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The labour market effects of VAT harmonisation in a multicountry AGE model

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**Wirtschaftswissenschaftliche Fakultät
der Eberhard-Karls-Universität Tübingen**

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of VAT Harmonisation
in a Multicountry AGE Model**

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ABSTRACT

This paper considers the sensitivity of policy simulation to the specification of the labour market in an Applied General Equilibrium (AGE) model of the European Union. We consider a variety of adjustments to the labour market, including the introduction of labour supply heterogeneity and involuntary unemployment, and examine how those adjustments influence the simulated impact of a move to European VAT harmonisation. Empirical results indicate that the precise mechanism by which unemployment is factored into the AGE model has important consequences for the price, quantity and welfare effects following the policy reform.

1. Introduction

This paper addresses the question of the sensitivity of policy analysis to the specification of the labour market. We compare the results of a specific reform of the value-added tax system in the European Union, according to a series of alternative specifications of a multi-country applied general equilibrium (AGE) model. Each specification introduces a different degree of detail into the labour market, with the general objective of achieving a greater degree of realism and hence policy-relevance and credibility into the model. The model design allows for the presence of unemployment, which opens up a set of choices over model closure, and we show how these choices affect the policy recommendations.

Our model is derived from that developed by Fehr, Rosenberg, and Wiegard (1995), explicitly designed to consider issues of VAT reform. We take one of the simplest questions in this area, the effects of complete harmonisation of all VAT rates in the EU at a uniform rate across all goods and all countries; the particular uniform rate chosen is 15 per cent. We do not consider other vexed issues of VAT reform, such as the choice between origin and destination principles, or some hybrid: in our simulations the destination principle remains in force. Nevertheless, the simple issue we confront is still topical, and harmonisation of VAT around a single rate is high on the current political agenda.

In our simulation experiments, we find there to be significant incentive effects in the labour market following a change in the direct/indirect tax balance, with participation rates among part-time workers especially affected.

2. Tax Reform, Unemployment and General Equilibrium Analysis

2.1. Harmonising Indirect Taxes in Europe

In 1987 the EU Commission set the agenda for the redesign of VAT and the realignment of rates in the Union, as part of the programme of measures to complete the Internal Market by 1992 (see Commission (1987)). At the time of writing, the proposed reforms have still to be finally agreed and implemented, a “transitional” system is in force and 1997 is the new target date for agreement on the “definitive system”. It seems likely, however, that a minimum 15 per cent VAT rate may be proposed to limit tax competition, with some limited provision for reduced rates on a list of “basic” goods and services¹. The welfare consequences of these proposals are, not surprisingly, ambiguous. As Bliss (1994) points out, the Diamond-Mirrlees Theorem can be extended to recommend differentiated national indirect tax rates to gain the full benefits of trade creation in a customs union. To fund the change, each country will adjust its marginal rate of income tax. For most countries, the effect will be a switch from direct to indirect taxation. Part of the fiscal impact of such a change would be any change in the social security bill arising from changes in unemployment, so we accommodate for this within the budget provision: insofar as unemployment rises, there will therefore be less scope for direct tax cuts.

In designing models for purposes such as the study of EU VAT harmonisation, choices must be made as to which features are essential within a model of given size and “solvability”. The model must be a multi-country one, and must contain a sufficient number of “commodities” to reflect the variety of VAT practice pre-reform. In the case of Fehr et al., eight countries and fourteen sectors, most giving rise to two-way trade flows, dictate a large minimum size, and rule out

1. See Smith (1993) for a discussion of the issues and the policy options.

intertemporal considerations. The role of the model here is to illustrate and quantify an essentially theoretical discussion.

2.2. Features of the New Model

Clearly it is not hard to find possible “improvements”, and we have chosen to modify the FRW model, making one market less than perfect, and to introduce some minor differentiation of labour. The reason for starting with the labour market is that the existence of unemployment has major fiscal consequences, so that any change on the revenue side of the budget which affects unemployment will generate important social security expenditure effects: this is the sort of knock-on effect general equilibrium models are designed to analyse. Our model is calibrated for the early 1980's, when unemployment in Europe was typically running at around 10 per cent, and social security expenditure amounted to about 20-30 per cent of GDP. In this context, tax reform can in principle yield larger gains, if the waste from unemployment is somehow reduced or the burden of supporting the social security budget is redistributed.

The introduction of unemployment into g.e. models is not new: an early example is Kehoe and Serra-Puche (1983) who analyse the unemployment consequences of the 1980 fiscal reform in Mexico, and Kehoe, Polo and Sancho (1995) who analyse the effects on a range of macro indicators of Spain's introduction of VAT in 1986. Recently Gelauff et al. (1991), and Gelauff (1993) have developed sophisticated models of the Dutch labour market, incorporating a detailed treatment of the tax and benefit system, including a distribution of household types, and explicit modelling of the wage-bargaining system and employment effects. The scale and complexity of their models, however, rule them out as candidates for our purpose, which is to operate within a multi-country model. The “curse of dimensionality” would be apparent.

