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## Tax policy and OECD unemployment

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**Tax Policy and OECD Unemployment**

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# TAX POLICY AND OECD UNEMPLOYMENT\*

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## **Abstract**

The effect of changes in payroll taxes on wages is a question of tax incidence. If workers can shift the burden of taxation onto employers, in the form of higher wages, we may expect increases in unemployment. This paper examines the extent to which workers succeed in shifting the burden of taxation onto employers and therefore the effects on unemployment of higher direct taxes. A reduced form vector autoregression model is used to estimate the effects, of a shock to direct taxes, on both wages and unemployment. The empirical estimates, estimated separately for eleven OECD countries, show workers failing to shift the burden of higher taxes and consequently insignificant changes in unemployment.

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\* I am grateful to Vincent Hogan for helpful comments.

## Tax Policy and OECD Unemployment

Whether or not a payroll tax increase influences wages and employment is a question of tax incidence. If workers succeed in shifting the burden of increased taxation onto employers, we would expect an increase in employer costs and consequently, the possibility of a reduction in the demand for labour. The ability of workers to shift the burden of taxation or alternatively the ability of employers to resist the shifting of such a burden lies in the relative bargaining strengths of the two groups. If workers fail to shift the burden of taxation, we would expect to see no effect on unemployment. The common perception, however, is that high tax regimes are consistent with high unemployment. This paper examines if this generalisation holds, by estimating the effects of a balanced budget tax change in eleven OECD countries. With a reduced form VAR model we consider the consequences for unemployment of a change in tax policy that increases direct taxes but leaves the budget balance unchanged.

Previous multi-country studies have used structural models to examine the effects of tax changes on wages and unemployment but have been unable to identify a causal relationship that holds consistently across most countries.<sup>1</sup> This paper takes the alternative approach of a reduced form model to estimate the effects of an increase in direct taxes. The model is an adaptation of previous work by Poterba, Rotemberg and Summers (1986) who use revenue neutral tax shocks to test for the existence of nominal rigidities. Using an exogenous variable that captures tax policy we employ a reduced form VAR to show that the hypothesis that increasing taxes increases unemployment does not hold universally. Section I reviews some of the background to how taxes may influence unemployment and the different effects direct and indirect taxes may have. Section II describes the model to be estimated and the construction of an exogenous tax variable; the following section is concerned with the data used. Section IV presents our empirical finding for eleven OECD countries and the concluding section reviews the implications of these findings.

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<sup>1</sup> For a complete review of this literature see Layard, Nickell & Jackman (1991)

## I. Taxes, Wages and Unemployment

We assume a simple model similar to Hogan (2001) and Blanchard and Katz (1997) to suggest how tax changes may affect unemployment. The wage that prevails in the market is a multiple of the reservations wage.

$$\frac{W}{P}(1-\tau) = \frac{W^R}{P} B(u, X) \quad (1a)$$

$W$  is the nominal market wage,  $W^R$  is the reservation wage,  $P$  is the consumer price index and  $\tau$  is the income tax rate.  $B()$  is a mark-up function, which is assumed to be increasing in unemployment,  $u$  and decreasing in other factors,  $X$ . Higher levels of unemployment should lead to more wage restraint.

Given the wage, the firms choose their optimal level of employment according to

$$u = G\left(\frac{W}{s}, Z\right) \quad (1b)$$

$G$  is an increasing function of the product wage and other variables,  $Z$ . An index of prices facing producers is given by  $s$ . The model therefore incorporates the assumption that increased producer costs, as affected by wages, lead to higher unemployment, holding other factors (such as productivity) constant. 1a and 1b jointly determine equilibrium wages and unemployment. Holding the other parameters constant if wages are increased above this level unemployment will rise and put a downward pressure on wages until they return to equilibrium. However, as there is some sort of inefficiency, which prevents market clearing, this equilibrium is at a point where unemployment exists and wages are in excess of the reservation wage.

Using this model we can highlight the contrasting effects on unemployment of changes in direct and indirect tax reforms. An increase in direct tax,  $\tau$  will cause workers to seek an increase in  $W$  to keep the mark-up on the reservation wage constant. If  $\tau$  is increased  $W$  must also be increased to maintain the equality with the right hand side of 1a. If workers

succeed in increasing  $W$  unemployment will rise, because in 1b unemployment is increasing in wages. The reason that an increase in tax will cause an increase in unemployment is that a change in tax affects the real after tax wage but not the reservation wage. However, if a tax were levied on the reservation wage as well, there would be no effect on unemployment. An important example of this is a sales tax. A sales tax is levied equally on those who work and receive the market wage, and those who receive benefits. Therefore an increase in indirect taxes would not change the equality in 1a and as such would place no upward pressure on wages in this model.

