gripaios (2002).

behaviour of the Welsh economy, subject to correct assumptions about the exogenous variables (Appendix A2). The static solution uses the actual values of the endogenous variables up to the previous period each time the model is solved. It generates a set of one-step ahead forecasts over the historical data. By contrast, the dynamic solution uses the model solved lagged endogenous variables, calculated in previous periods, and thus is a more demanding test of 'fit'.

Several impulse response exercises are undertaken to show the behaviour of endogenous variables of interest for policy, in particular employment and output, under alternative specifications of exogenous variables. The graphs in Appendix A2 depict the behaviour of endogenous variables assuming that a permanent shock occurred in 1991. The values of endogenous variables calculated ten years later should be at, or close to, their long run equilibrium values[14]. Of particular interest for regional policy is the impact of changes in income tax, in the employment (national insurance) tax, in the effective cost of capital and in numbers on sickness benefit. For practical purposes it is useful to distinguish between the short and long term effects on the endogenous variables. Thus, Table 3 presents the short-term impact of selected shocks, obtained by assuming a temporary 1% increase in the corresponding exogenous variable for three consecutive years for the 1991-1993 period. The results in Table 4 are obtained under the assumption that the shocks were permanent, with 1991 as the first year in which the shock was experienced.

Simulation 1- Employment Tax.

As indicated earlier, a permanent rise in manufacturing wages paid to employees can be brought about by a reduction in the tax on employment (national insurance contribution) without affecting gross unit labour costs, determined on world markets. Tables 3 and 4 (cols. 5) show the opposite effects, a one per cent rise in the 'taxfirm' variable (and the inverse movement of the manufacturing wage rate), in the short and the long term. In the short run manufacturing employment (EMPT) falls by 0.43% - or 875 jobs - with manufacturing output falling by the same percentage. In the long run the contraction in manufacturing output (YMAN) is only very slightly smaller, -0.45% after 11 years. Lower activity in the traded sector has a negative effect on non-traded sector output (YNMAN) which contracts by around 0.2%. Employment in the non-traded sector (EMPNT) falls by 0.26% - or some 1,755 jobs in the short term, whereas in the long term, it drops by 0.42% - over 2,800 jobs.

Such a big drop in the employment in the non-traded sector occurs because, in the current model specification, the fall in traded sector wage (WMAN) triggers a fall in the non-

[14] Another option would have been to conduct the simulation exercise for hypothetical future policy shocks by specifying some driving processes for the exogenous variables.

traded sector wage via equation (A1.10), which, in turn affect non-traded emlpoyment through the labour demand equation (A1.4).

The consequence of a one percent employment tax change (fall) is that the wage goes up from £418 to £421.7 a week in the manufacturing sector and from £467.7 to £469.8 in the non-traded sector. Tax revenue goes down by this differences times the difference between the number of employees and the extra employees (corresponding to each sector), times the tax they pay. The overall cost per extra job is £46,766 in revenue forgone.

Simulation 2. International Competitiveness.

A 1% increase in gross manufacturing wage – which can be brought about only by a change in international competitiveness, as indicated by equation (A1.1) - raises manufacturing employment in the short and long run by almost 0.5%, creating an extra 970 jobs (cols. 4). The expansion in manufacturing output is 2.5% in the short run and 4.2% a decade later. More manufacturing employment raises total employment which then feeds into the non-traded sector. Thus, the extra income in the manufacturing sector spills over into the non-traded sector where, however, output rises less strongly than in the manufacturing sector. Non-traded output and demand increase by 2.3% and 4.2% respectively, over the decade (Table 4). The reduction in unemployment during the same period is rather small, -0.7%, because the rise in non-manufacturing jobs comes from a larger working population.

Simulation 3. Unemployment Benefits

A 1% rise in real unemployment benefits contracts manufacturing employment by changing the tradeoff with net take-home pay (cols. 1). Some workers in the manufacturing sector substitute leisure for work. Employment in this sector falls by 0.49% causing a similar reduction in manufacturing output. Consequently, unemployment rises by 0.1% in the short run (UN_W, Table 3). The contraction in manufacturing sector spills over into the non-traded sector, where output initially falls 0.19%, and then declines gradually to 0.22% by the end of the simulation period (YNMAN, Table 4). Total output and demand fall by 0.23% and 0.44% respectively. Total employment (EMP) falls by 0.49% - or 970 jobs, in the long run.

Simulation 4. Income Tax

A 1% rise in income tax induces a 0.62% fall in manufacturing output and emploment (cols 2). Again, the contractionary effects in the manufacturing sector spill over into the non-traded sector. In the short term non-traded output falls by 0.24% triggering a 0.21% reduction in total output. Total employment falls by 0.27%, or some 3,308 jobs, while working population is also reduced by a meagre 0.075%.

Table 3. Short-term impact of shocks
(deviations from the base run)

	+1% BEN	+1% Tax_inc	+1% SIB	+1% WMAN	+1% Tax_firm & a fall in WMAN	+1% YG
Y	-0.16%	-0.21 %	-	+1.2%	-0.13%	+0.35%
YMAN	-0.49%	-0.62 %	-	+2.5%	-0.43%	-
YNMAN	-0.19%	-0.24 %	-	+2.0%	-0.16%	+0.17%
DD	-0.38%	-0.48 %	-	+3.9%	-0.31%	+0.34%
EMP	-0.11%	-0.27%	-0.009%	+1.1%	-0.22%	+0.09%
EMPNT	-0.16%	-0.27%	-0.016%	+1.7%	-0.26%	+0.15%
EMPT	-0.49%	-0.62%	-	+0.49%	-0.43%	-
WPOP	-0.041%	-0.075%	-0.04%	+0.42%	-0.07%	+0.04%
UN_W	+0.10%	+0.21%	+0.033%	-0.7%	+0.18%	-0.06%

Number of jobs in parentheses - the estimates are for year 2001.