We also investigate the feasibility and effects of distinguishing full-time and part-time labour,

recognising that part-time labour has become a larger fraction of the labour force within recent decades, and that the degree of unionisation and legal protection of these workers is such that one should model their participation in the labour market differently from that of full-time workers. In the 1980's between 5 per cent and 25 per cent of all workers were part-time, and the fraction has risen again in the 1990's; further, many part-time workers are female. The idea here is that a “competitive fringe” in the labour market may alter the predictions from those of a model of homogeneous unionised labour, and may pick up interesting consequences of the switch to or from direct to indirect taxation implied by VAT reform.

2.3. Why Focus on the Labour Market?

One might legitimately ask how such adjustments to the structure of the FRW model might affect the simulated general equilibrium consequences of a move towards European indirect tax harmonisation, particularly since such a move would seem quite naturally to impact most on the goods market rather than the labour market. Our response to this is threefold:

Firstly, there has been some suggestion in the literature (see Mercenier (1995) for example) that when the economy is located away from the efficiency frontier (with labour fully employed), the magnitude of any welfare change that one might expect from a given policy reform may be greater. Mercenier's example, considering the effect of the 1992 Single Market exercise, illustrated a distinctly Keynesian response to a demand shock in the presence of a fixed real wage.

Secondly, the production sector in a country typically draws on heterogeneous labour resources, with potentially different responses to wage rate movements, shifts in policy and the like. In the United Kingdom, for example, there is strong evidence of a move towards increased utilisation of part-time or flexible labour. Such a change in the character of the labour market has clear behavioural implications. Since part-time employees are typically more flexible in their

labour supply, and more responsive to changes in their economic circumstances, any shift in policy may induce a differentiated ultimate behavioural (and welfare) response among the various elements of the actual and potential labour force.

Thirdly, the specific formulation of a policy of indirect tax harmonisation will have quite direct implications for other sectors of the economy. For example, the initial knock-on effects of adjustments to indirect tax rates within each country following harmonisation will be to push the domestic budget in each country out of balance. Given the need to maintain government budget balances within each country, another tax instrument would typically be set endogenously to compensate for the indirect tax shock. If, for example, direct taxes were floated within an AGE framework, one might expect this too to have distributional, behavioural and hence welfare consequences also. The budgetary consequences of VAT harmonisation would be trivial or major, depending on the revenue effects of the switch to the uniform VAT rate: in Germany, for example, with low VAT rates, harmonisation would reduce the relative importance of direct taxation, while the opposite would be true of Denmark.

Taken together, there seem strong a priori grounds for a move away from simple market clearing characterisation of the labour market, towards a model which admits labour supply heterogeneity and involuntary unemployment. In doing so, the potential of the model to reveal more realistic welfare responses to policy change is enhanced.

3. Theoretical Framework

3.1. The Basic Model

The FRW model is a multi-country, multi-sector general equilibrium model typical in structure of the class of CGE models reviewed in Shoven and Whalley (1984). It is fully described in Fehr,

Rosenberg and Wiegard (1995), and we need only note modifications here.

3.2. *Specification of Non-Clearing Market Structures*

The solution strategy in the basic model is common to the majority of AGE models in the literature. n commodity markets generate a system of excess demand functions $\xi_i(p)$ for $i = 1, \dots, n$ conditional on some price vector $p = (p_1, \dots, p_n)'$. Under conditions of Walrasian equilibrium, prices adjust to force zero excess demands in all markets, whereby the equilibrium vector \bar{p} satisfies

$$\xi_i(\bar{p}) = 0, \quad \forall i \quad (3.1)$$

Behind these conditions is the tautology that if all agents satisfy their ex ante budget constraints whether at equilibrium prices or not, simple aggregation of these budget constraints in each market yields the result that the price-weighted sum of excess demands is zero. Thus, Walras' Law states that

$$\sum_{i=1}^n p_i \xi_i(p) = 0 \quad (3.2)$$

where p_i denotes the unit price in the i th market and $\xi_i(p)$ denotes the i th excess demand as a function of prices. Whilst Walras' Law holds for any price vector, conditions (3.1) move prices and wages to a point where each $\xi_i(p)=0$. In terms of solution strategy, a Walrasian equilibrium can be brought about either by imposing zero excess demands in all n markets (in which case Walras' Law is simply a confirmation of internal consistency), or by forcing zero excess demands in $n-1$ markets and relying on (3.2) to clear the n th market. Under either strategy, the solution mechanism might be characterised as one of 'unconstrained price-adjustment', whereby prices and wages are adjusted to bring about a Walrasian equilibrium. Notably, since (3.2) is a homogeneous system, one good must be taken as numéraire with, say, $p_n=1$.