## II. Methodology

In order to examine a model as outlined above, this paper avoids the structural approach to estimating the effects of tax changes, instead favouring a simple reduced form approach. We do not use a structural model to avoid the difficulty of specifying a convincing and complete macroeconomic model. As a reduced form model is used behavioural equations have not been specified. The drawback of this approach is that it is vulnerable to the Lucas critique. Given this we must be careful in interpreting the results to predict the future effects of tax changes.

To estimate whether or not increases in direct taxes cause unemployment we employ a VAR model where the auto regressive vector,  $Y$  consists of the variables unemployment, wages, budget surplus, direct taxes and indirect taxes. Due to the complex nature of modern tax systems it is not possible to use a single tax rate for direct taxes and indirect taxes. Both tax variables are therefore modelled as tax revenue as a share of GDP. The drawback of this method is that either direct taxes as a share of GDP, or indirect taxes as a share of GDP, will vary over the business cycle causing reverse causality. The danger of reverse causality is feedback from unemployment to our tax measures, rather than the direction of causality we wish to estimate; which is from the tax variables to unemployment. This paper follows Poterba et. al. (1986) and uses the variable TAXMIX to attempt to avoid the problem. TAXMIX is the difference between direct taxes as a share of GDP,  $\tau$  and indirect taxes as a share of GDP,  $\theta$ . Including the difference

between  $\tau$  and  $\theta$  rather than including them as separate regressors will reduce the problem of reverse causality. The central idea behind TAXMIX is that a change in the tax policy mix of a government is a policy change that is exogenous to this model.

Treating the TAXMIX variable as an exogenous tax policy shock we therefore estimate the model as:

$$Y_t = \alpha(L)Y_{t-1} + \gamma(L) \text{TAXMIX}_t + \varepsilon_t \quad (2)$$

$$Y_t = (\ln U_t, \ln W_t, \text{Surplus}_t)'$$

Where  $(L)$  is a matrix of lag polynomials,  $\ln U$  is natural logarithm of the unemployment rate,  $\ln W$  is the natural logarithm of the real wage adjusted for productivity and  $\text{Surplus}$  is the budget balance as a share of GDP.

The concept of exogeneity is important in the context of ensuring accurate results from a VAR. In this model the endogenous variables, (unemployment, wages, budget balance) are included the vector  $Y$ . TAXMIX is assumed to be exogenous and its contemporaneous values are included as an explanatory variable. It is appropriate to include contemporaneous values of TAXMIX in the VAR only if it is a valid exogenous variable. We maintain that TAXMIX is such a variable and therefore, this approach is valid. If the elasticity of  $\tau$  with respect to GDP has the same sign as the elasticity of  $\theta$  with respect to GDP, TAXMIX will offset the two sources of bias that would be caused due to business cycle fluctuations. If the size of the elasticities are not the same, there will remain some bias, however, it is smaller than would result if TAXMIX were not constructed. Alesina and Perotti (1995) support this assertion by arguing that the endogeneity of taxes should not be a serious problem in practice as the bias caused by demand and supply shocks would cancel each other out. Granger causality tests, as reported in Table 2, provide some support for the assumption that TAXMIX is a valid exogenous variable. At the 5% significance level we can not reject the hypothesis that

lnU does not Granger cause TAXMIX in nine of the eleven countries, for lnW we can not reject in ten countries and for Surplus we can not reject in ten countries.

We are interested in the supply-side effects of changes in direct taxes, that is on the incentives for firms and workers. Therefore, it is necessary to control for Keynesian demand effects. We do this with the variable, *Surplus*. Similar variables are used by Poterba et al (1986), Alesina and Perotti (1995) and Hogan (2001). Poterba et al (1986) use an additional variable to control for total tax revenue, thus ensuring that any change in the tax mix is a revenue neutral change. To adopt this approach in our model would be to reintroduce the problem of endogeneity. However, by using the variable, *Surplus*, which is the budget balance as a share of GDP we ensure that any shocks to TAXMIX are measured as balanced budget shocks. In addition, using a variable to control for demand fluctuations should also reduce any possibility of TAXMIX remaining endogenous.

From the simple model of Section I, if workers are successful in shifting the burden of taxation, an increase in direct taxes should result in higher wage costs for employers and consequently higher unemployment. Theory would suggest that this effect will hold only in the short run and that in the long run the reservation wage will adjust, workers will bear the burden and tax changes will have no effect on unemployment. Therefore we examine the long run neutrality of TAXMIX by testing the restriction that the sum of the TAXMIX coefficients in each equation equal zero. We also examine the short run neutrality of TAXMIX or that changes in the tax policy mix have no effect on the endogenous variables, unemployment, wages and Surplus. We do this by testing that the coefficients on TAXMIX from the three equations of the VAR are jointly zero.

