

Hutton, John P.; Ruocco, Anna

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

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in Europe**

John P. Hutton
Anna Ruocco



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Tax Reform and Employment in Europe*

John P. Hutton

University of York, Heslington, York, UK.

Anna Ruocco

University of Tübingen, Mohlstr. 36 D-72074,

Tübingen, Germany.

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Abstract

The purpose of this paper is to investigate to what extent modifications of tax systems between 1985 and 1992 within major parts of the European Union contributed to changes in the labour market. The principal countries under investigation are Germany, Italy, France and the United Kingdom, and the method of investigation is the numerical simulation of a multi-country general equilibrium model. Changes in VAT rates and in the personal income tax schedule are investigated. We conclude that a non-trivial part of the labour market changes may be due to reactions of the market to changes in these tax rates.

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1 Introduction

The 1980's saw significant changes in the pattern of employment and unemployment in Europe, as detailed in the *OECD Jobs Study* (OECD (1995)). Table 1 shows some relevant data on the structure of the labour market for Germany (D), France (F), Italy (I) and the United Kingdom (UK), which are the principal countries being investigated in this paper, for the years 1985 and 1992. α_p^w is the share of women employed part-time as a percentage of all employed women; α_p^m is the share of the men employed part-time as a percentage of all employed men; χ is the women's percentage of total employment and finally u_r denotes the unemployment rates¹.

Table 1. Labour market composition (%) in 1985 and 1992

Country	1985				1992			
	α_p^w	α_p^m	χ^*	u_r^{**}	α_p^w	α_p^m	χ^*	u_r^{**}
D	29.6	2.0	39.0	7.7	30.7	2.6	41.7	●7.9
F	21.8	3.2	41.6	8.1	24.5	3.6	43.3	10.4
I	10.1	3.0	32.2	7.7	11.5	2.9	35.1	9.0
UK	44.8	4.4	41.6	11.2	45.0	6.3	44.5	10.1

Sources: Eurostat (1996) p.120; ** Statistisches-Bundesamt (1996) p.44; **OECD (1997), p.162, data for 1983. ●Unified D, 1993.

Among the most important changes in labour markets since roughly 1980 throughout the EU has been the high participation rates of women and the

¹Data on unemployment are drawn from the OECD booklet *Employment Outlook 1997* (originally produced by EUROSTAT). We choose to use the standardised unemployment rates, which are based on definitions of the 13th Conference of Labour Statisticians (following the guidelines of ILO). The main idea is that *unemployed are the persons of working age, who in the reference period, are without work, available for work and have taken specific steps to find work*. Instead national unemployment data in some countries would only include persons registered at government labour offices.

overall growth of part-time employment which continued to develop throughout the period. The increased participation rate of women in 1992, particularly in the form of part-time employment is indicative of this development.

As far as the trend of unemployment rates is concerned, throughout the decade one can observe an increase in the overall level of unemployment, particularly male unemployment, except for in the UK, for which unemployment rates fell sharply. This situation also reflects the more recent development of the labour market. In fact, for Germany, France and Italy, the unemployment rates continued to grow and by 1996 they reached the level of 10.3, 12.4 and 12.1 percent respectively, while in the UK a substantial reduction took place so that the level of the unemployment rate has fallen to 7.4 percent.

The reasons for the changes in labour market structure are complex and include sociological, political and technological factors well outside the scope of this paper. Nevertheless, as the *OECD Jobs Study (OECD (1995))* illustrates, economists saw tax policy as being both (a possibly small) part of the explanation for these changes and possibly part of the solution to some of the obviously undesirable aspects of these developments, such as the rise of overall unemployment rates and the associated social costs. In particular, in this paper we have focused our attention on the influence of changes in the structure of taxation between 1985 and 1992 on the labour market. Two features of tax reform during the 1980's interest us: the tendency to reduce the progressivity of income taxation, and the harmonisation of value-added taxation within the EU. These developments are connected, since for many countries harmonisation meant an overall increase in VAT rates, allowing a reduction in at least the top rates of income taxation and other direct taxes: details of the main tax changes are shown in Tables 3 and 3a below.

Comparing the efficiency and equity effects of direct and indirect taxation is a traditional topic in public finance. Proportional taxes are usually demonstrably more efficient than progressive ones, but, clearly, less appealing from a redistributive point of view. Some policy makers have adopted the idea that indirect taxation implemented with differentiated tax rates could

be a good compromise for improving the tax system's efficiency, while still taking into account distributional issues. In addition, they would claim that increasing indirect taxation would allow for a decrease in the marginal rate of direct taxation, encouraging labour supply and employment. In contrast to that view, recent literature on the effects of progressivity of direct taxes on the labour market has suggested that in the presence of involuntary unemployment, increasing the level of progressivity may have a positive effect on the employment level. For example, Lockwood and Manning (1993) have recently argued that high marginal rates may reduce real wages and pre-tax inequality, and thereby the natural rate of unemployment, as an outcome of employer-union bargaining. They also produce some econometric evidence to support this prediction. They summarise recent theoretical bargaining literature thus:

....a very robust result is that increases in the marginal rate of income tax lower the pre-tax real wage, and hence unemployment, whereas an increase in the average tax usually has the opposite effect.

Less controversial are the effects of changes in the average tax rates on the labour market. Bean, Layard, and Nickell (1986) and Knoester and de Windt (1987) both used multi-country econometric models to study the impact of the tax wedge on the labour market in the 1970's and early 1980's, focusing on the effect of high average rates of income taxation. The former concluded that tax changes had raised unemployment rates by several percentage points in most countries, while the latter concluded that high tax rates had contributed importantly to increases in pre-tax real wages. In general, a large consensus supports the interpretation that a reduction of the tax burden on labour, thereby moderating real wages, is a means of encouraging employment.

Within the last decade or so, the combination of an increase in VAT rates and a decrease in marginal income tax rates has been adopted by several European countries. Given the complexity of the topic, a natural way of

studying these changes is to make use of a computational general equilibrium model, in which involuntary unemployment may arise. And it is particularly interesting to work in a multi-country context when the countries in question have strong trade links.

More concretely, the analysis reported in this paper investigates the consequences of changes in the tax codes of each country between 1985 and 1992, determined by imposing the 1985 VAT rates and marginal as well as average income tax rates on the 1992 benchmark equilibrium. While investigating the changes in the tax system from 1992 to 1985, we were mainly concerned with the changes in tax rates, and therefore, the different tax incidence of the existing tax structure. In the simulation we do not change the taxable base, but only the tax rates of the different types of taxes already in force.