We adopt the proposition that equilibrium condition (3.1) is not sustainable in the labour market, which forces us to adjust the solution strategy slightly. In fact, the adjustment is not too severe. One characterisation we might adopt for such an AGE model is one of ‘constrained price-adjustment’, a technique which closely mirrors the standard Walrasian solution, but which includes an additional set of constraints on a subset of excess demands². Consider, for example, the introduction of an additional quantity constraint on the first market (the labour market, say) whereby $\bar{U} = \xi_1(p) > 0$ for some (fixed) positive \bar{U} . That is, the first market is forced to a position of excess supply at a level \bar{U} . If we again aggregate budget constraints for a given price vector, we find that

$$p_1[\xi_1(p) + \bar{U}] + \sum_{i=2}^n p_i \xi_i(p) = 0 \quad (3.3)$$

which requires our constrained equilibrium at prices $\hat{p}_i > 0$ to be such that

$$\begin{aligned} -\xi_1(\hat{p}) &= \bar{U} \\ \xi_i(\hat{p}) &= 0, \quad i = 2, \dots, n \end{aligned} \quad (3.4)$$

For a price vector identical to the unconstrained equilibrium levels, the quantity constraint forces the representative household to consume more leisure and fewer goods. However, the equilibrium solution to the constrained Walrasian equilibrium will typically be different from the unconstrained solution.

The quantity constraint described above has been expressed in terms of some fixed level \bar{U} below which excess demand $-\xi_1(p)$ is not permitted to fall. However, this is not the only possibility. We might instead parameterise the constraining level U to be dependent upon prices, such that

2. For rigorous demonstrations of the existence of constrained equilibria, see Dreze (1975).

$U=U(p)$, giving a ‘price-dependent quantity constraint’ of the form $-\xi_1(p) = U(p)$. By Walras’ Law

$$p_1 [\xi_1(p) + U(p)] + \sum_{i=2}^n p_i \xi_i(p) = 0 \quad (3.5)$$

A set of constrained equilibrium conditions may then be written as³

$$\begin{aligned} -\xi_1(\hat{p}) &= U(\hat{p}) \\ \xi_i(\hat{p}) &= 0, \quad i = 2, \dots, n \end{aligned} \quad (3.6)$$

In the context of a model in which labour markets do not clear, this equilibrium would relate directly to the imposition of some ‘surrogate’ labour supply schedule; specific parameterisations of a price-dependent quantity constrained labour market can be derived from a variety of models of wage determination (for example, a wage curve derived from an efficiency wage or an insider-outsider model).

As a third alternative, we might consider a ‘price-constrained’ AGE model which includes a constraint not on the level of excess demand in the first market, but on the price of the first market good. This constraint would take the form $p_1 = \bar{p}_1$. To force excess supply in the first market, we would set \bar{p}_1 at a level which exceeds the market-clearing price. Let $p_{-1} = (p_2, \dots, p_n)'$ represent an $(n-1)$ vector of unconstrained prices in the remaining markets. Then the solution to our price-constrained equilibrium would be of the form

$$\begin{aligned} -\xi_1(\bar{p}_1, \hat{p}_{-1}) &> 0 \\ \xi_i(\bar{p}_1, \hat{p}_{-1}) &= 0, \quad i = 2, \dots, n \end{aligned} \quad (3.7)$$

3. We use p for all constrained equilibrium price vectors, though the vectors will differ for each case considered.

In this world of, say, an administered wage, labour is again in excess supply; the system is solved using only equations 2 to n, for which a reduced Walras' Law holds:

$$\sum_{i=2}^n \hat{p}_i \xi_i(\bar{p}_1, \hat{p}_{-1}) = 0 \quad (3.8)$$

4. Labour Market Variants

4.1 *Heterogeneous Labour Supply*

The basic model has a single representative consumer as the sole supplier of homogeneous labour. The richness of the labour sector can however be enhanced at relatively low computational cost. If the representative consumer can be interpreted more as a kind of consumer 'aggregate', then there is every justification for that consumer to supply elements of labour of different skill types. For the purposes of this study we choose to disaggregate labour into elements which might loosely be interpreted as part-time and full-time work. This is by no means the only interpretation, and the mechanism by which we introduce labour skill heterogeneity into the model is equally consistent with socio-demographic heterogeneity.

In order to have different labour supplies in the model, we modify the representative consumer utility maximisation, adding an additional nest to the production side and consequently modifying the clearing condition in the labour market and in the government budget constraint. Given two labour types we can specify tax structures for each. We also divide the labour market so that just one is subject to involuntary unemployment in equilibrium.

4.1.1 Household Sector

A simple way of modelling two types of labour is to imagine that the household comprises two

individuals, each with a specific time endowment, but having the same leisure consumption preferences. The household first decides its total leisure demand and aggregate consumption. Then, it decides how to share the leisure between two types by minimising its expenditure function, defined over the two types of leisure.

From the solution of that problem we obtain the conditional leisure demands and as usual we determine the two different labour supplies by taking the difference between the total time endowment and leisure demand.

More formally, (suppressing country-specific subscripts), the representative consumer solves the following optimisation problem:

$$\max UT = (cc^{\frac{1}{\delta_1}} UT_2^{\frac{(\delta_1-1)}{\delta_1}} + cl^{\frac{1}{\delta_1}} LL^{\frac{(\delta_1-1)}{\delta_1}})^{\frac{\delta_1}{(\delta_1-1)}} \quad (4.1)$$

subject to the budget constraint

$$PUT_2 UT_2 + w(1-T)LL = M \quad (4.2)$$

where full disposable income M is determined by:

$$M = [rKS + w_1 E_1 + w_2 E_2](1-T) + A + T + TR + QL$$

We use the following notation:

UT	top utility level	$E_{1,2}$	time endowment of labour type 1 and 2
UT ₂	second utility level	T	marginal income tax rate
LL	aggregate leisure demand	A	income tax allowance
cc,cl	share parameters	TR	transfer payments by government
δ_1	elasticity of substitution	QL	Laspeyres price index
PUT ₂	price index of UT ₂	KS	capital endowment
w	net aggregate wage index		
$w_{1,2}$	gross wage for labour type 1 and 2		

To guarantee the equivalence of Hicksian and Marshallian demand the following equation must hold:

$$PUT1 \quad UT = M$$

where

$$PUT1 = \left[cc \, PUT2^{(1-\delta_1)} + cl \left[w(1-T) \right]^{1/(1-\delta_1)} \right]$$

Using the definition of M in (4.2) we can rewrite the budget constraint as

$$PUT1 \quad UT1 = [r \, KS + w_1 E_1 + w_2 E_2](1-T) + A \, T + TR \, QL$$

Demand for aggregate leisure is given by

$$LL = cl \, UT \left[\frac{PUT1}{w(1-T)} \right]^{\delta_1}$$

This gives us total leisure demand. The consumer must now choose which type of leisure to demand, given that the cost per unit of aggregate leisure is:

$$w = \left[\alpha_1 (w_1(1-T))^{1-\delta_s} + \alpha_2 (w_2(1-T))^{1-\delta_s} \right]^{1/(1-\delta_s)}$$

Using Shephard's Lemma, we may derive the two optimal leisure demands:

$$LL_1 = \alpha_1 LL \left[\frac{w}{w_1(1-T)} \right]^{\delta_s}$$

$$LL_2 = \alpha_2 LL \left[\frac{w}{w_2(1-T)} \right]^{\delta_s}$$

The two labour supplies LS1 and LS2 simply constitute the difference between total endowments and leisure demands

$$LS_i = E_i - LL_i$$

$$LS_2 = E_2 - LL_2$$

4.1.2 Production Sector

We now consider the production side, where each firm chooses a labour aggregate and capital as inputs into the production process. Value added is derived from aggregate labour and capital through a CES function of the form

$$VA = \left[\delta_1^{1-\sigma_2} LD^{(\sigma_2-1)/\sigma_2} + (1-\delta_2)^{1-\sigma_2} KD^{(\sigma_2-1)/\sigma_2} \right]^{\sigma_2/(\sigma_2-1)}$$

where

LD aggregate labour demand

KD capital demand

δ_2 share parameter

σ_2 elasticity of substitution

We may now define the cost function as

$$CVA = \left[\delta_1 w^{1-\sigma_2} + (1-\delta_2) r^{1-\sigma_2} \right]^{1/(1-\sigma_2)} VA = PVA \quad VA$$

where the aggregate production wage index is defined as

$$w = w_1^{t_1} w_2^{1-t_1}$$

and where r is the rental cost of capital (uniform across sectors and countries) and t_1 is a share parameter. Hence the price of value-added is

$$PVA = \left[\delta_1 w^{1-\sigma_2} + (1-\delta_2) r^{1-\sigma_2} \right]^{1/(1-\sigma_2)}$$

Demand for aggregate labour and capital, respectively, are given by

$$LD = \delta_1 VA \left[\frac{PVA}{w} \right]^{\sigma_2}$$

$$KD = (1-\delta_2) VA \left[\frac{PVA}{r} \right]^{\sigma_2}$$

Given the demand for aggregate labour the firm must choose between labour types. We therefore add an additional nest to the production function, using a Cobb-Douglas cost function to determine the choice between demand LD1 and LD2 for labour types 1 and 2 respectively. The conditional demands are therefore

$$LD_1 = t_1 LD \frac{w}{w_1}$$

$$LD_2 = (1 - t_1) LD \frac{w}{w_2}$$

The labour market equilibrium conditions are, summing over production sectors,

$$\sum LD_1 - LS_1 = 0$$

$$\sum LD_2 - LS_2 = 0$$

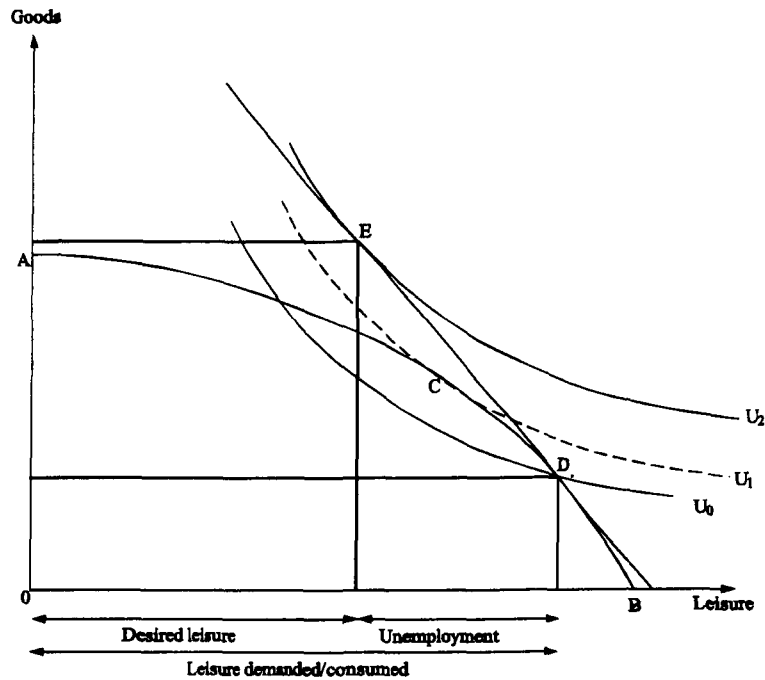
In the presence of unemployment, care must be taken to relate household income and tax revenues to labour demand rather than labour supply. Hence, for example, income tax revenue in the government budget constraint should be expressed as