Table 4. Long-term impact of permanent shocks - after 11 years
(deviations from the base run).

	+1% BEN	+1% Tax_inc	+1% SIB	+1% WMAN	+1% Tax_firm & a fall in WMAN	+1% YG
Y	-0.23%	-0.28 %	-	+2%	-0.21%	+0.38%
YMAN	-0.49%	-0.62 %	-	+4.2%	-0.45%	-
YNMAN	-0.22%	-0.28 %	-	+2.3%	-0.21%	+0.18%
DD	-0.44%	-0.55 %	-	+4.2%	-0.41%	+0.34%
EMP	-0.18% (2010)	-0.37% (4296)	-0.009% (110)	+1.1% (12550)	-0.32% (3707)	+0.09% (1023)
EMPNT	-0.19% (1040)	-0.45% (3069)	-0.016% (110)	+1.7% (11560)	-0.42% (2856)	+0.15% (1023)
EMPT	-0.49% (970)	-0.62% (1227)	-	+0.49% (990)	-0.45% (851)	-
WPOP	-0.05%	-0.11%	-0.04%	+0.42%	-0.1%	+0.04%
UN_W	+0.15%	+0.26%	+0.033%	-0.7%	+0.24%	-0.06%

The revenue from the extra income tax would be substantial. The one percent is calculated as a percentage of take-home pay. A 1% cut in take home pay in the manufacturing sector, for example, amounts to £217/year/employee (£418/week*1%*52 weeks) On 198,000 workers the tax revenue would be £43 million in the manufacturing sector and £166 million in the non-traded sector. Adding the two figures up and dividing the result by 4,296, the total number of jobs destroyed, yields £48,627 per job. However this understates the true number of

jobs destroyed,- the true cost per job would be lower - because the direct impact of the tax hike on the non-traded sector is not taken into account in this calculation.

From the viewpoint of job creation, the policy is inefficient because much of the tax cut has no effect on employment; intra- marginal employment and intra-marginal firms receive the tax cut as well as marginal employment and employers. On the other hand precisely because it is not discriminatory it does not require an expensive bureaucracy to operate nor does it divert business energies from productive activities into pursuing grants.

Simulation 5. Government Employment Spending

A 1% increase in government expenditure on employees leads to a rise in Welsh demand and has no impact on the Welsh manufacturing sector (cols. 6). Unemployment falls and the working population rises by 0.04%. For year 2001 a 1% increase in YG implies that the government has to raise an additional £96.31 million. In terms of cost per job, in the short term, this translates roughly into £90,178 (£96.31 million divided by 1,068, the number of jobs created).

Regional Selective Assistance

The most compelling argument in favour of such a regional policy instrument may be that the parameters of the present model imply that an RSA capital subsidy policy is actually harmful to employment in the long run. It might be contended that employers state that they have created jobs as a result of their subsidies, but since such statements are a condition of their receiving the subsidy, their testimony must be suspect. Quite possibly they would have undertaken the projects that attracted RSA even if the subsidy had not been available.

Another objection is that the model estimate of the marginal productivity condition is simply wrong[15]. If instead an elasticity of substitution of 0.5 is assumed then the wage multiplier of the return on capital is:

$$-0.5g^{-0.5}d^{0.5}(r/P)^{-0.5}$$

Taking the output of manufacturing as £6 billion and capital share and costs as 25%, a £50 million subsidy represents 3.33% of capital costs, or reduction in the rate of return on capital. This would raise wages by about half this percentage, say 1.7%. A unit elasticity of labour supply implies that the subsidy would increase employment also by 1.7%, say, by a substantial 3,400 jobs, and then there would be multiplier effects on the nontraded sector. The cost per job per year could be brought down to perhaps £10,000.

[15] Harris and Robinson (2003) investigate the impact of RSA on total factor productivity, rather than on employment, and impose an elasticity of one by assuming a Cobb-Douglas production function. They find no effect within assisted areas (excluding Scotland).

For job creation, the true cost of RSA depends critically upon the elasticity of substitution as well as the excess burden of taxation. Government expenditure is apparently cheaper than cutting employment taxes. Income tax cuts appears very expensive but the likelihood is that this result stems from incomplete modelling of the nontraded sector.

The Export Base Multiplier

In conventional demand side models there is only one type of labour and an expansion of the export base increases employment of shop assistants, estate agents, hairdressers and garage mechanics in the non-traded sector. The present model does not allow unemployment among the 'skilled' employees in the non-traded sector in the absence of export employment expansion. They would have left the working population either by migration or by withdrawal. Therefore the export multiplier has a weaker effect on unemployment than on employment in contrast to demand side models.

The effect of an expansion or contraction of the base or export employment on non-traded sector employment in the present model is relatively large (the ratio EMPNT/EMPT in Table 3). Since constant returns to scale are imposed on the model, there are no effects on income per head independent of induced changes in economic activity. But total activity can rise.

Although public sector employment in some respects resembles export employment, the multiplier effects appear to be much smaller. The 1% increase government spending (Table 3) amounts to a raise of 1,773 jobs in the nontraded private sector.

7 Discussion and Conclusion

The data assembled indicate that, although unemployment has fallen markedly from the 1980s, percentages are only back to their 1970s levels, and the equations show that sickness benefit claimants have taken up a considerable share of the reduced unemployment, cutting the working population. A 1% rise in numbers on sickness benefit is associated with a 0.1% fall in working population (A1.2, A1.11). Over the period as a whole this is roughly equivalent to one for one displacement from the workforce.