From the results we derive some indications about how much of the general trends observed on the labour market are tax-induced. First of all, we determine whether the changes in the tax system have pushed the labour market in the direction which it has actually taken: increases in the female and part-time labour supply, and an increase in the unemployment level, except in the UK. Secondly, we quantify these effects in order to verify whether the tax system may have played a significant role in the development of the labour market structure. Since we assume no changes in tastes or preferences, any remaining changes can be attributed to compositional changes in the pattern of production, due either to technical substitution or changes in demand.

The model used here is a standard international trade model in the tradition of Shoven and Whalley (1984), but placing particular emphasis on the labour market. We distinguish between four intersecting categories of labour supply, male and female and full-time and part-time, within an extended representative household model in which time endowments are classified according to the type of labour market participation. The choice between full-time and part-time labour supply is determined within a preference system in which the imperfect substitutability of these labour types is represented

in a constant elasticity of transformation (CET) function. These two labour types are also imperfect substitutes in production, while male and female workers (of a given type) are assumed to be perfect substitutes. Labour market composition varies across countries, and this is crucial for the simulations.

Extending the approach of Duncan, Hutton, Laroui, and Ruocco (1998), we model unemployment as a characteristic of the full-time labour market, while the part-time market is assumed to clear. Efficiency wage arguments support the existence of a wage-curve within each country for full-time labour. International labour mobility is ruled out, but capital is assumed to be perfectly mobile.

In the benchmark equilibrium, the tax systems of each country are modelled using the approach of Fehr, Rosenberg, and Wiegard (1995); our model is an extension of this approach. The income tax function is modelled as being linear, with uniform marginal rates across labour and capital income. A VAT based on the destination principle applies with non-uniform rates across and within countries. The tax system is completed by differentiated production tax rates and tariffs on trade flows between the EU and the rest of the world. The introduction of non-clearing labour markets has direct fiscal consequences insofar as unemployment raises government expenditures on unemployment benefits and other forms of social security. Given that the government is not permitted to borrow, all expenditure changes have tax consequences. The existence of terms-of-trade effects of any policy action has the effect of producing “tax exports”, and this links the fiscal policies of trading partners.

The paper is structured in the following way: in section 2 we describe the main features of our simulation model, putting particular emphasis on the labour market structure, while also briefly discussing the parametrisation of the model. We also show how we calculate the equivalent variations in order to measure the welfare effects of the policies at issue. Section 3 describes the policies analysed and presents the results obtained in simulation and

their economic interpretation. Section 4 concludes by summarising the main findings.

2 Model description

In this section we describe our numerical multicountry general equilibrium model, which represents 6 groups of European Union countries. Some of these groups represent single states while others represent groups as follows: 1. Belgium & Luxembourg -Denmark - Netherlands (BL), 2. Germany (D), 3. Spain - Greece-Ireland - Portugal (ES), 4. France (F), 5. Italy (I), 6. United Kingdom (UK). The Rest of the World (ROW) completes this setting. Aggregating some of the countries will not undermine our simulation results as we concentrate our attention in particular on Germany, France, Italy and the UK.

2.1 The household sector

Given that the focus of the paper is on the labour market structure, we emphasise the description of the labour supply aspect of the household's decisions.

The phenomenon of differential labour market behaviour of men and women has encouraged continued work on models of the household. Fortin and Lacroix (1997) review this literature and test rival unitary and collective models of the household. They find that their less restrictive collective model is more data-coherent. Nevertheless, an empirically adequate model of household behaviour has still to be proposed. In this paper, we work within the traditional unitary model, in which the household acts as if maximising a single utility function subject to a household budget constraint. The arguments of this utility function are labour supply and consumption. Labour supply is distinguished by family member, while consumption is aggregated over family members, without loss of generality. We add another dimension to the nature of the labour supply by allowing each family member

to choose her/his optimal combination of full- and part-time labour supply, distinguishing between the preferences of *men* and *women*.

Formally, the preferences of households are represented by a nested utility function, a formulation implying Hicksian separability, and multi-stage budgeting . Given that the countries differ only in the parametrisation of the functional forms, we will not index the variables by country in what follows. For each country we have modelled only one representative household composed of two groups of individuals identifiable by gender, each with distinct time endowments.

The top level of the utility function, specified as a constant elasticity of substitution function, is defined over aggregate consumption (C), leisure for women (ℓ_w) and leisure for men (ℓ_m) :

$$U(C, \ell_m, \ell_w) = \left[\alpha_c^{1/\delta_1} C^{\pi_1} + \alpha_m^{1/\delta_1} \ell_m^{\pi_1} + \alpha_w^{1/\delta_1} \ell_w^{\pi_1} \right]^{1/\pi_1}, \quad (1)$$

where $\pi_1 = \frac{\delta_1 - 1}{\delta_1}$.

The representative household solves the programme:

Maximise $U(C, \ell_m, \ell_w)$

subject to

$$p_c C + w_m \ell_m + w_w \ell_w = I \quad (2)$$

where I , *full disposable income*, is determined by:

$$I = K r (1 - t_k) + TA_k r t_k + E_m w_m + E_w w_w + T + \sum_{j=f}^p TA_j w_j t_j \quad (3)$$

We use the following additional notation:

i	index for gender (m, w)
j	index for full and part-time labour (f, p)
w_i	composite wage rates for gender i
w_j	gross wage rates for f and p labour
α_c, α_i	share parameters
δ_1	elasticity of substitution ($\delta_1 > 0$)
p_c	aggregate consumption price index
r	rental price of capital
K	capital endowment
t_k	marginal capital income tax rate
E_i	total potential number of working weeks of gender i
T	government transfer payments, including unemployment benefits (see section 2.3)
TA_k	tax allowances for capital income
TA_j	tax allowances for f and p labour income

The last term of the budget constraint represents the values of the tax allowances for full and part-time labour income. Tax allowances accrue to the total full and part-time labour of the *household* and not to the single *gender*. That is why they appear separately in I .

From the solution of this optimization problem, we are able to determine the household's choice concerning aggregate consumption and leisure demand for women and men. Given aggregate consumption, the household then chooses between different consumption goods, and, for each type of good, it distinguishes between imported and domestic commodities. Finally it determines the composition of the consumption goods imported by source countries. Collective consumption goods are provided free of charge and enter the utility function in an additively separable manner (and, consequently, can be omitted). For a more complete description of the consumption structure see Ruocco (1996).

The difference between the level of the total time endowment and leisure demand for each group yields the total labour supply for men (L_m^T) and for

women (L_w^T):

$$L_i^T = E_i - \ell_i, \text{ where } i = m, w. \quad (4)$$

Now we may also write the *money income* constraint:

$$M = K^n + \sum_{i=w}^m L_i^T w_i + \sum_{j=f}^p TA_j w_j t_j + T \quad (5)$$

where $K^n = K r (1 - t_k) + TA_k r t_k$.