$$[rKS + w_1 LD_1 + w_2 LD_2]T - AT$$

4.2 Full-time Labour Market Non-clearing

To gain some insight into the structure of a non-clearing labour market, consider the scenario described in Figure 4.1. The representative individual is modelled with preferences over consumption and leisure (consistent with the indifference map $\{U_0, U_1, U_2\}$ in Figure (4.1)). In the absence of taxes, firms are able to achieve efficiency by producing at the boundary of the production possibility frontier AB. In the absence of price or wage rigidities, and the absence of taxes, a competitive equilibrium would be achieved with zero excess demand for labour at real wages set at a level defined by the tangency of U_1 and the PPF (at point C).

Figure. 4.1 Constrained equilibrium and unemployment



However, by introducing additional price or quantity constraints into the AGE model of the form described above, a benchmarked equilibrium can be obtained which includes an element of ‘involuntary’ unemployment. Consider, for example, a constraint which forces the real wage rate to a level above that which would have been achieved at competitive equilibrium. The slope of chord DE describes such a position. Then firms would demand less labour (or equivalently demand more leisure) by producing at point D. The consumer, on the other hand, would prefer less leisure (point E in Figure 4.1). Under these circumstances the actual consumption of leisure will exceed that which is desired, leaving the consumer on the lower indifference curve U_0 at point D. The horizontal difference between D and E represents the level of involuntary unemployment in the market.

The calibration of consumer preferences in such a constrained equilibrium requires some care. It

is clear that the calibrated equilibrium at point D in Figure 4.1 does not correspond to the consumer's maximum attainable utility for a given real wage. Instead, consumer preferences are calibrated at point E to take account of an amount of 'excess' leisure consumption equivalent to the horizontal distance between D and E4.

This demonstrates how a given level of involuntary unemployment can feature in a benchmarked general equilibrium by introducing some form of constraining labour market imperfection. However, we have yet to discuss the precise nature of the constraint. The question is an important one, since the nature of the constraint will impact on any counterfactual equilibrium outcome following either a policy reform or some technological change.

4.2.1 Wage Curve

One can appeal to a number of theories of wage determination to rationalise a labour market model where real wages are set at a level other than the competitive equilibrium rate. One rationalisation stems from the 'efficiency wage' hypothesis; a second characterises wage determination as the outcome of a bargaining process between firms and unions as monopoly suppliers of labour; a third relies on the 'insiders/outsiders' model⁵.

Whatever the economic rationale, there is a good degree of empirical support for the use of a wage curve as a model of wage determination. Blanchflower and Oswald (1991) have demonstrated the empirical robustness of a wage curve with an elasticity of -0.1 across a wide

4. To operationalise this setup in an AGE model, the benchmark data set should therefore include information on the level of employment of labour ("labour consumed" and the rate of involuntary unemployment.

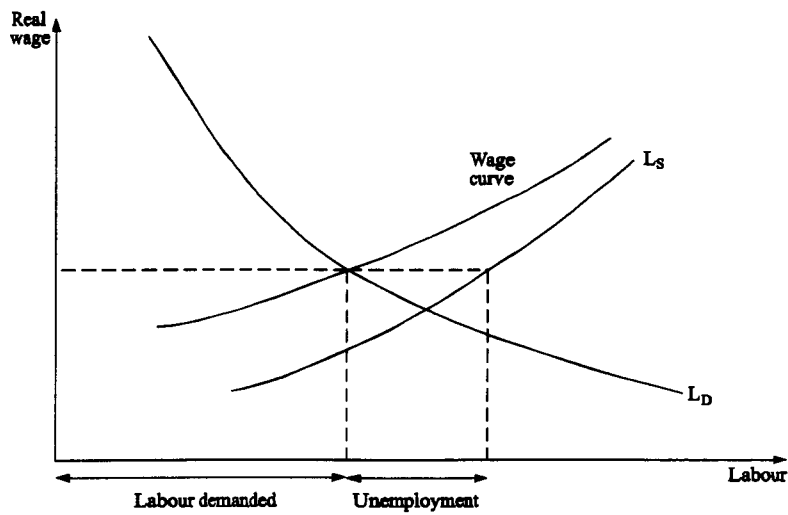
5. A useful survey of the empirical evidence can be found in Booth (1995).

cross-section of countries: we use this value. In general terms, the wage curve relationship typically takes the form

$$\frac{w}{p} = f(U); \quad f'(U) < 0 \quad (4.4)$$

where U represents the level of unemployment. In the operation of the labour market, the wage curve effectively becomes a 'surrogate' aggregate labour supply schedule which interacts with labour demand to determine the level of real wages. Figure 4.2 describes one such equilibrium in which wages are set to a level above the competitive equilibrium, creating involuntary unemployment in the labour market. Naturally there are general equilibrium aspects to the introduction of a wage-unemployment trade-off in the labour market. Upward pressure on wage rates will feed through to the operation of the remaining commodity markets, forcing prices and quantities away from the competitive (unconstrained) equilibrium. By expressing eq. (4.4) in its inverse form $U=f^{-1}(w/p)$, we can relate the equilibrium outcome in the presence of a wage curve directly to the price-dependent quantity constrained equilibrium [eq (3.6)].