The model has simplified the facts, but that is the nature of a model. The true traded sector is larger than just manufacturing- at the beginning of the period mining was equivalent to about 11% of industrial production, declining to virtually nothing. Agriculture was never a significant employer after 1971. Tourism comes increasingly to matter, as do other service exports such as call centres. The omission overstates multiplier effects because they include as

induced some proportion that would be exogenous[16]. The critical model assumption concerns employee mobility rather than skill; export sectors must be intensive in immobile labour. Employees with higher skills tend to earn more, and the higher the prospective wage, the greater the optimal search and travel distance for employment, including shifting residential location.

Properties of the model include only small scope for price adjustment- there is no nominal exchange rate, world prices and the return on capital are parametric, so that shocks must be met primarily by changes in quantities. This is a key distinction between the present model and the other UK supply side regional model that allows regional prices to depend on regional wages[17].

The Welsh balance of payments estimates implied by the model suggests the size of transfers from the rest of the UK are very large, perhaps 30 percent of output. The transfers must be primarily government funds but also will include net remittances from family and friends, pensioner payments and income of (net) Welsh commuters to England.

Regional tax rate cuts are apparently more expensive and less effective (because less selective) in Wales than government employment creation, even though the employment multipliers are much less favourable for the public sector. Regional Selective Assistance according to the parameters of the present model is actually detrimental to employment creation, although the parameter estimate is not consistent with experience elsewhere. The measure of 'additionality' of RSA employment in official figures is determined by the grant recipient and is therefore questionable[18]. Subsidies such as RSA require admininstaration that further raises costs per job; the Welsh Development Agency employs over one thousand and spends 15% of expenses on administration. The cost of subsidies also includes the 'excess burden' of taxation necessary to finance the subsidies. The elasticity of substitution between capital and labour is a critical parameter for RSA in the present model; the higher the elasticity the less favourable the impact on employment of the policy of implicitly subsidising capital. When the elasticity exceeds unity there is an adverse effect. Moreover when the capital that has been subsidised is

[16] Suppose that the manufacturing employment share in total employment is 20, public sector's share is 30 and private nontraded employment's share is 50. Assuming marginal effects are the same as the average and treating public employment as export employent , there is a job multiplier of 1, i.e. one public sector or export employee creates one service non-traded job. Assume there is a 20% understatement of the export sector (the true figure is 24) and private nontraded is 46. The true implied multiplier of one export job would be 46/54=0.85.

[17] The central assumptions of an exogenous wage and the inverse relationship between rental price and the wage have not been tested directly, although they pass the indirect test of giving rise to a model that fits the data well.

[18] Individual offers of grants are made to applicants, with job and capital investment targets agreed before a project commences. RSA applicants state they will create or safeguard the target number of jobs as a direct result of their

replaced, unless more RSA is forthcoming there will be no long run effect, in the absence of embodied technical change. A permanent commitment of RSA is necessary to achieve a permanent effect.

The tax simulations can be interpreted as evidence against conferring tax powers to devolved governments, insofar as the restraints on state spending are weaker at the regional level, for institutional and political reasons. Devolved governments will be inclined to boost spending and taxation, reducing employment and output and exacerbating 'the regional problem'.

planned investments. The emp loyment is monitored but whether the jobs would have been created without the grant is not.