Once the total labour supply has been determined for each gender, women and men must still decide whether to work full or part-time, so that the household will offer a combination of full and part-time work. Since neither men nor women as a whole work exclusively full or part-time, it is clear that these forms of labour supply are not perfect substitutes and some optimal mix will be sought, depending on the relative wages being offered. We model this choice as each group making its decisions by maximising a homothetic CET preference function subject to a net income constraint. We should recall that tax allowances are modelled as independent of gender, but are allowed against, respectively, the total level of full or part-time labour in the household.

Disaggregating female and male labour supply into full and part-time labour, we can rewrite the household money income constraint as follows:

$$M = K^n + \sum_{i=w}^m \sum_{j=f}^p \left[L_{j,i}^T w_j (1 - t_j) \right] + \sum_{j=f}^p TA_j w_j t_j + T$$

To explain this disaggregation, we proceed as follows. Formally, each gender i solves the problem:

Maximise

$$CET(L_{f,i}^T/L_i^T, L_{p,i}^T/L_i^T) = - \left[\beta_{f,i}^{1/\delta_2} \left(L_{f,i}^T/L_i^T \right)^{\pi_2} + \beta_{p,i}^{1/\delta_2} \left(L_{p,i}^T/L_i^T \right)^{\pi_2} \right]^{\frac{1}{\pi_2}} \quad (6)$$

subject to

$$(L_{f,i}^T/L_i^T)w_f(1-t_f) + (L_{p,i}^T/L_i^T)w_p(1-t_p) = w_i \quad (7)$$

where the notation is as follows:

- δ_2 elasticity of substitution ($\delta_2 < 0$)
- π_2 $\frac{\delta_2-1}{\delta_2}$
- t_j marginal tax rates for f and p labour
- $L_{j,i}^T$ Total f and p labour supply for gender i
- $\beta_{j,i}$ share parameters for f and p labour supply for gender i .

The share parameters ($\beta_{j,i}$) together with the elasticity of substitution (δ_2) determine the shape of the CET function (see Appendix for details).

For arbitrary values of w_i , w_f and w_p , the full-time and part-time shares would not sum to unity: the general equilibrium set of wages and prices must therefore satisfy the condition

$$L_{f,i}^T/L_i^T + L_{p,i}^T/L_i^T = 1.$$

The solution to this problem, therefore, determines the optimal choice of the household, given net wages and preferences over full or part-time work. Each gender's labour supply is

$$L_i^T = L_{f,i}^T + L_{p,i}^T. \quad (8)$$

Figure 1 provides a graphical explanation of the choice between full and part-time labour supply. The CET curve represents the preference of gender i for full and part-time work. At point A the CET function is tangent to the budget line, and the solution is feasible as the shares sum to unity.

2.1.1 Individual behaviour within the representative household model

In order to write the household's maximisation problem precisely, we should distinguish between total time endowment E_i and the number of individuals

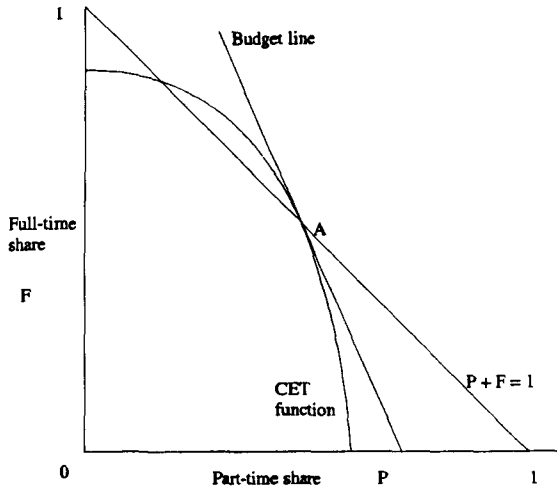


Figure 1: Full-time vs part-time choice

n_i , the latter being a parameter since in our static model, we assume no population growth. Given that our utility functions are homothetic and assuming that all of the n_i individuals have the same preferences, for simplicity's sake and without loss of generality, we have normalised n_i to be equal to one.

Our modelling of household choice between full and part-time labour is, however, also consistent with a log-logistic distribution of preferences over mode of work, with the threshold value of relative wages as the random variable: i.e. $L_{f,i}^T/L_i^T = F\left(\frac{w_f(1-t_f)}{w_p(1-t_p)}\right)$. Each member of the labour force has a threshold value of $\left(\frac{w_f(1-t_f)}{w_p(1-t_p)}\right)$, above which he/she decides to switch from part-time to full-time work, according to each individual's preferences. The threshold values are distributed according to the log-logistic distribution function, which yields the proportion of the population whose threshold lies below the value $\frac{w_f(1-t_f)}{w_p(1-t_p)}$ (see Appendix).

For an intuitive explanation of the mechanism which leads to differing supplies of full and part-time labour, it is useful explicitly to consider the difference between aggregate time endowment and the number of individuals. In the first step, we assume households choose how many weeks they are willing to take off from working (leisure time), which is in our notation equal

to $n_i \ell_i$. Now, if we subtract this amount from the total amount of potential working weeks ($n_i E_i$), we have the total labour supply for each gender $n_i L_i$ (which corresponds to our L_i^T in (8) above). At this stage, each group will comprise a different combination of individuals working full-time for a certain number of weeks, and individuals working part-time for the remaining number of weeks. Hence each gender's labour supply by type is:

$$L_{j,i}^T = n_{j,i} L_{j,i}. \quad (9)$$

The total amount of working weeks offered on the market by the n_i individuals is equal to the number of weeks a certain share of individuals would offer as full-time work (i.e. 40 hours a week) plus the remaining number of full-time equivalent weeks the other individuals would offer as part-time work (i.e. 20 hours).

The statistics summarised in Table 1 provide information regarding gender-specific labour supply. Both men and women offer part-time and full-time labour on the labour market, but in quite different ratios. Women work prevalently part-time, while men work mostly full-time. These differences between women's and men's preferences concerning the type of job they would choose is reflected in the values of the share parameters of each gender's CET functions for each country.