Figure 4.2 Unemployment and the wage curve



4.2.2 Fixed Wage

By fixing wages through a constraint of the form $(w/p) = (\overline{w/p})$ where $(\overline{w/p})$ exceeds the market-clearing rate, we would generate a price-constrained equilibrium of the form (3.7). This is an approach that Mercenier (1995) adopts in his analysis of the impact of European single market integration. There are a number of economic rationales for such a rigidity (of which fixed real wages are an extreme form).

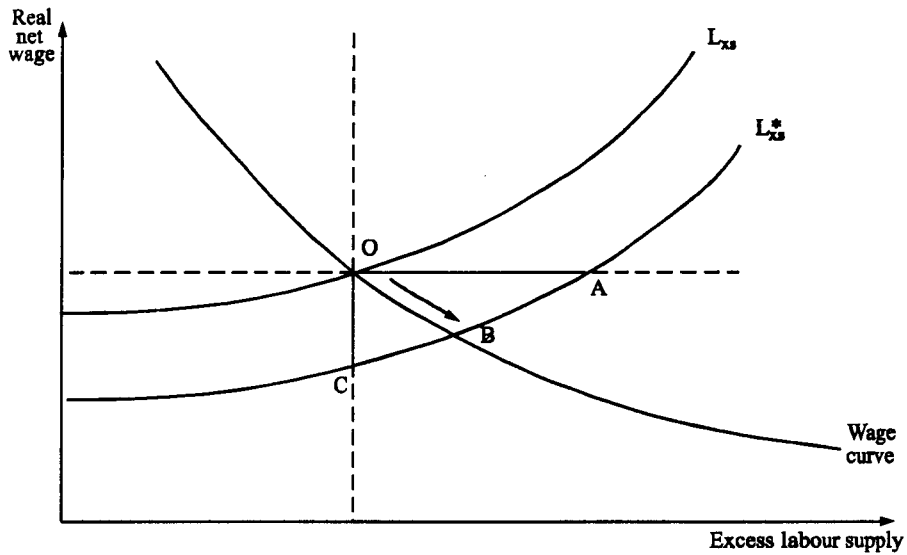
4.2.3 Fixed Unemployment

Finally, instead of solving out for a solution with $U=0$ for full-employment, we can solve for $U = \overline{U}$, some fixed level of unemployment. This might be the “natural rate”, or the NAIRU (non-accelerating inflation rate of unemployment) appropriate for the economy. Estimates of these rates can be derived from most macro-econometric models, but must be regarded with scepticism as highly dependent on model specification. Nevertheless, such estimates tend to be quite close to prevailing levels of unemployment, which is not surprising when the model’s data-set covers a period of roughly stable inflation. Accordingly, as one of our model variants we take 1981 (the benchmark year) rates of unemployment as the values of.

Suppose that we observe a labour market with a given level of unemployment. The same equilibrium outcome can be achieved by fixing unemployment directly, by fixing wage rates to generate the required level of unemployment, or by calibrating a wage curve to cross the labour demand schedule at the required distance from the supply schedule. Consider the relationship between excess supply of labour (i.e. unemployment) and real wage rates as described in Figure (5.1). Point O represents the benchmarked equilibrium for a given level of observed unemployment. Now, consider a policy shock which forces excess demand from LXS to LXS*.

The direction and scale of wage and employment effects depend directly on the means by which unemployment is factored into the AGE model. Under a fixed real net wage scenario, unemployment increases in the direction OA. At the other extreme, a fixed unemployment assumption forces wage rates to decrease along OC. And if a wage curve is used to generate the benchmarked equilibrium, wages fall and unemployment rises along OB.

Figure 4.3 Wage and employment effects in constrained equilibrium.



5. Implications for Counterfactual Simulations

5.1 Theoretical Considerations

Making use of a simple one-good closed economy model, let us anticipate the effects of the VAT reform under the three closure rules: fixed real net wage, wage curve and fixed unemployment. The real net wage can be defined as $rnw = (w/p^*)(1-a)/(1+v)$ where p^* is the pre-tax price of value-added, w/p^* is the real product wage, a is the average income tax rate and

v is the value-added tax rate. The first-round, partial equilibrium effect of a revenue-neutral switch from direct to indirect tax would leave $(1-a)/(1+v)$ and rnw unchanged (conditional on unchanged employment and output). However, by reducing the marginal tax rate by more than the average tax rate, the reform would raise the supply of labour because of the higher opportunity cost of leisure. The resulting rise in unemployment would induce a rise in transfers, requiring a higher value of a . To maintain rnw constant, w/p^* must increase, with the effect of reducing output and the demand for labour. We can therefore expect the VAT reform to be welfare-reducing under this closure rule, since households are moved further from their preferred consumption and leisure choices.