### **III The Data**

The data used in the estimation comes from the OECD Economic Outlook 1999 and the IMF International Financial Statistics and covers the years 1960 to 1999. The VAR was estimated separately for the eleven individual countries. The countries used in the study



are Austria, Canada, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal and the USA. Unfortunately data was not available for the U.K. The countries chosen reflect the availability of data and also an attempt to choose countries with contrasting labour markets; therefore including North American, Scandinavian and Western European countries.

As was discussed in Section II we construct an exogenous tax variable which captures changes in tax policy. As it is impossible to use actual tax rates due to the complicated nature of most modern tax systems the tax variables are modelled as tax revenue as a share of GDP. Direct taxes are defined as taxes on households as a share of GDP and do not include social security taxes. Indirect taxes includes the VAT, excise taxes and other duties levied on goods and services. As GDP is measured in after tax prices we adjust the variables to take account of this.

The variable TAXMIX is simply the difference between the direct and indirect tax revenues as a share of GDP. TAXMIX, which is effectively the ratio of direct to indirect taxes, is surprisingly different across countries and also has changed within countries throughout the period examined by this paper. Sometimes this change has been the result of deliberate policy, such as the Thatcher government, which, as a matter of policy, reduced income tax while increasing indirect taxes. Many governments have kept indirect taxes constant with income tax changing more frequently. Ireland in the 1990s is an example of this; income tax rates fell whereas VAT remained more rigid.

The wage variable  $\ln W$  is the log of the real wage adjusted for productivity. The nominal wage rate is divided by the consumer price deflator and this real wage is adjusted for productivity by subtracting the filtered natural logarithm of a productivity index from the natural logarithm of the real wage. We filter the log of measured productivity as it may be endogenous in the short run due to labour hoarding and measurement error. The log of productivity was filtered, by regressing it on a constant, a time trend and a time trend squared and keeping the fitted values.

LnU is simply the natural log of the unemployment rate and Surplus is the budget balance as a share of GDP. Surplus is included to control for cyclical effects and to allow balanced budget changes to be measured.

Unit root tests were carried out on the series lnU, lnW, Surplus, TAXMIX for each country to see if they contained unit roots. Both Weighted Symmetric and Dickey-Fuller tests were used. The null hypothesis of a unit root could not be rejected for most of the variables. However, theory suggests that unemployment and the budget balance as a share of GDP, Surplus should be mean reverting. Many economists / econometricians have pointed out the low power of these tests<sup>2</sup> and in fact the results of the two tests used here frequently contradict each other. It is possible that the tests are weak because of a low number of observations; the sample period covers 1960 to 1999 however not all data for all countries was available for the entire period resulting in less observations for certain variables. For these reasons we rely on the theory which suggests that lnU and Surplus are mean reverting and that while lnW may be I(1) when productivity is controlled for it should have no long run trend. Therefore the option of forcing unit roots on these variables by including them as first differences is avoided. While we remain agnostic about the order of integration of these variables we include lags in the VAR, which avoids the spurious regression problem.

#### **IV Empirical Findings**

The model is estimated for the eleven countries. We create Impulse response functions for each country, using the coefficients to estimate the response of both unemployment and wages to one unit increases in TAXMIX. Two standard error confidence bands are also constructed, in order to determine the significance of the point estimates. The role of TAXMIX can be ascertained from both the impulse responses and from neutrality tests. The null hypothesis of TAXMIX being neutral in the short run is tested. We test the

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<sup>2</sup> See, for example, Blanchard and Perotti (1999)

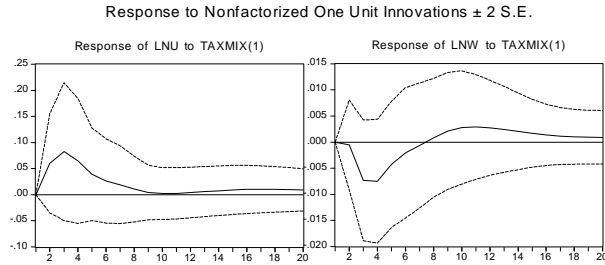
theory suggests that taxes may have an effect in the short run but over time, the labour market should adjust, and taxes should be neutral.

The model was estimated with two lags of all the variables. LM autocorrelation tests were used to determine if sufficient lags were used. The results of the LM autocorrelation tests as reported in Table 3 show that for all countries, except Portugal and Germany, the null hypothesis of no serial correlation of the residuals can not be rejected at the 5% confidence level. For both Portugal and Germany four lags would have been necessary to remove autocorrelation according to LM tests. However due to the restriction of having a low number of observations and consequently insufficient degrees of freedom it was not possible to estimate the VAR with four lags. However when Portmanteau autocorrelation tests were performed on Portugal and Germany the Q statistics were such that autocorrelation could be rejected at conventional confidence levels. Due to the conflicting results of different autocorrelation tests the responses of these two countries are reported but their results should be viewed with this in mind.