2.2 The production sector

The other features of the model are fairly standard in the tradition of Shoven and Whalley (*op. cit.*), and the reader can refer to Ruocco (1996) for a more detailed description. In this section we will, therefore, report the main differences between our model and the original model of Fehr, Rosenberg, and Wiegard (1995). Three primary factors of production (capital, full-time and part-time labour) and 11 commodities are identified for each country. The sectors are: agriculture (1), energy and water (2), chemicals and steel (3), machinery and transport equipment (4), food and drinks (5), textiles and leather (6), paper goods, products of printing (7), other manufactured products (8),

banking and insurance, communication, market services of education and health (9), other market services (10) and non-market services (11). On the demand side of the labour market, however, we assume that firms cannot distinguish between full-time labour offered by men or by women. Overt sexual discrimination is, therefore, ruled out: we assume that firms cannot discriminate across genders and, therefore, the different observed market wage rates of women and men depend solely on the fraction of full or part-time work provided by women and men respectively.

Full-time and part-time labour form a Cobb-Douglas nest within a CES value-added production function with aggregate labour and capital as arguments. In the absence of precise information on the shares for full-time labour in production sectors, we have chosen them to be equal to the ratio of total full-time labour to the total amount of labour within each country. We implicitly rule out effects due to the different intensity in which full and part-time labour is used in different sectors. Since we do not deal with taxes on the use of labour, this assumption does not seem to be extremely restrictive.

2.3 The public sector

Let us now consider the expenditure side of the government budget. There are two expenditure categories: lump-sum payments to the representative consumer and government outlays for the provision of public goods. Because firms pay for the use of the public good as an intermediate input, only net public expenditures (provided free of charge to the consumer) have to be financed by taxes. Transfers are implemented as a linear function of the level of unemployment:

$$T = \gamma + \eta u_r \sum_i L_{f,i}^T, \quad (10)$$

where γ and η are parameters representing respectively the intercept and the slope of the transfer function, while u_r is the unemployment rate (calculated as a percentage of the total full-time labour supply).

In particular, we have calibrated the model such that the share of transfers linked to the level of unemployment corresponds to the value of unemployment compensation in the respective countries under consideration. Table 2 shows the data we have used.

Table 2. Unemployment compensation
as a percentage of GDP

D	1.99
I	0.71
F	1.61
UK	1.63
Source: OECD (1997), pp.185, 187 and 190.	

The intercept of the transfers function corresponds to those transfer payments which the government makes independent of the level of unemployment, for example pensions. The remaining transfers are either directly linked to unemployment or indirectly linked as a consequence of unemployment, such as social security and other welfare benefits.

On the revenue side of the budget, the government collects various taxes: full-time labour income tax, part-time labour income tax, capital income tax, value added taxes, tariffs and production taxes. Taxes on capital and labour are modelled as linear progressive taxes: we assume constant marginal tax rates but we give the consumer a certain level of allowances to create the effect of progressivity.

2.4 Labour market equilibria

In equilibrium, all of the market clearing conditions are satisfied², except for the full-time labour market. We assume here that workers are quantity-rationed on the full-time market, while the part-time market clears by means

²Clearing conditions on the commodity markets for private and public goods, the international capital market and the balance of payment constraint are fulfilled.

of adjustment of the part-time wage. We argue that part-time labour is different in kind from full-time labour, and that the mechanisms giving rise to non-clearing wages do not apply.

To generate genuine involuntary unemployment, we require a mechanism which prevents wages from clearing the full-time labour market. Our model has been developed to yield zero-profit competitive equilibria, with prices and wages being taken as given to firms and households: in this environment, the efficiency wage model is an attractive way of explaining unemployment. The “true” labour input into production is a product of effort and hours, with effort being a positive function of the wage rate. Shapiro and Stiglitz (1984) show that profit maximisation results, in general equilibrium, in a “no-shirking constraint” (NSC), which replaces the traditional labour supply curve in determining employment and wages. The NSC is such that higher levels of employment induce employers to pay higher wages to eliminate workers’ incentive to shirk. In equilibrium, the number of workers is, therefore, still a measure of the labour input. A standard empirical counterpart to the NSC is the loglinear wage-curve, though as Blanchflower and Oswald (1994) show, there are several alternative rationalisations for the apparently robust finding that unemployment rates and wage rates are negatively correlated in both cross-section and time-series studies for a wide range of countries. A remarkable feature of these studies is that the elasticity of wages w.r.t. unemployment is consistently estimated around the value of -0.1, making calibration of our model easy. For a recent review of the evidence, see Nickell (1998), who stresses the ‘substantial’ body of evidence for a non-zero elasticity and the ‘profound implications’ of these results.

We therefore specify the following wage curve:

$$\log \left(\frac{w_f(1 - t_f^A)}{Q} \right) = \varphi - \lambda \log(u_r), \quad (11)$$

where we use the following notation:

- t_f^A average full-time labour income tax rate
- Q producer price index.

On the full-time labour market, therefore, we have unemployment equalling the difference between the level of leisure that the consumer would choose at the equilibrium wage rate (ℓ_m or ℓ_w) and the level of leisure that the consumer is forced to choose (ℓ_i^*), thus:

$$\ell_i^* = \ell_i + u_r L_{f,i}^T. \quad (12)$$

Unemployment therefore corresponds to excess leisure consumption. The market equilibrium condition for the full-time labour market is:

$$\sum_n L_{f,n}^D = (L_{f,m}^T + L_{f,w}^T)(1 - u_r),$$

where $\sum_n L_{f,n}^D$ is the demand for full-time labour (summed over production sectors), and in the part-time market the conventional clearing condition holds:

$$\sum_n L_{p,n}^D = L_{p,m}^T + L_{p,w}^T.$$

2.5 Policy evaluation

To evaluate the policy changes of the 1980's, we need appropriate indicators of their welfare effects. A welfare function which represents the economy as a whole in a world with a single consumer and without rationing is straightforward: the welfare function coincides with the utility function of the representative consumer (U).

A common way to evaluate the welfare changes due to a policy reform is to use the so-called equivalent variations (EV), expressed as:

$$EV = \frac{U_c - U_b}{U_b} I_b,$$

where the index c refers to the counterfactual equilibrium and b to benchmark equilibrium. Hence, I_b is full disposable income in the benchmark equilibrium.

In the presence of involuntary unemployment, things become slightly complicated. In order to explain the problem we are faced with and in order to

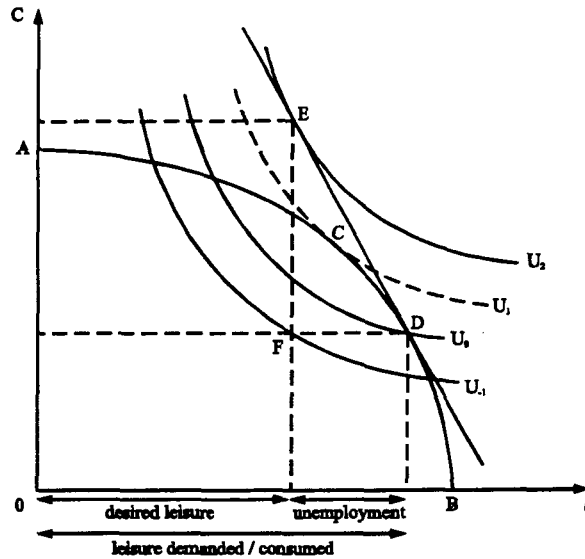


Figure 2: Consumer's constrained equilibrium

avoid unnecessary complications, we assume in this paragraph only that the utility function of our representative consumer is defined over consumption and leisure, and that there is no distinction between men and women and full and part-time labour. The labour market does not clear, however.