If instead the closure rule is constant unemployment, no change in transfers will be induced, and the increased labour supply must be matched by increased labour demand: this is achieved by reducing w/p^* and hence rnw . Consumption and employment are closer to households' preferred values and welfare will increase. Full-employment is a special case of the fixed-unemployment rule, with welfare increases also expected.

In the case of the wage-curve, the results will be intermediate to the two cases just discussed, so we can expect unemployment to rise for most countries, more moderately than under the fixed rnw rule, but we cannot predict the welfare effects. Simulation is necessary to yield determinate results. For countries (like Denmark) for which the reform would amount to a switch towards direct taxes, we can predict the opposite results on the basis of this analysis: reduced unemployment for the wage-curve, but ambiguous welfare effects. It is notable that in these examples, there is a strong negative correlation between the real product wage and welfare.

6. Results

6.1 *The Design of the Tax Harmonisation Counterfactuals*

The set of models for analysis are: (1) the original FRW model; (2) a model with homogeneous labour, but with unemployment; (3) a model with full-time and part-time labour, with unemployment of full-timers. Both (2) and (3) were simulated subject to the three alternative closure rules discussed above.

6.2 *Numerical Results*

Table 1 in appendix shows the welfare effects of the VAT harmonisation for the various scenarios. The first feature to note is that, for groups (i), (ii) and (iii), the pattern of gains and losses across closure rules is much as we predicted in section 5.1, with welfare losses and higher unemployment for the fixed wage case, welfare gains for the fixed unemployment case, and intermediate values with mixed signs for the wage-curve. The size of the welfare gains for the fixed positive unemployment case are, with one exception (Denmark), greater than for the fixed zero unemployment case of the FRW model: this is also in line with expectations, although the difference is very small indeed. The presence of heterogeneity in (iii) is associated with small positive welfare gains relative to (ii) for all cases (except Denmark with fixed U). Thus introducing heterogeneity in labour supply appears to have provided households with the means to mitigate the welfare impact of VAT reform when real net wages are fixed or sticky.

Tables 2a, 2b, 3a, 3b and 4 illustrate how heterogeneity works with VAT reform. With real net wages fixed, and VAT reform pushing up prices only partially offset by reduced income tax, the rise in the real product wage reduces the demand for full-time labour. Households respond by increasing their supply of part-time labour, reducing the w_p/w_f ratio (by between 1%

and 3%) and offsetting the output fall. The fall in fulltime employment is still substantial at 2 or 3%, but part-time employment increases (by less than 1%) and unemployment rates of fulltimers rise quite sharply (by 1 to 4%). Another feature of the heterogeneous case is that the income tax rate for most countries falls further below the benchmark except, of course, for Denmark (see Table 5).

When the closure rule is fixed unemployment, welfare and real consumption effects are much the same for all cases (i.e. (i) full employment, (ii) benchmark unemployment with homogeneous or (iii) heterogeneous labour), this is not the case for real net wage effects (see Table 6), which in the cases of France, Italy and Denmark depend considerably on the level of unemployment. Clearly aggregate employment effects in these countries offset the wage effects, so that household real income is stabilised. Thus similar welfare indicators may conceal compositional differences.

Overall, introducing alternative closure rules, and some labour market differentiation, does yield different signs for welfare and other indicators, and does change the distribution of effects across countries. The general nature of these effects can be predicted quite easily, using simple partial equilibrium and closed economy arguments, for both the homogeneous and heterogeneous labour cases. Policy recommendation for VAT reform therefore depends crucially on the closure rule, with results consistent with economic intuition.

7. Conclusions

In this paper we have studied the economic consequences of VAT harmonisation to a common rate in the presence of unemployment, and when the income tax is used to offset revenue changes. We show that model closure rules, reflecting alternative approaches to modelling

unemployment, and the incentive effects of the switch between direct and indirect taxation, have major impacts on the outcomes. In summary, we find that:

- changes in the direct/indirect tax balance have significant incentive effects on labour supply and unemployment;
- participation rates among part-time workers are especially affected;
- policy recommendations and welfare gains/losses are sensitive to the choice of fixed unemployment, sticky wages or a wage curve as the closure rule;
- admitting unemployment into the applied general equilibrium framework has major budgetary effects since transfer payments depend on the level of unemployment: this means that harmonisation policy raises quite complex issues when a switch between direct and indirect taxation is envisaged, and applied general equilibrium analysis is well-suited to explore these issues.