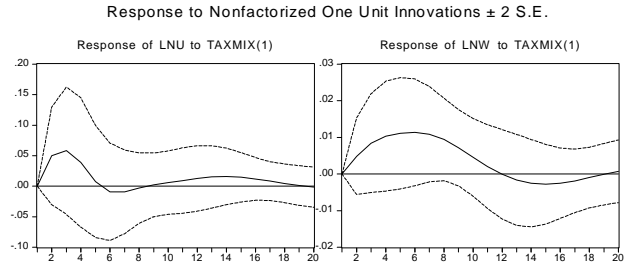
The responses of the eleven countries to a one unit increase in TAXMIX are reported in Table 1. As TAXMIX is calculated as direct taxes less indirect taxes as a percentage of GDP, a one unit increase in TAXMIX may be considered as the equivalent of an increase in direct taxes by one percent of GDP, holding indirect taxes constant. As we are primarily concerned with the effects on wages and unemployment these responses are shown. Surplus was included in the VAR to control for demand and cyclical fluctuations, therefore, the response of Surplus is not reported.

TABLE 1 : Impulse Response Functions

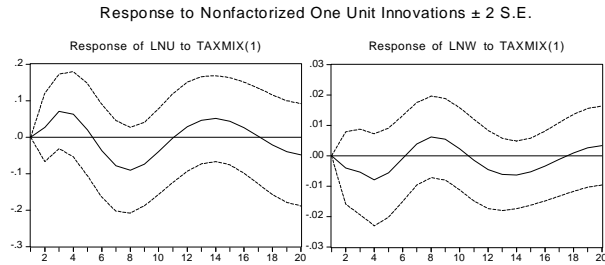
**AUSTRIA**



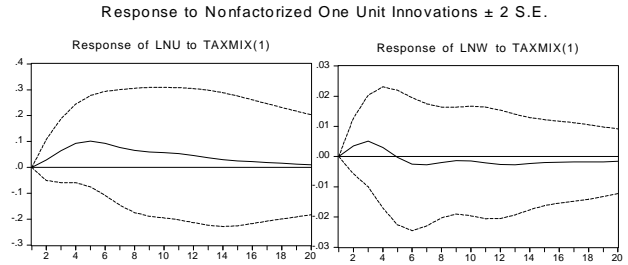
**CANADA**



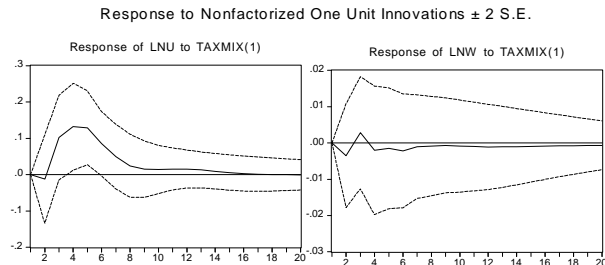
**FINLAND**



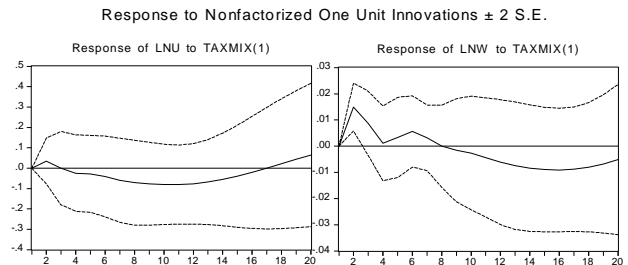
**FRANCE**



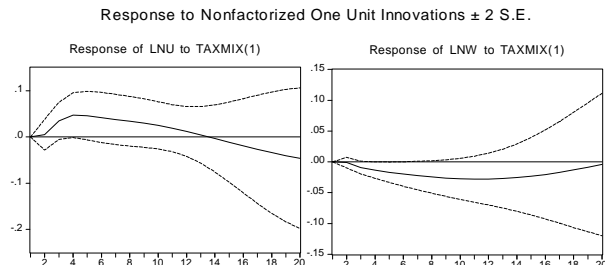
**GERMANY**



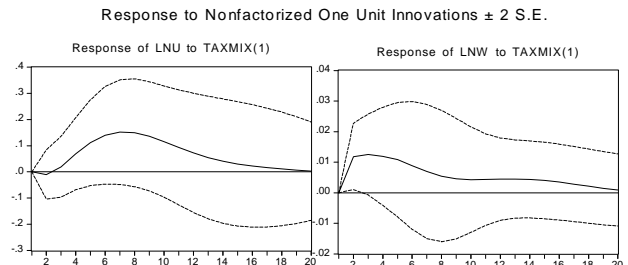
**IRELAND**



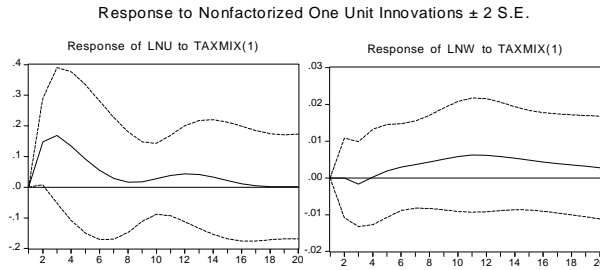
**ITALY**



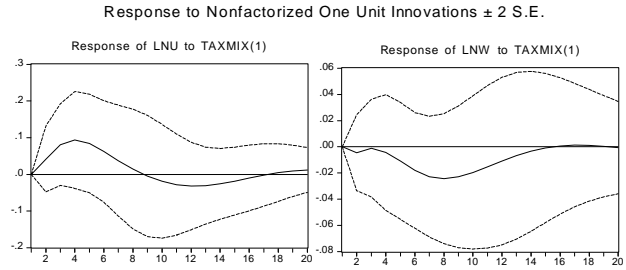
**NETHERLANDS**



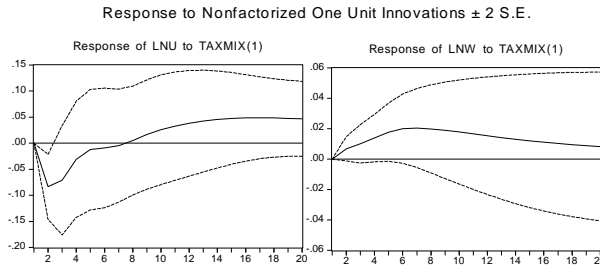
## NORWAY



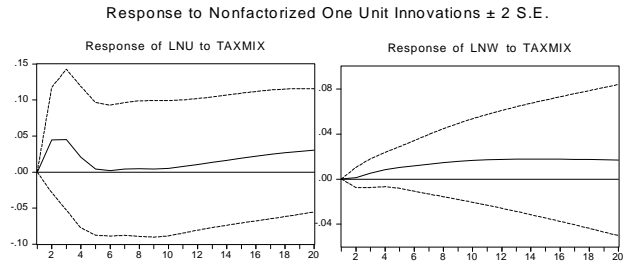
## PORTUGAL



## USA



## USA (without contemporaneous TAXMIX)



### Wage Responses:

The model as used in this thesis assumes that, if increases in direct taxes lead to increases in unemployment, it is because workers succeed in shifting the burden of taxation to employers, who reduce demand for labour in the face of higher wages. The response of wages to unit increases in TAXMIX is therefore crucial in understanding the mechanism by which taxation affects unemployment. If workers succeed in shifting the tax burden in the short run, real wages would follow a pattern with an initial increase followed by a return to equilibrium levels. The responses do not provide concrete evidence for this hypothesis. The point estimates show increases in the real wage level in only five of the eleven countries with just two (Ireland and Netherlands) experiencing statistically significant increases. The largest increase in wages is in Ireland where the point estimate is for a one and a half percent increase in wages is significant. The point estimates show that there is almost no effect in four countries, with real wages falling in two countries; although neither is statistically significant.