In Figure 2 we depict the transformation function $g(C, \ell) = 0$ (in the graph, the curve connecting point A to B) defined over consumption (C) and leisure (ℓ). The optimal consumers' choice is defined in C , the point of tangency of the transformation function and the indifference curve U_1 . In a competitive labour market, this would also be the equilibrium point for the economy and the slope of the tangent would also be the equilibrium real wage rate. But in a model with involuntary unemployment, the real wage is higher than that realised in the competitive economy. In our graph, therefore, we can illustrate the presence of rationing on the labour market by considering a line tangent to the transformation function, but with a slope greater than that going through point C .

Therefore, with some form of rationing, the agent cannot achieve U_1 : prices which do not clear the labour market yield an actual utility of U_0 at

point D, although the agent will aspire to U_2 at point E. The latter is, in fact, the tangency of the indifference curve U_2 and the line which represents the real wage rate for the non-clearing labour market. At this point we determine the optimal leisure demand for the consumer at this set of prices, while at point D we determine the level of leisure which the agent must consume. The difference between these two values yields what we call *excess leisure consumption* or *notional unemployment*. The question now is: which level of utility should one consider when evaluating equivalent variations? The obvious measure is the utility level at point D and the equivalent variation:

$$EV_{C,l+u} = \frac{(U_0)_c - (U_0)_b}{(U_0)_b} I_b,$$

where $U_0 = U(C^*, \ell^* + u^*)$, and C^* is the actual consumption of goods, ℓ^* desired consumption of leisure and u^* the unemployment level.

Another approach is to interpret the model as representing an aggregate mix of agents, some of whom are *lucky* and can realise their labour supply choices in full at E, while *unlucky* agents remain fully unemployed at a point above B: the former achieve U_2 and the latter achieve some minimum level of utility determined by non-wage income. The leisure of this latter group, much in excess of their preferred choice, will yield zero marginal utility and low average utility. If we completely discount any utility from leisure from the fully unemployed, then point F on U_{-1} may represent the aggregate outcome. Therefore, in order to provide an alternative metric, we also calculate the equivalent variations simply in terms of C^* and ℓ^* :

$$EV_{C,l} = \frac{(U_{-1})_c - (U_{-1})_b}{(U_{-1})_b} I_b,$$

excluding, therefore, excess leisure consumption u^* from the welfare measure and instead considering $U_{-1} = U(C^*, \ell^*)$.

3 Economic Analysis

3.1 Changes in the tax structure from 1985 to 1992

In this section, we report the results of our policy experiments. In the simulations, we exogenously impose the tax rates which were in force in 1985 in order to analyse the influence of the tax system in the actual development of the labour market. The change in the tax system is performed for Germany(D), France(F), Italy(I) and the UK only. In Table 3, we report the values of the different tax rates for our benchmark of 1992 and for the year 1985. The two types of taxes involved in our simulation are the differentiated VAT based on a destination principle and a progressive labour income tax, even though the tax rates of production taxes as well as tariffs, which apply to imports from the ROW, were also changed in this decade.

Taking the actual changes in the tax rates avoids the problem of choosing arbitrary changes with the risk of constructing scenarios which are too far from reality. We can also discuss the effects of actual policy.

Table 3: VAT rates in 1992 and 1985

	Reduced rate		Normal rate	
	1992	1985	1992	1985
D	7.0	6.5	15.0	13.0
F	5.5 (2.1)	7.0	18.6	17.6
I	4.0	3.5	19.0	15.0
UK	0	0	17.5	15.0

Sources: Ernst and Young (1995); pp.100, 122, 177, 294.

Table 3a: Income tax rates in 1992 and 1985.

	D		F		I		UK	
	1992	1985	1992	1985	1992	1985	1992	1985
t_j	42.0	42.0	28.1	24.4	32.7	33.4	34.0	39.0
t_j^A	30.5	31.3	21.8	17.5	20.4	22.6	19.2	23.1
I_f^P	1.37	1.34	1.29	1.39	1.60	1.48	1.77	1.69

Sources: OECD (1995); p.147, 151, 155, 179

For almost all these countries, the old tax system featured lower normal and reduced VAT rates in comparison with the 1992 rates (n.b. 'reduced' refers to the rates on certain categories of goods, like food). The only exception is France, for which the reduced tax rates were actually higher in 1985 than in 1992. Particularly relevant seems to be the change which took place in Italy: the normal tax rate is decreased by 4 percentage points by going back to 1985. Instead, the reduced VAT rates in the old tax system implies a rates reduction for Germany, Italy and UK.

As far as the change in the labour income tax³ is concerned, we observe a certain homogeneity across Germany, Italy and the UK, while France moved in the opposite direction. For Germany, Italy, and the UK, the 1985 average tax rates were higher than in 1992, while in France t^A was lower in 1985 than in 1992. In addition, for Italy and the UK, the 1985 marginal tax rates were higher than in 1992, while for France the opposite was true, and for Germany no changes took place. In Table 3a we have also reported as an index of the income tax progressivity (I_f^P), liability progression, defined as the elasticity of the tax liability to pre-tax income or, more simply, as the ratio of marginal to average tax rates (see Lambert (1993), p.160, on the index of Musgrave and Thin).

³The values shown in Table 3 for the marginal tax rates refer to a two-earner couple with two children. We actually report the tax rates of the principal earner as tax rates on full and part-time labour, where the percentage of the APW (average production worker) income principal/secondary earner is 100/33.

In summary, recalling that our reference year is 1992, in the simulation with 1985 rates, the changes in marginal and average tax rates we imposed imply a reduction in progressivity for Germany, Italy and UK, but an increase in progressivity for France. While the average tax rates increase for Germany, Italy and the UK, the average tax rate for France decreases.

3.2 Simulation design

We report four different exercises.

(i) In the first simulation, we impose the VAT rates and the marginal and average tax rates on labour in force in 1985. Given that the following relation links the marginal and the average tax rates,

$$t_j^A = t_j \left(1 - \frac{TA_j}{\sum_{i=w}^m L_{j,i}^T} \right),$$

fixing both marginal and average rates means that allowances have to be determined endogenously. This mechanism reflects the fact that, generally, changes in the top rates have been accompanied by changes in the taxable base.