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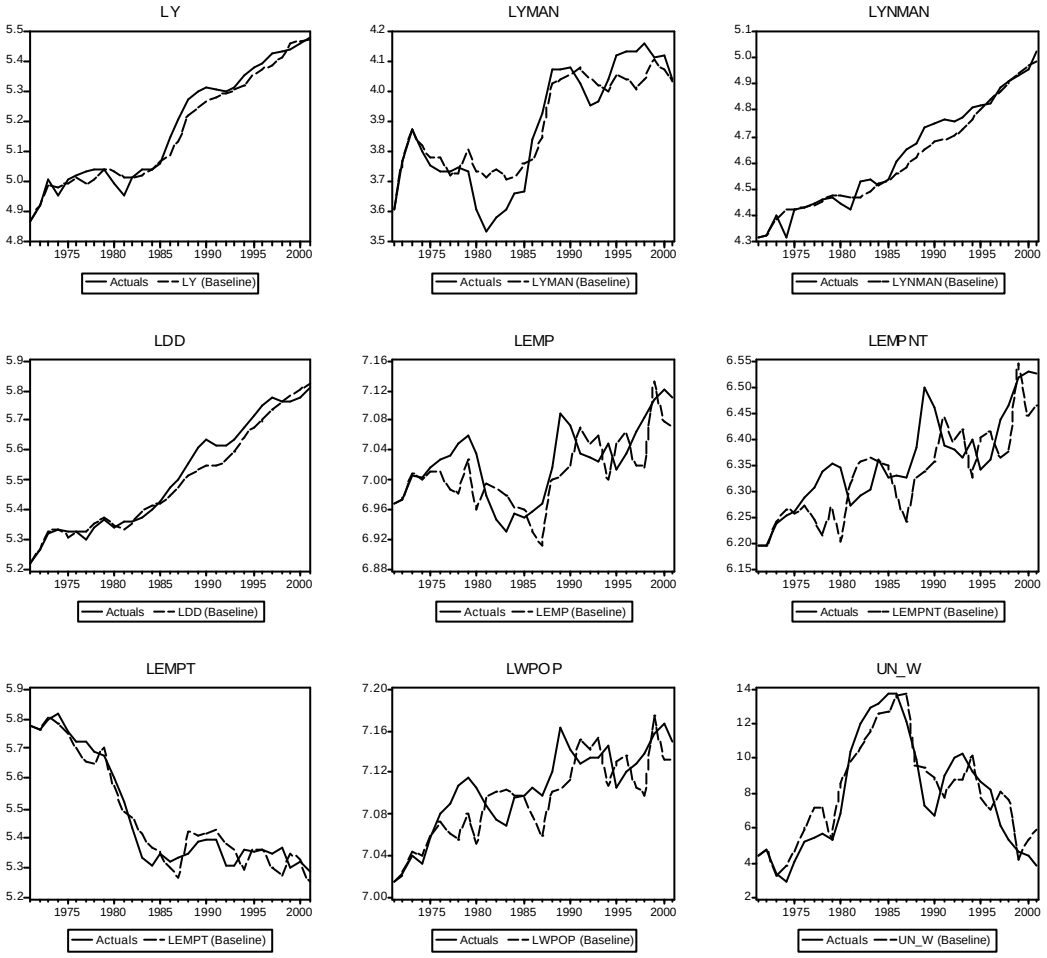
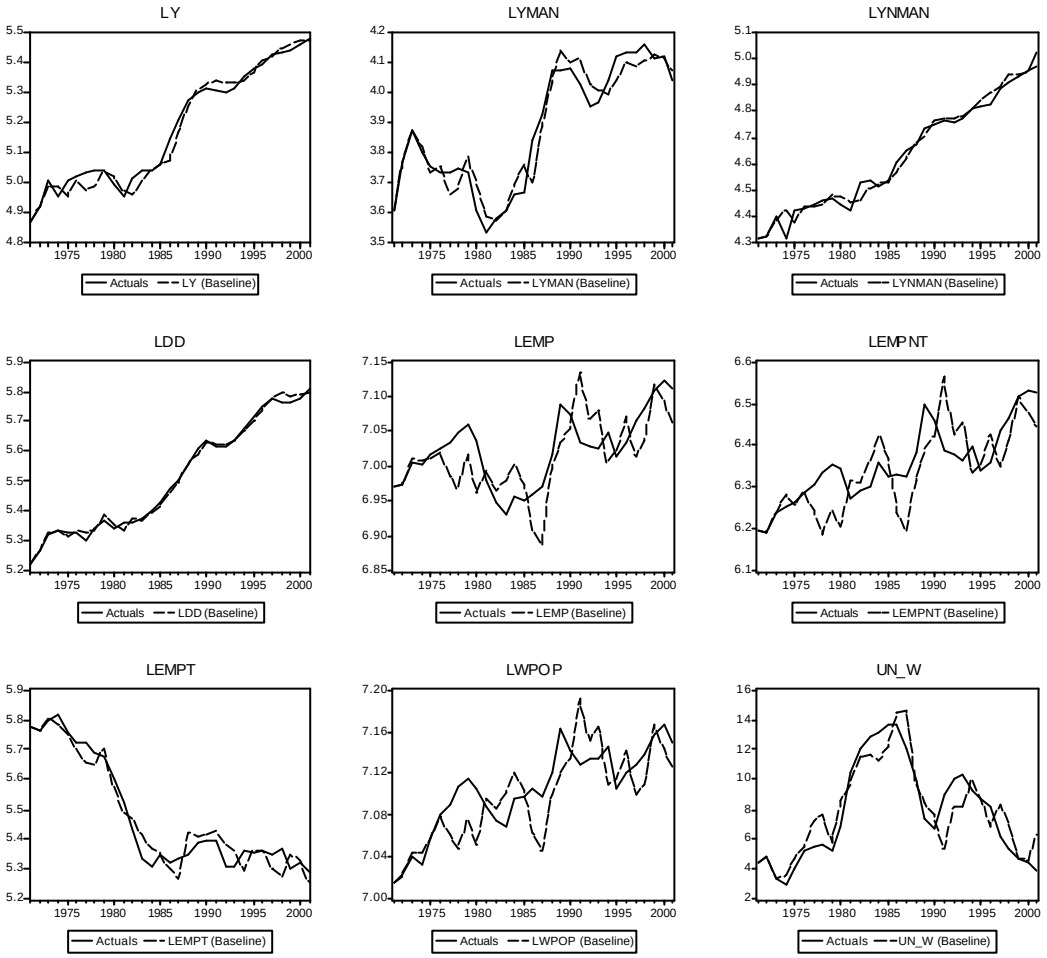
Appendix 1