### Unemployment Responses:

The results fail to show either substantial or significant increases in unemployment given the increase in direct taxes. The responses follow somewhat the pattern one may expect, however, the effects are frequently insignificant and sometimes of small magnitude. The trend predicted by the model, if workers are successful in shifting the burden of taxation, would see unemployment rise at first and then subside. The responses for nine of the eleven countries follow this pattern. However, of the nine countries that follow the expected pattern of initial increases, followed by a gradual reduction, only two countries (Norway and Germany) have increases in unemployment that are significant. However, the level of the increases are small. The peak of the point estimate for Germany is just under 15%. That is if the unemployment rate were 10% it would rise to 11.5%. Ireland shows almost no effect and curiously USA shows a decrease in unemployment. This decrease is significant (at a two standard error band) but the reduction is small. However, when contemporaneous values of TAXMIX are omitted, the U.S. point estimates show a small increase in unemployment. The dangers of assuming similar effects across countries should be highlighted as the magnitude and significance of the increases in unemployment varied substantially between the different countries.

When the VAR was estimated without contemporaneous values of TAXMIX the accuracy of the results was reduced, as indicated by wider confidence bands. We also estimated a fixed effects, panel version of the model in order to increase the number of observations. The impulse response functions followed a similar pattern showing only small increases in wages and unemployment.