This simulation represents our main exercise. But to assist in interpreting the results, we performed two other simulations. (ii) In the second, we impose only the VAT rates in force in 1985 and (iii) in a third simulation, starting from the equilibrium we reached by running the second simulation, we impose the 1985 marginal and the average income tax rates. In this way, we may disentangle the influences of the changes in indirect and direct taxation on the development of labour markets.

These three simulations are performed as a *differential incidence* analysis. The total government constraint is fulfilled by varying the capital income tax rate. The capital income tax is based on the residence principle and, given that our capital stock is fixed in supply, would generate exclusively income effects. We intentionally chose this type of tax in order to eliminate any substitution effects (or efficiency effects) other than those arising from VAT

and labour income tax. For this reason, differential incidence is in this case indistinguishable from balanced budget incidence analysis.

(iv) We finally perform a revenue neutral simulation (differential incidence) in which we exogenously fix the 1985 marginal and average income tax rates only, allowing for a percentage change in the VAT rates (i.e. reduced and normal rates change proportionally) in order to fulfil the budget constraint. In this way we may find the implication for VAT of income tax changes, when no other taxes change.

3.3 Some theoretical considerations

In order to help understand the results, we briefly recall the distortions implied by consumption taxes and labour taxes in our context. Let us consider a case in which we have a proportional labour income tax and a uniform VAT system. In this case, both of these types of taxes would distort the consumer choice between consumption and leisure. In other words, we would have a distortion of the domestic allocation. Here, VAT would be equivalent to a tax on total income, namely a tax on labour income together with a tax on capital on a residence basis. As already noted, however, the latter is in our context a non-distortive tax. Therefore, a tax on consumption should be Pareto superior to a tax on labour income.

But if we consider a VAT with differentiated tax rates as we have in our model and in reality, then VAT also introduces a wedge between the marginal rate of substitution and the marginal rate of transformation for some consumption goods, implying additional domestic and international distortions. We also consider a progressive labour income tax, which is more distortive to the leisure-consumption choice than a proportional tax, in the sense that raising the same tax revenue would imply a larger deadweight loss in the economy.

In a competitive labour market, if leisure is a normal good, a decrease in the VAT rate should actually reduce leisure demand and, therefore, increase labour supply. On the other hand, a positive income effect due to the increase

in the net of tax wage leads to a general increase in consumer demand for leisure and consumption. Even though one cannot say *a priori* which of these two effects will prevail, we may assume that the net effect is an increase in leisure demand, which, in a partial equilibrium setting, would mean an increase in real wages and a decrease in the employment level. In contrast, a decrease in the marginal tax rate would decrease the demand for leisure, increase labour supply and the level of employment.

Policy choice in our model is complicated both by the fact that we work within a general equilibrium framework, and by the presence of involuntary unemployment.

A feature of our model construction is that, even in the presence of unemployment, an increase in the marginal tax rate (keeping the t_f^A constant) would generally lead to a decrease in employment as well as a decrease in *involuntary* unemployment. This is due to the presence of a variable labour supply: an increase in the marginal tax rate would decrease the opportunity cost of leisure, leading to a decrease in labour supply. In other words it would be less attractive for the people to work more if they have to pay higher marginal tax rates. *Ceteris paribus*, a reduction in labour supply would decrease the level of involuntary unemployment: the voluntary level of leisure consumption has increased or, in other words, the level of involuntary leisure consumption (i.e. unemployment) has decreased. As described by equation (11), a decrease in the level of unemployment implies an increase in the pre-tax wage rate (holding t_f^A constant) and, consequently, a decrease in labour demand. Given that in our model we need not distinguish between effort and labour supply⁴, the increase in the pre-tax wage is a reflection of efficiency wage setting, which compensates for better outside opportunities by offering workers a higher wage rate. In this scenario, individuals have been discouraged from work by higher marginal tax rates, and in the economy as a whole, employment decreases. This policy is therefore not an attractive means of reducing unemployment.

⁴Since the No Shirking Constraint holds, no employees shirk.

3.4 Simulation results

Our simulations work backwards in time in the sense that our benchmark equilibrium refers to the year 1992 and we impose the tax rates of 1985. We can make some inferences from our results about the evolution of the labour market in the decade under consideration. For example, if we have an increase in full-time employment in the simulation, then the evolution of the tax system in the last decade would seem to have led to a *reduction* in full-time employment: the interpretation of the direction of the changes in variables is, therefore, reversed.

3.4.1 Simulation 1

We change the VAT rates and the marginal and the average tax rates on labour as specified in Tables 3 and 3a. The results obtained in this simulation are displayed in Tables 4 and 4a.

Table 4: 1985 VAT and labour income tax rates (% changes)

	D	F	I	UK
male employment	0.39	2.81	0.16	-2.59
female employment	0.40	2.65	0.18	-2.52
full-time employment	0.38	2.94	0.15	-2.65
part-time employment	0.50	1.38	0.50	-2.28
unemployment rate	1.78	-16.67	4.38	4.53
tax revenue from f labour as a percentage of GDP	2.90	-21.56	11.75	22.52

Table 4a. Welfare measures (% changes)

	D	F	I	UK
$EV_{C,l+u}$	0.17	0.02	0.19	-0.17
$EV_{C,l}$	0.10	0.65	0.02	-0.16
ToT^5	1.04	0.98	1.05	1.08

⁵ ToT are the terms of trade effects, and the EVs shown are percentages of money income.

Let us first look at the effects on the labour market in the UK. In the simulation, we obtain a reduction in both the level of employment of full-time and part-time labour, as well as of the male and female levels of employment. One might be tempted to say that the reason is the reduction in the level of progressivity (see discussion in Introduction), but if we look at the data more carefully, we can see an increase in the total tax burden on labour. It is this increase in labour burden which dampened the labour supply and increased the pre-tax real wage (which is also partly due to the decrease in VAT rates), leading to a reduction in employment as well as an increase in unemployment.

In simulation, the effects on the labour market for the French case are the opposite of those for the UK. This is unsurprising given that France adopted exactly the opposite changes in income tax rates as the UK, namely increasing the marginal tax rates while decreasing the average one. Germany and Italy, instead, adopted a policy which is qualitatively quite similar to that of the UK, but not in quantity terms. Both Germany and Italy decreased the marginal tax rates while increasing the average one. One can look at the case of Germany and Italy as a sort of sensitivity analysis for the type of policy adopted by the UK. Table 4 shows that the effects on the level of employment for Germany and Italy are, in contrast to what happens in the UK, positive.