Multi-step (dynamic in-sample) forecast

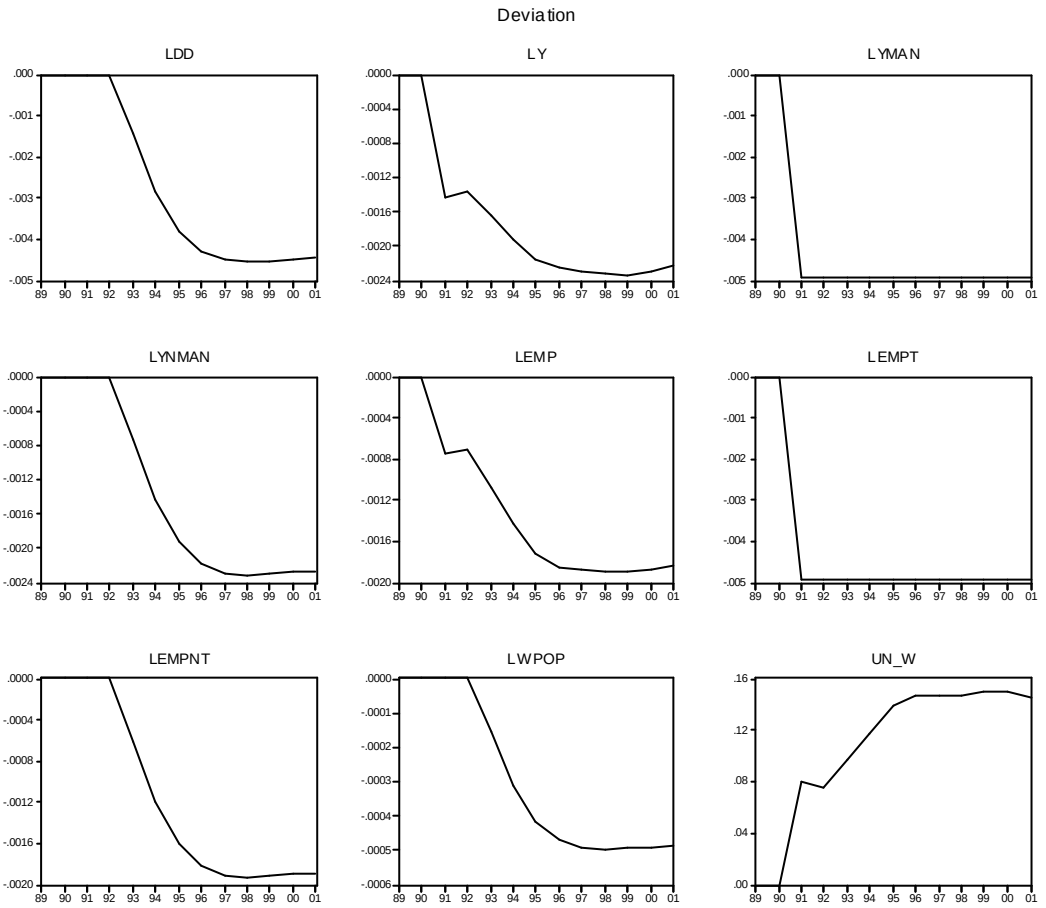


On-step ahead (in-sample) forecast

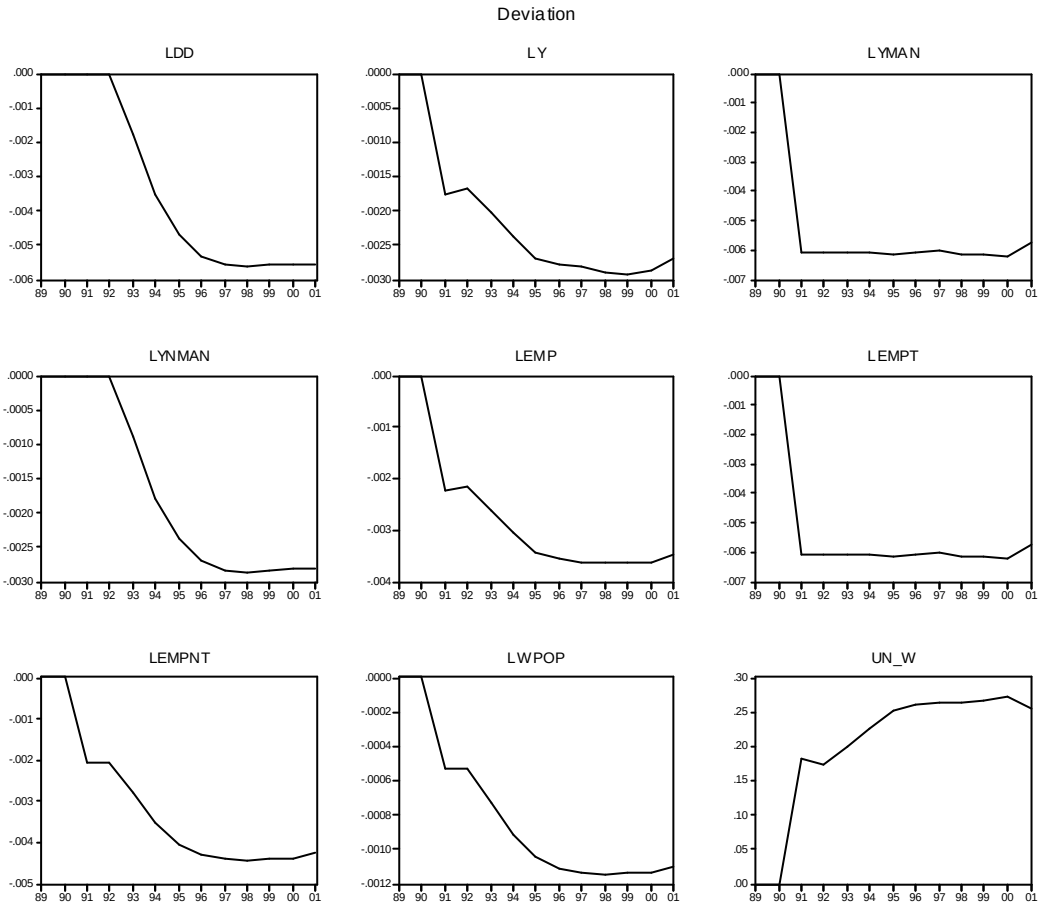


Appendix 2 Model Simulations