Theory would suggest that in the long run the reservation wage would adjust, workers would bear the burden of taxation, and taxes should have no long run effect. This was tested using Wald tests. The Wald test for long run neutrality tests that the sums of the coefficients in each of the three equations are jointly equal to zero. Surprisingly long run neutrality was rejected in four countries at a 5% significance level. This is a curious result and it goes against the common view of taxes having no effect in the long run. However these results are not very robust; when the tests are re-estimated without

contemporaneous values of TAXMIX, the results change. Only Italy country can reject long run neutrality for in both sets of tests.

Of greater interest are the tests of short run neutrality. While it is accepted that taxes are neutral in the long run it is a commonly held view that the burden of tax increases may be shifted to employers in the short run. Therefore a change in TAXMIX would affect wages and unemployment. The evidence of short run neutrality tests does not support this hypothesis. Short run neutrality is examined by testing the null hypothesis that the coefficients on TAXMIX are jointly equal to zero. At a 5% significance level only four of the eleven countries can reject the null hypothesis, suggesting there is not strong evidence to support the idea that a change in tax policy will affect either wages or unemployment.

The main conclusion that one can draw is that the empirical evidence does not lend much support to the expectation that increases in direct taxes, relative to indirect taxes, causes unemployment. The differences in the results across countries certainly highlight the dangers of making non country specific statements about taxes and unemployment. The results varied from country to country, the effects were significant in some and insignificant in others and the effects in significant countries were of small magnitude. The incidence of tax as discussed above is crucial to the effects of tax changes, however the effect on wages of increasing taxes was also ambiguous. It was expected that workers would have some success in shifting the burden of taxation onto firms but there is little evidence to support that wages rise by any substantial amount.

## **V Conclusions**

The general implications for unemployment, of altering fiscal policy, are of great interest to economists. The specific focus of this paper is to estimate the effects on wages and unemployment of increasing direct taxes while holding the budget balance constant. The results of estimating the model suggest that increasing direct taxes does not have significant effects on either wages or unemployment. We might have strong priors that

workers would have some success in shifting the burden of taxes onto employers but the empirical evidence did not support this hypothesis. This could have important implications for fiscal policy and suggests a move away from indirect taxation towards direct taxation could be beneficial. In light of the recent economic downturn, some governments have been faced with a need to increase taxation. The Irish government, for example, has chosen to raise indirect taxation, which may increase inflationary pressure. If the costs of increasing direct taxation, in terms of higher wages and unemployment, as indicated by our empirical results, are not that high, then the question of whether a country's economic performance could be improved by moving towards direct forms of taxation may be posed.



## REFERENCES

Alesina, A, A. Ardagna, R. Perotti, F. Schiantarelli, (1999). 'Fiscal Policy, Profits and Investment', National Bureau of Economic Research, Cambridge, MA. Working Paper #7207.

Alesina, A, & R. Perotti, (1995). "Taxation and Redistribution in an Open Economy", *European Economic Review* 39 pp961-979.

Ball, L., R. Moffitt, (2001). 'Productivity Growth and the Phillips Curve', National Bureau of Economic Research, Cambridge, MA. Working Paper #8421.

Bean, C.R., P.R.G. Layard, & S. Nickell, (1986). 'The Rise in Unemployment: A Multi-country Study', *Economica*, 53, S1-S22.

Bean, C.R., (1994). 'European Unemployment: A Survey', *Journal of Economic Literature*, 32, pp. 961-979.

Blanchard, O., L. Katz, (1997). 'What We Know and Do Not Know About the Natural Rate of Unemployment', *The Journal of Economic Perspectives*, 11, pp. 51-72.

Blanchard, O. & R. Perotti, (1999). 'An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output', National Bureau of Economic Research, Cambridge, MA. Working Paper #7269.

Booth, A., (1995). *The Economics of the Trade Union*. Cambridge University Press, Cambridge.

Bruno, M., & J. Sachs, (1985). *The Economics of Worldwide Stagflation*. Basil Blackwell.

Denny, K., A. Hannan, K. O'Rourke, (1995). 'Harmonising Irish Tax Rates: A Computable General Equilibrium Approach', Department of Economics, University College Dublin. Working Paper # 95/03.

Greene, W., (2000). *Econometric Analysis*. Prentice-Hall, New Jersey.

Hall, B., (1999) *Time Series Processor version 4.5, reference manual*, TSP International, Palo Alto.

Hamilton, J., (1994). *Time Series Analysis*. Princeton

Hogan, V., (2001). 'Do Taxes Cause Unemployment?', Department of Economics, University College Dublin. Working Paper # 01/01.

Jenkinson, T.J., (1988). 'The NAIRU: Statistical Fact or Theoretical Straitjacket?' in Cross, R. (ed) *Unemployment, Hysteresis & the Natural Rate Hypothesis*, Blackwell, U.K.

Kay, J., (1990). 'Tax Policy: A Survey', *Economic Journal*, 100 pp. 18-75.