3.4.2 Simulation 2

In order to provide a better explanation for these results, we performed two further simulations. The results of the fairly simple second exercise are summarised in Table 5. In this case, we decrease the tax rates on final consumption (with the exception of France). The first reaction is, therefore, on the consumer side. Households find consumption more attractive than before and they increase their final consumption, substituting away from leisure. Almost no substitution effects take place with respect to the different types of leisure demand: changes in female and male labour supply are almost

equi-proportional. As usual, substitution effect and income effects are both positive for commodity demand while they work in opposite directions for leisure demand. For the latter, substitution effects are negative and income effects are positive. Depending on which effects dominate, a decrease or an increase of leisure demand will take place. Consequently, also the effects on unemployment are, *a priori*, not predictable.

A stronger effect is, however, expected on the production side. The positive change in final demand leads to an increase in the level of production and, therefore, to an increase in the factor demands, in particular for full-time labour, which is, broadly speaking, more *intensively* used than part-time labour. All of these changes on the production side should, in principle, mitigate the predominantly negative effects on the labour market coming from the consumer side.

If we look at Table 5, that seems to be what happened in all countries, even in France where the policy undertaken was to increase the reduced tax rate and decrease the normal one. Employment increases and unemployment decreases. Male and female labour proportions seem not to be greatly affected, while full-time labour seems to benefit more than proportionately to the increase in the level of employment.

As expected, all countries experience positive welfare effects, no matter what parametrisation we use to calculate the *EV*. Part of the welfare gains are certainly due also to the positive ToT effects.

Table 5. VAT switch from 1992 to 1985 rates (% changes)

	D	F	I	UK
male employment	0.64	0.26	0.96	0.90
women employment	0.60	0.24	0.94	0.82
full-time employment	0.67	0.28	0.98	0.97
part-time employment	0.38	0.10	0.46	0.53
unemployment rate	-4.33	-1.94	-6.37	-5.14

Table 5a. Welfare measures (% changes)

	D	F	I	UK
$EV_{C,t+u}$	0.15	0.18	0.19	0.21
$EV_{C,t}$	0.24	0.26	0.35	0.36
ToT	1.03	1.01	1.04	1.04

3.4.3 Simulation 3

The third simulation results appear in Tables 6. In this case we have analysed the effects solely due to a change in the tax rates of the income tax schedule, given that the VAT rates have already been changed. The simulation, in fact, has been run using the equilibrium with VAT rates from 1985 as a starting point. As we have seen, in 1985 Germany, Italy and the UK had higher average rates t^A , higher marginal rates (except Germany) but also a lower index of progressivity. The main reaction in this case should come from the consumer side and from the efficiency wage mechanism.

First, increasing the average tax rate means a decrease in consumers' money income and, consequently, a decrease in consumers' demand for goods and leisure. But the increase in the marginal tax rates would also reduce the opportunity cost of leisure: therefore, in the first round, leisure demand increases, and labour supply and the level of unemployment decreases. To motivate 'effort', the pre-tax wage has to be raised, in turn leading to a reduction in labour demand. Of course this pressure on the pre-tax wage works on the full-time wage only, given that we assume part-time labour as clearing. So producers substitute from full time to part-time labour, leading to an increase of part-time labour employment (see Table 6). When the first negative income effect is strong enough, as in the case of the UK, then we have a general decrease in employment. Part-time labour should in all cases decrease proportionally less than full-time, because of this substitution effect.

Finally, it becomes clear by looking at Table 6 that the changes in the labour market are much stronger in the UK than in Germany and Italy. In simulation, the strong negative effects on the labour market due to the

change in the pattern of the income taxation outweigh, for the UK only, the positive effects of decreased the VAT rates.

Table 6. Labour income tax switch from 1992 to 1985 rates
(VAT rates 85) (%changes)

	D	F	I	UK
male employment	-0.26	2.54	-0.79	-3.46
female employment	-0.20	2.40	-0.75	-3.32
full-time employment	-0.29	2.66	-0.83	-3.58
part-time employment	0.12	1.28	0.04	-2.80
unemployment rate	6.38	-15.02	11.48	10.20

Table 6a. Welfare measure

	D	F	I	UK
$EV_{C,t+u}$	0.02	-0.16	-0.13	-0.36
$EV_{C,t}$	-0.13	0.39	-0.31	-0.50
ToT	1.04	0.97	1.06	1.09
T_r	6.73	4.62	5.23	5.44

3.4.4 Simulation 4

As a final revenue-neutral simulation, once again we exogenously impose the 1985 marginal and the average labour income tax rates but in this case only we let the VAT rates vary endogenously in order to fulfil the government budget constraint. In Table 7b we show the VAT rates for 1992, for 1985 and those that would be necessary to shift the tax burden from direct to indirect taxation (or vice versa). As expected the results (see Tables 7 and 7a) are homogenous across Germany, Italy and the UK, still with the exception of part-time labour.

Table 7. Labour income tax switch from 1992 to 1985 rates
with endogenous VAT rates (% changes)

	D	F	I	UK
male employment	-0.23	1.41	-0.54	-2.22
female employment	-0.17	1.33	-0.50	-2.18
full-time employment	-0.27	1.47	-0.57	-2.25
part-time employment	0.17	0.69	0.23	-2.05
unemployment rate	6.58	-8.42	9.70	2.43

Table 7a. Welfare measure

	D	F	I	UK
$EV_{C,l+u}$	0.01	-0.19	0.00	-0.19
$EV_{C,l}$	-0.17	0.11	-0.29	-0.13
ToT	1.03	0.99	1.05	1.07
T_r	6.74	4.66	5.27	5.42

Table 7b. Labour income tax switch from 1992 to 1985 rates
endogenous VAT rates

	Reduced rate			Normal rate		
	1992	1985	simulation	1992	1985	simulation
D	7.0	6.5	6.9	15.0	13.0	14.7
F	5.5 (2.1)	7.0	6.7 (2.5)	18.6	17.6	22.5
I	4.0	3.5	3.7	19.0	15.0	17.6
UK	0	0	0	17.5	15.0	13.9

The actual policy applied in the UK therefore seems to have had positive effects on the labour market in the decade considered. This results from having increased the VAT rates and more crucially, although the progressivity of the tax system increased, from decreasing the total burden on labour. Even though Germany and Italy operated a similar policy, only for the UK are the positive effects of the changes in the overall burden of labour income taxation large enough to outweigh the negative effects of having increased the VAT rates.

4 Conclusion

In this paper we have analysed the effects of actual changes in the tax system on the labour market. With reference to the decade 1985-1992, we chose to focus our attention on the changes in the rates of the VAT and the marginal as well as average tax rates on labour income adopted in Germany, France, Italy and in the UK.