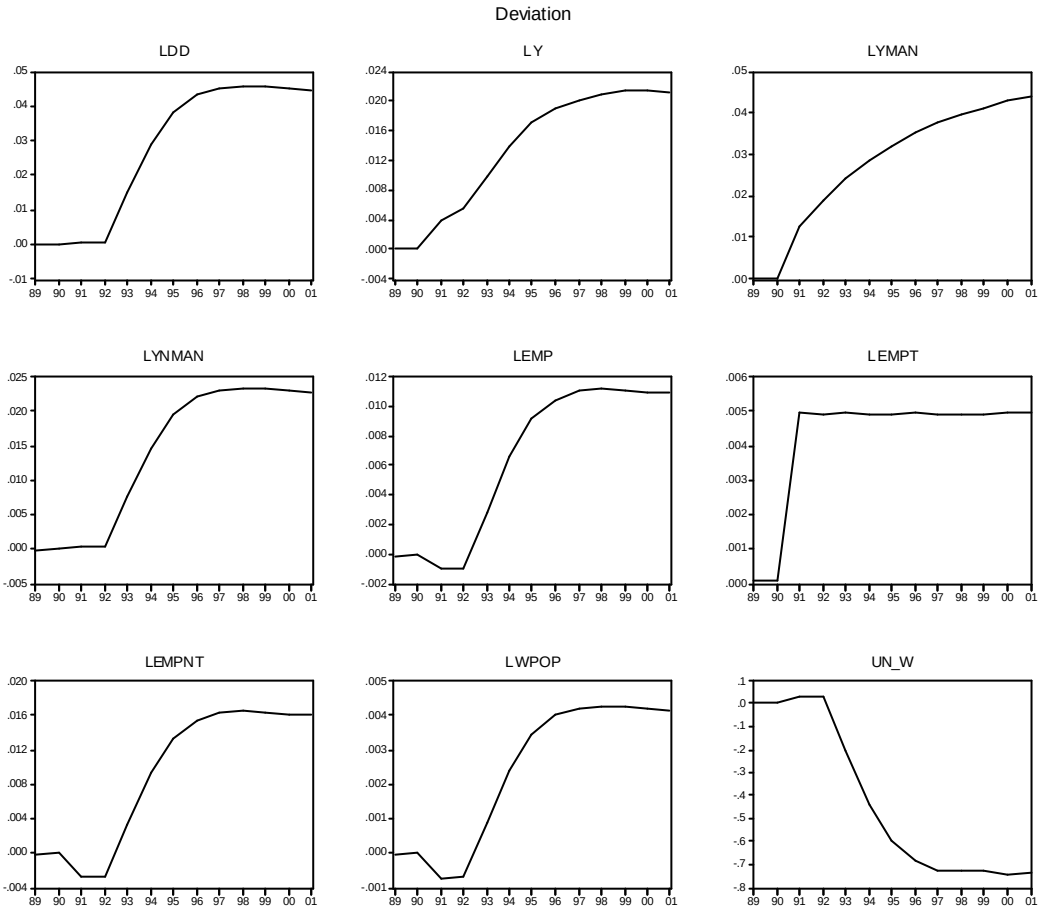
A Permanent 1% increase in Unemployment Benefits, BEN.



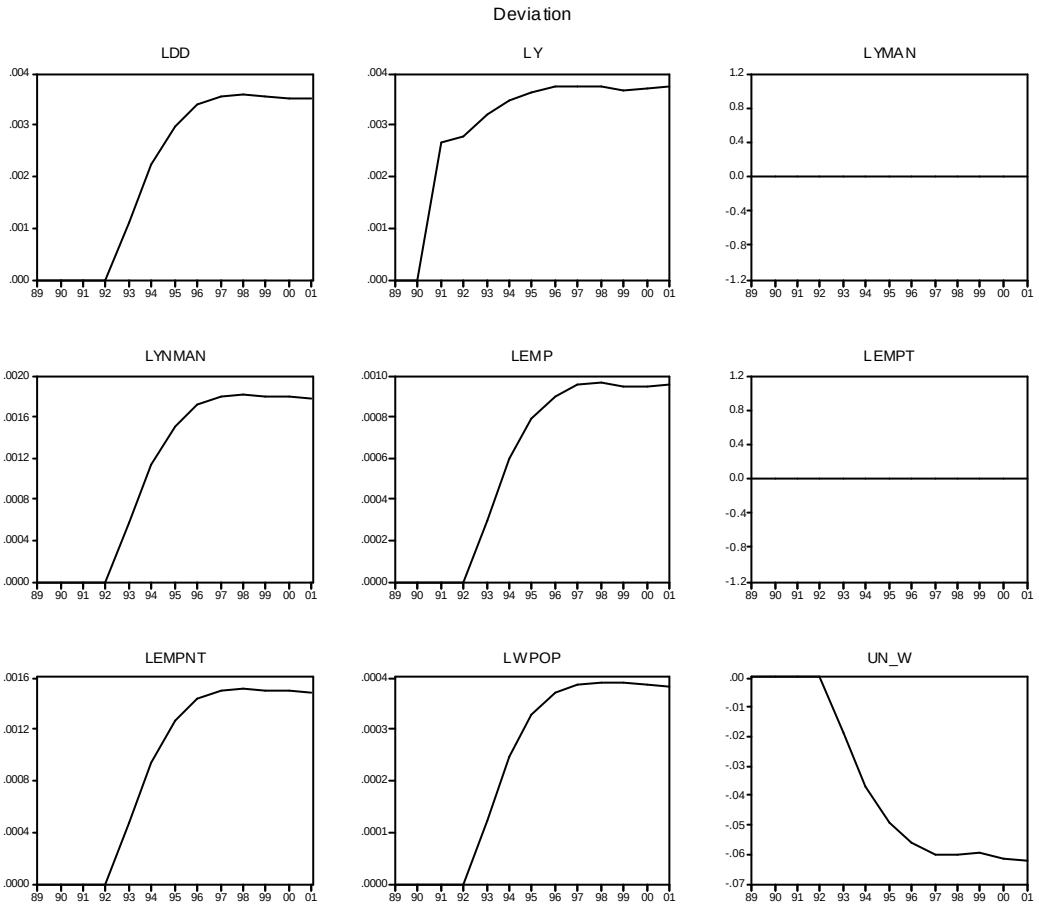
A Permanent 1% Increase in Income Tax, Tax_inc.