Appendix

Table 1 Consumer welfare (percentage variation from benchmark)

Country	F	BL	NL	D	I	UK	DK
(a) Homogenous labour, 0% unemployment							
	0.408	0.401	0.235	0.210	0.383	0.187	0.376
(b) Homogenous labour, with unemployment							
Fixed wage	-0.547	-0.837	-0.816	-0.265	-0.374	-0.707	-1.313
Wage curve	0.148	0.091	-0.041	0.059	0.198	-0.003	-0.143
Fixed U	0.429	0.436	0.232	0.255	0.420	0.266	0.330
(c) Heterogeneous labour with unemployment							
Fixed wage	-0.389	-0.593	-0.641	-0.263	-0.265	-0.574	-1.133
Wage curve	0.188	0.161	-0.005	0.079	0.230	0.026	-0.098
Fixed U	0.436	0.452	0.237	0.273	0.436	0.274	0.323

Table 2a Full-time wage (percentage variation from benchmark)

Country	F	BL	NL	D	I	UK	DK
(c) Heterogeneous labour with unemployment							
Fixed wage	2.17	4.63	4.35	4.66	4.50	5.26	1.43
Wage curve	0.49	0.71	0.08	-0.53	1.17	0.08	-0.57
Fixed U	0.33	-1.18	-2.24	-1.81	-0.70	-2.52	0.52

Table 2b Part-time wage (percentage variation from benchmark)

Country	F	BL	NL	D	I	UK	DK
(c) Heterogeneous labour with unemployment							
Fixed wage	1.14	2.43	1.52	2.42	2.22	2.20	0.78
Wage curve	0.33	0.01	-0.87	-0.99	0.37	-0.92	-0.37
Fixed U	0.33	-1.18	-2.24	-1.81	-0.70	-2.52	0.52

Table 3a Full-time employment (percentage variation from benchmark)

Country	F	BL	NL	D	I	UK	DK
(a) Homogenous labour, 0% unemployment							
	0.48	0.56	0.08	1.22	0.73	1.18	-0.62
(b) Homogenous labour, with unemployment							
Fixed wage	-1.40	-2.24	-3.16	-2.31	-1.78	-2.81	-2.11
Wage curve	0.20	-0.30	-1.02	0.47	-0.15	-0.17	-0.40
Fixed U	0.47	0.55	0.08	1.21	0.72	1.14	-0.61
(c) Heterogeneous labour with unemployment							
Fixed wage	-0.61	-2.01	-2.98	-1.55	-1.55	-2.16	-1.55
Wage curve	0.30	-0.28	-1.00	0.60	-0.10	0.00	-0.39
Fixed U	0.47	0.55	0.08	1.21	0.72	1.15	-0.61

Table 3b Part-time employment (percentage variation from benchmark)

Country	F	BL	NL	D	I	UK	DK
(c) Heterogeneous labour with unemployment							
Fixed wage	0.40	0.08	-0.28	0.59	0.63	0.76	-0.92
Wage curve	0.48	0.47	0.01	1.11	0.71	1.06	-0.62
Fixed U	0.47	0.55	0.08	1.21	0.72	1.15	-0.61

Table 4 Unemployment rate*

Country	F	BL	NL	D	I	UK	DK
(b) Homogenous labour, with unemployment							
Fixed wage	9.5	14.2	12.6	8.0	11.1	13.3	9.9
Wage curve	7.9	12.0	10.1	5.4	9.1	10.5	8.4
Fixed U	7.7	11.1	8.8	4.8	8.0	9.2	8.7
(c) Heterogeneous labour with unemployment							
Fixed wage	9.1	13.9	12.5	7.8	11.0	13.1	9.5
Wage curve	7.9	12.0	10.1	5.4	9.0	10.5	8.4
Fixed U	7.7	11.1	8.8	4.8	8.0	9.2	8.7

* Full-time unemployment rate in the heterogeneous case.

Table 5 Income tax rate

Country	F	BL	NL	D	I	UK	DK
Benchmark	5.10	16.70	9.80	17.80	10.70	18.20	27.10
(a) Homogenous labour, 0% unemployment							
	0.50	10.90	3.80	9.90	1.30	9.10	30.10
(b) Homogenous labour, with unemployment							
Fixed wage	3.80	12.85	6.16	13.94	2.71	12.40	32.75
Wage curve	1.02	11.51	4.61	10.82	1.80	10.24	29.99
Fixed U	0.51	10.94	3.82	9.97	1.31	9.18	30.16
(c) Heterogeneous labour with unemployment							
Fixed wage	1.24	12.97	5.78	11.95	2.22	10.63	31.47
Wage curve	0.65	11.59	4.50	10.42	1.64	9.67	30.10
Fixed U	0.51	10.94	3.82	9.97	1.31	9.18	30.16

Table 6 Full-time real net wage (percentage variation from benchmark)

Country	F	BL	NL	D	I	UK	DK
(a) Homogenous labour, 0% unemployment							
	0.33	-1.21	-2.23	-1.85	-0.73	-2.61	0.57
(b) Homogenous labour, with unemployment							
Fixed wage	-	-	-	-	-	-	-
Wage curve	-0.35	-0.96	-1.60	-1.56	-1.48	-1.67	0.30
Fixed U	-0.07	-1.47	-2.62	-1.74	-2.38	-2.57	1.52
(c) Heterogeneous labour with unemployment							
Fixed wage	-	-	-	-	-	-	-
Wage curve	-0.30	-0.91	-1.59	-1.51	-1.45	-1.64	0.37
Fixed U	-0.07	-1.47	-2.62	-1.74	-2.38	-2.57	1.53

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