Kesselman, J., (1996). 'Payroll Taxes in the Finance of Social Security', *Canadian Public Policy*, pp.162-179.

Knoester, A., & N, Van der Windt, (1987). 'Real Wages and Taxation in Ten OECD Countries', *Oxford Bulletin of Economics and Statistics*, 49, pp.151-169.

Layard, R., & S. Nickell, (1986). 'Unemployment in Britain', *Economica*, 53, S121-S169.

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

Lockwood, B., A. Manning, (1993). 'Wage Setting and the Tax System: Theory and Evidence for the United Kingdom', *Journal of Public Economics*, 52, pp. 1-29.

Mankiw, N. G., R. Reis, (2001). 'Sticky Information versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve', Harvard Institute of Economic Research, Cambridge, MA. Discussion Paper #1922.

Phelps, E., (1994). *Structural Slumps, The Modern Equilibrium Theory of Unemployment, Interest, and Assets*. Harvard University Press.

Poterba, J., J. Rotemberg & L. Summers, (1986). 'A Tax-Based Test for Nominal Rigidities', *The American Economic Review*, 76, pp659-675.

Thomas, A., (1997). "Payroll Taxation and its Effects on Unemployment: An Application to Canada" International Monetary Fund, Working Paper # WP/97

Shapiro, C., J. Stiglitz, (1984). 'Equilibrium Unemployment as a Worker Discipline Device', *The American Economic Review*, 74, pp. 433-444.

Summers, L., (1990). *Understanding Unemployment*, Massachusetts Institute of Technology.

Walsh, B.M. (1983). 'Unemployment and the Labour Market in Ireland', *Economic and Social Review*, 14(2), 73-76

Table 2 : Granger Causality Tests

H0: X does not Granger cause TAXMIX.

P-values are given.

|             | X= lnU  | X= lnW  | X=Surplus |
|-------------|---------|---------|-----------|
| Austria     | 0.08772 | 0.67434 | 0.14775   |
| Canada      | 0.86159 | 0.69098 | 0.30004   |
| Finland     | 0.82598 | 0.33669 | 0.48195   |
| France      | 0.1582  | 0.42156 | 0.18943   |
| Germany     | 0.26982 | 0.04004 | 0.35091   |
| Ireland     | 0.02074 | 0.39935 | 0.1829    |
| Italy       | 0.06073 | 0.38509 | 0.00091   |
| Netherlands | 0.36933 | 0.25409 | 0.61792   |
| Norway      | 0.93193 | 0.03217 | 0.66674   |
| Portugal    | 0.08772 | 0.67434 | 0.14775   |
| USA         | 0.04684 | 0.0756  | 0.56428   |

Table 3 : Autocorrelation Tests

H0: No Serial Correlation of the Residuals

LM Statistics and P-Values

| Country     | LM Statistic | P-Value |
|-------------|--------------|---------|
| Austria     | 18.014       | .323    |
| Canada      | 17.413       | .359    |
| Finland     | 17.713       | .341    |
| France      | 18.774       | .281    |
| Germany     | 28.648       | .026    |
| Ireland     | 14.373       | .571    |
| Italy       | 24.328       | .083    |
| Netherlands | 15.318       | .502    |
| Norway      | 15.670       | .476    |
| Portugal    | 27.325       | .038    |
| USA         | 6.969        | .974    |

All LM statistics are distributed as  $\chi^2_{16}$

Table 4 : Variable Construction

| Variable         | Definition                                 | Source <sup>3</sup> and Construction    | Code    |
|------------------|--|---|---------|
| SURP             | Government Surplus                         | IFS                                     | 80...ZF |
| Y                | Nominal GDP                                | OECD EO                                 | GDP     |
| A                | Labour Productivity                        | OECD EO                                 | PDTY    |
| Pc               | Consumption Price Deflator                 | OECD EO                                 | PCP     |
| U                | Unemployment Rate                          | OECD EO                                 | UNR     |
| WRB              | Wage Rate in Business Sector               | OECD EO                                 | WR      |
| S                | Indirect Taxes                             | OECD EO                                 | IND     |
| T                | Direct Taxes levied on households          | OECD EO                                 | TYH     |
| $\tilde{\tau}$   | Indirect Tax share                         | $T / Y$                                 | -       |
| $\tilde{\theta}$ | Direct Tax share                           | $S / Y$                                 | -       |
| $\tau$           | Indirect Tax share (adjusted) <sup>4</sup> | $(1 + \tilde{\theta}) * \tilde{\tau}$   | -       |
| $\theta$         | Direct Tax share (adjusted)                | $\tilde{\theta} / (1 - \tilde{\theta})$ | -       |
| Surplus          | Surplus as a share of GDP                  | $Surp / Y$                              | -       |
| TAXMIX           | Tax policy mix                             | $\tau - \theta$                         | -       |
| W                | Real wage                                  | $WRB / Pc$                              | -       |
| lnW              | log real wage adjusted for productivity    | $\log W - \text{filtered}^5 \log A$     | -       |

<sup>3</sup> E.O. : OECD Economic Outlook, IFS: International Financial Statistics, IMF/

<sup>4</sup> Adjusted because GDP is measured in after tax prices.