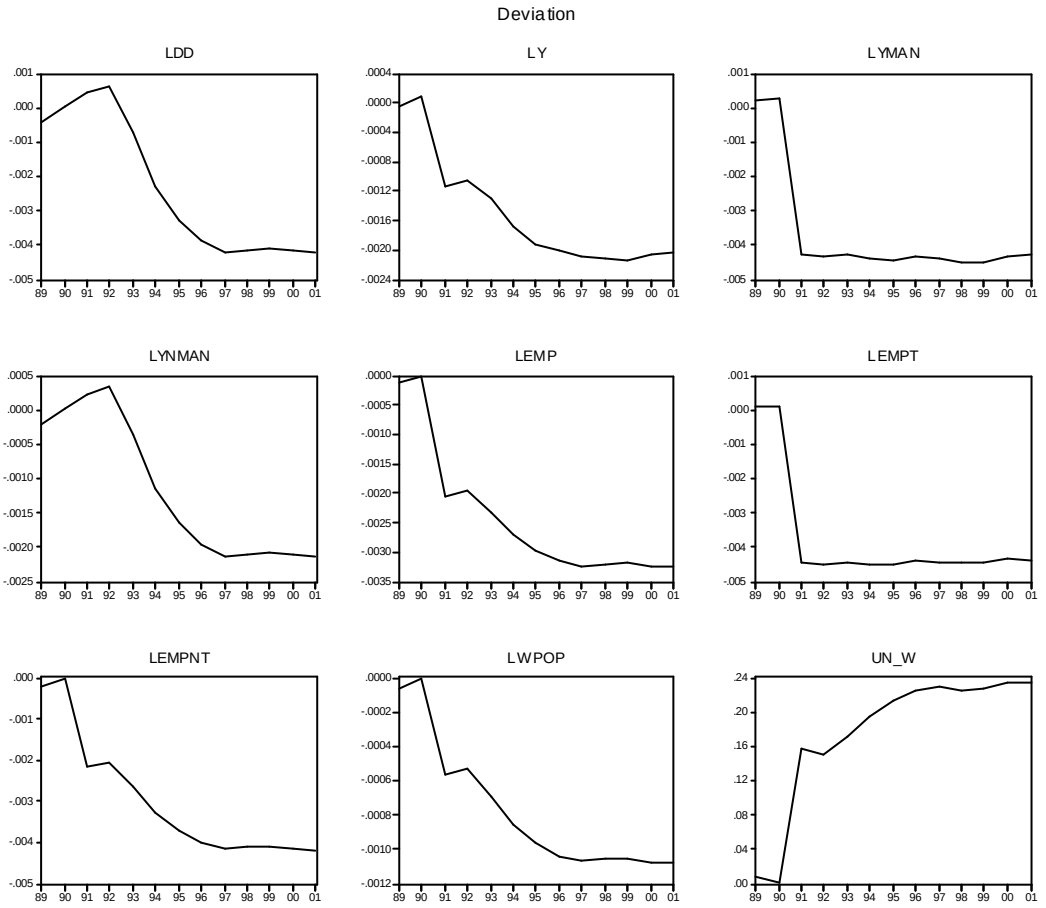
A Permanent 1% Increase in Manufacturing Wage, Wman



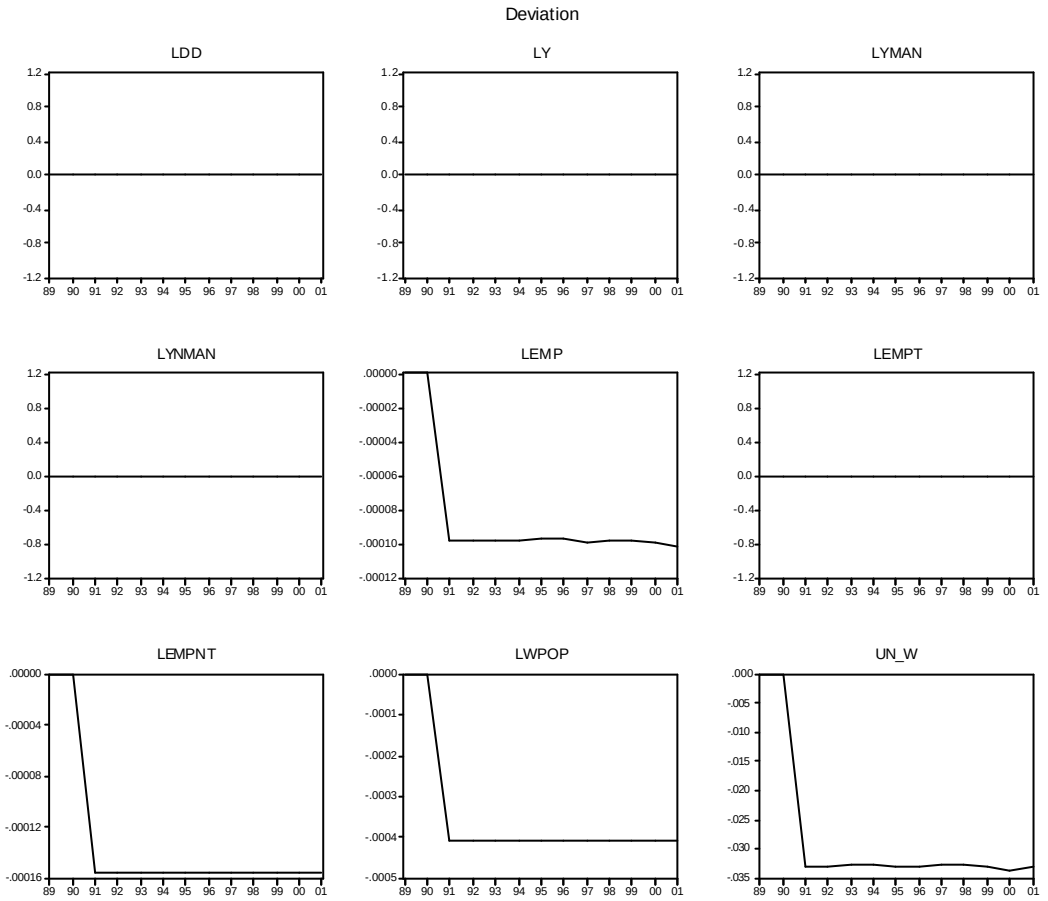
A Permanent 1% Increase in Government Expenditure, YG



A Permanent 1% Increase in Employment Tax, Tax_firm



A Permanent 1% Increase in Sickness Benefits, SIB



Appendix 3

Data Sources and Definitions

Sources:

NES	New Earnings Survey
DWHS1	Digest of Welsh Historical Statistics 1931-1975
DWHS	Digest of Welsh Historical Statistics 1974-1996
ONS	Office for National Statistics, ONS web site: www.statistics.gov.uk
DWS	Digest of Welsh Statistics
RT	Regional Trends
NAW	National Assembly for Wales website , http://www.wales.gov.uk/keypubstatisticsforwales/index.htm
OECD	OECD National Accounts, volume 2.
DWP	Department of Work and Pensions
MDS	Monthly Digest of Statistics, ONS
ODPM	Office of the Deputy Prime Minister website, www.odpm.gov.uk

Definitions:

Manufacturing wages (WMAN) – £/week. This is "average weekly earnings, full time manual and non-manual male". For the 1986-2001 period the data is from NES. For the 1971-1985 period no such series is available. However, the NES reports separate time series for manual and non-manual male weekly earnings so that we re-constructed the series by assuming a constant share of manual males in total male employment of 0.7. This ratio was obtained (approximated) for year 1990 from Table 8.2, pg 159 in DWHS. To get the real wage the series was deflated by the CPI.

CPI – Is the UK consumer price index ONS, (1990=100).

GDP deflator (GDPD) – ONS, (1990=100)

Price of UK manufactures output (PM) – ONS, 1990=100.

Working population (WPOP) – Thousands. Data from 1974-1996 from DWHS, Table 7.2, pg 137.

Manufacturing, total employment (EMPT) – Thousands. Data for 2000 and 2001 was taken from the NAW. For other periods data is from RT.

Total employment (EMP) – RT. Thousands.

Welsh Output (Y) – £ millions, GDP at factor cost, current prices. Data from 1999 to 2001 are estimates and was taken from NAW. Data from 1974-1996 is from DWHS, Table 2.1, pg. 25.

Manufacturing Output (YMAN) - £ Millions. For the 1971-1990 period data is from RT (it has been multiplied by a coefficient of 1.075 for consistency because from 1996 the series has been revised

backwards to 1989 by the Welsh Assembly Government to reflect the new European System of Accounts 1995 requirements, ESA95). For the 1989-1997 period it is from DWS 1999 issue, pg. 231. The 1998-2001 data from the NAW.

Employment tax rate borne by the firm (taxfirm) – Percentage. To get an approximation for this we took the ratio of two indexes, namely total labour costs per unit of output divided by wages and salaries per unit of output (for the UK, whole economy). The latter is series LNNK and the former is series LNNL, both are from the ONS web site. Alternatively unit wage costs for the 1960-2001 period are in Table 3.8 in the Economic Trends Annual Supplement 2002.

Income tax (taxinc) – Percentage. This has been computed as (DT+SS)/HCR where
DT is direct taxes on household income, SS is the household's contribution to social security schemes, and HCR is households' current receipts minus employer contributions to social security schemes. All three time series were taken from the OECD National Accounts, vol 2.

Ratio of females in employment (FWPOP) – Percentages. The female employees in employment series (which does not include the self-employed) obtained from RT was divided by the WPOP and multiplied by 100.

Ratio of house prices Wales/South East (HP) – ODPM.

Public sector employment (EMPPS) – Thousands. This is from DWHS, Table 7.3, pg 139 for the 1974-1996 period. To get a consistent time series we added employment from 'other services' to 'public administration, education, and health' for the 1974-1980 period. For the 1971-1973 period we assumed that public sector employment follows the same trend with public sector data. This is published in the row 27 in the table reporting data on insured employees from the WDHS1. Data for the 1997-2001 period was taken from various issues of DWS.

Sickness and invalidity benefits (SIB) – Thousands. For the 1978-2001 period data is from DWP (e-mail). For the period prior to 1978 we used the data from RT. The table 'Sickness and Invalidity benefit: days of certified incapacity in period' in RT reports Wales data on both males and females. The time series was extended backwards for the period 1971-1978 by assuming that the 1982 ratio of the number of people who received SB to the number of days (i.e. 116/36.3) remained unchanged over the period. An alternative way would be to take a fraction of the number of people who received SB in the UK during that period.

Population (POP) – RT and DWHS, Thousands.

Unemployment Benefits (UB) – In real terms, from the Liverpool model data file.

UK household consumption (UK_CON) - £ Millions. Household final consumption expenditure: National concept series ABJO, MDS from the ONS.

UK government expenditure (UK_G) - £ Millions. This is obtained by adding the Central Government final consumption expenditure (series NMBJ) to Local Government final consumption expenditure (series NMMT). Both series are from the ONS.

UK total fixed gross capital formation (UK_I) - £ Millions. This is obtained by adding 'gross fixed capital formation' (series NPQX), 'changes in inventories',(series ABMP) and 'acquisitions less disposables' (series NPJO). All there series are from the ONS.

UK demand (UK_dmd) – obtained by summing up UK_CON+UK_G+UK_I

Welsh Government Consumption (YG) - £ Millions. Obtained by multiplying the public sector average yearly wage by the number of public sector employees.

Welsh Demand (DD) - £ Millions. Computed by adding Welsh household consumption, Welsh investment and Welsh government spending (which also includes government transfers). DWHS.