<sup>5</sup> Log A is filtered by regressing it on a constant, a time trend and a time trend squared and keeping the fitted values.

Table 5 : Unit Root Tests

H0: Variable has a Unit Root

P-Values are given

|             | Surplus  | TAXMIX    | lnW      | lnU     |                    |
|-------------|----------|-----------|----------|---------|--------------------|
| Austria     | 0.10552  | 0.24863   | 0.9962   | 0.98502 | Weighted Symmetric |
|             | 0.32862  | 0.17297   | 0.50252  | 0.78634 | Dickey-Fuller      |
| Canada      | 0.51694  | 0.7704    | 0.60349  | 0.67192 | Weighted Symmetric |
|             | 0.75116  | 0.62816   | 0.11183  | 0.99646 | Dickey-Fuller      |
| Finland     | 0.03001  | 0.07559   | 0.90843  | 0.24311 | Weighted Symmetric |
|             | 0.061398 | 0.0079648 | 0.94245  | 0.22556 | Dickey-Fuller      |
| France      | 0.10043  | 0.49879   | 0.99658  | 0.99771 | Weighted Symmetric |
|             | 0.22506  | 0.074732  | 0.076837 | 0.99686 | Dickey-Fuller      |
| Germany     | 0.1554   | 0.94896   | 0.996    | 0.95672 | Weighted Symmetric |
|             | 0.33114  | 0.96194   | 0.76855  | 0.97119 | Dickey-Fuller      |
| Ireland     | 0.96192  | 0.96291   | 0.5752   | 0.97064 | Weighted Symmetric |
|             | 0.95477  | 0.99686   | 0.3845   | 0.99553 | Dickey-Fuller      |
| Italy       | 0.99797  | 0.99558   | 0.99744  | 0.91758 | Weighted Symmetric |
|             | 0.99686  | 0.99548   | 0.7401   | 0.8803  | Dickey-Fuller      |
| Netherlands | 0.76326  | 0.92084   | 0.93396  | 0.99516 | Weighted Symmetric |
|             | 0.82466  | 0.98911   | 0.95743  | 0.34842 | Dickey-Fuller      |
| Norway      | 0.17274  | 0.13517   | 0.96585  | 0.86454 | Weighted Symmetric |
|             | 0.3475   | 0.18141   | 0.56459  | 0.64332 | Dickey-Fuller      |
| Portugal    | 0.96595  | 0.5378    | 0.68651  | 0.96649 | Weighted Symmetric |
|             | 0.81206  | 0.45659   | 0.4807   | 0.89724 | Dickey-Fuller      |
| USA         | 0.56203  | 0.12541   | 0.89598  | 0.69384 | Weighted Symmetric |
|             | 0.75702  | 0.29311   | 0.88552  | 0.97665 | Dickey-Fuller      |

Table 6: Neutrality Tests

Long Run Neutrality

H0: TAXMIX is neutral in the long run, the coefficients on TAXMIX sum to zero in each of the three equations in the VAR.

Short Run Neutrality

H0: TAXMIX is neutral in the short run, the six coefficients on TAXMIX are jointly equal to zero.

|             | CHISQ(3)  | P-value  | CHISQ(6)  | P-value  |
|-------------|-----------|----------|-----------|----------|
| Austria     | 2. 684408 | 0. 44288 | 4. 188663 | 0. 65116 |
| Canada      | 8. 081088 | 0. 04437 | 10. 16391 | 0. 11792 |
| Finland     | 6. 568188 | 0. 08701 | 7. 568195 | 0. 27147 |
| France      | 6. 244982 | 0. 10028 | 6. 819171 | 0. 33789 |
| Germany     | 6. 907318 | 0. 07491 | 10. 88146 | 0. 09211 |
| Ireland     | 14. 00334 | 0. 0029  | 26. 64966 | 0. 00017 |
| Italy       | 10. 33182 | 0. 01595 | 13. 06644 | 0. 04199 |
| Netherlands | 14. 51501 | 0. 00228 | 23. 94676 | 0. 00053 |
| Norway      | 4. 967943 | 0. 17416 | 12. 20055 | 0. 05764 |
| Portugal    | 3. 013342 | 0. 38957 | 3. 67072  | 0. 72113 |
| USA         | 6. 921035 | 0. 07446 | 18. 24204 | 0. 00565 |