Certain trends in the labour market, a general increase in female participation in the form of part-time labour, characterised the EU as whole. In addition, the level of unemployment increased in almost all countries except the UK.

The idea that policy makers can actually use the fiscal system as an instrument to influence the labour market is not new. With our simulation we underline the necessity of coordinating the goals and the duties imposed by the Maastricht Treaty all around Europe with the necessity of solving also problem of unemployment.

In our simulation, we show that one possible contribution to the trend in the labour market in the UK may be its different fiscal policy. In particular, it seems that the relatively sharp British movement from direct to indirect taxation in the decade from 1985-1992, with an effective reduction of the tax burden on labour even in the presence of a higher level of progressivity, may have substantially contributed to the positive development of employment and unemployment.

5

Appendix: The CET function and the distribution of threshold relative wages

Consider the CET function as a model for determining the full-time share of men's or women's labour supply. It is convenient to simplify the notation.

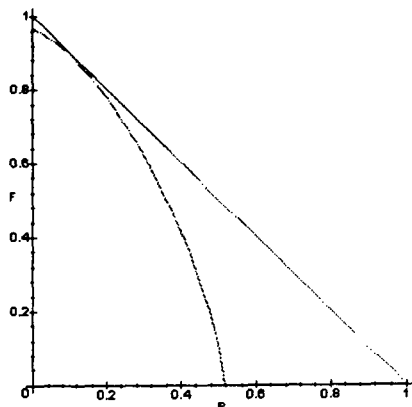


Figure 3: CET function and budget line

The CET model is given as

$$P^{\pi_2} + \beta F^{\pi_2} = k^{\pi_2} \quad (13)$$

$$P + F = 1 \quad (14)$$

$$w_p(1 + t_p)P + w_f(1 + t_f)F = w \quad (15)$$

where P is the part-time share, F is the full-time share, β is a share parameter, k a scale parameter, and π_2 a (positive) constant. A typical example is shown in Figure 3. In this example k is chosen to satisfy equation (14) for given values of β and π_2 , and illustrates a choice of 90% full-time labour supply, conditional on a relative wage rate $\tau = \frac{w_f(1-t_f)}{w_p(1-t_p)}$ of unity.

We wish to investigate the consequences of varying the relative wage, in order to express F as a function of the relative wage τ . τ is to be interpreted as randomly distributed across a large labour force, and $F(\tau)$ as the distribution function.

The result is obtained by equating the gradient of the budget line, $-1/\tau$, to the gradient of the CET function at the tangency point shown in Figure

3 above. By straightforward manipulation we obtain

$$F(\tau) = (1 + e^{-\psi\tau^{-\delta}})^{-1} \quad (16)$$

where $F(\tau)$ has the standard form of the log-logistic distribution function (see Balakrishnan (1992)). The parameters of this distribution function relate to those of equation(13) as follows:

$$\begin{aligned} \delta &= -\frac{1}{1 - \pi_2} \\ \psi &= \frac{1}{1 - \pi_2} \ln \beta \end{aligned}$$

Its key characteristics of central tendency and spread are as follows: the median is

$$Q_2 = \beta,$$

and the relative interquartile range is

$$(Q_3 - Q_1)/Q_2 = 3^{\pi_2-1} - 3^{-(\pi_2-1)}.$$

It is helpful at this point instead to express these results in terms of the notation and concepts of equation (6), the CET function in the paper. The elasticity of substitution (between part-time and full-time work),

$$\delta_2 = \frac{1}{1 - \pi_2},$$

and the share parameter in equation (13),

$$\beta = (\beta_{f,i}/\beta_{p,i})^{1/\delta_2} = (\beta_{f,i}/(1 - \beta_{f,i}))^{1/\delta_2},$$

hence

$$\begin{aligned} \delta &= -\delta_2 \\ \psi &= \delta_2 \ln \beta = \ln(\beta_{f,i}/(1 - \beta_{f,i})) \\ Q_2 &= (\beta_{f,i}/(1 - \beta_{f,i}))^{1/\delta_2} \\ (Q_3 - Q_1)/Q_2 &= 3^{-1/\delta_2} - 3^{1/\delta_2}. \end{aligned}$$

The distribution function may therefore be expressed in terms of model notation as

$$F(\tau) = (1 + (\tau/\beta)^{\delta_2})^{-1} \quad (17)$$

$$= (1 + \tau^{\delta_2}(\beta_{f,i}^{-1} - 1))^{-1}. \quad (18)$$

Thus the spread of the distribution depends only on the elasticity of substitution δ_2 : the distribution function would degenerate to a step function for the Leontief case of $\delta_2 = 0$, while the CET function in Figure 3 would in this case become rectangular. The median is given by both the ratio of share parameters and δ_2 ; when the share parameters are equal, the median equals unity; and finally note that $F(1) = \beta_{f,i}$. The form of the distribution and density functions corresponding to the CET function in Figure 3 is now shown in Figure 4:

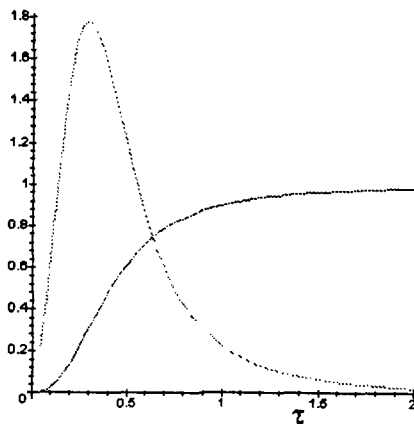


Figure 4: Log-logistic distribution and density functions

The interpretation of these functions depends on the standard latent variable argument. Each member of the labour force has a threshold value of τ above which he/she decides to switch from part-time to full-time work, according to each individual's own idiosyncratic preferences. These threshold values are randomly distributed according to the log-logistic as shown

in Figure 4 The distribution function $F(\tau)$ therefore yields the proportion of the population whose threshold lies below the value τ and who therefore prefer to work full-time.

References

- BALAKRISHNAN, N. (1992): *Handbook of the Logistic Distribution*. Marcel Dekker.
- BEAN, C. R., P. R. G. LAYARD, AND S. J. NICKELL (1986): "The rise in unemployment: a multi-country study," *Economica*, 53, s1–s22.
- BLANCHFLOWER, D. G., AND A. OSWALD (1994): *The Wage Curve*. M.I.T. Press, London, UK.
- DUNCAN, A. S., J. P. HUTTON, F. LAROUÏ, AND A. RUOCCO (1998): "Labour Market Effects of VAT Harmonisation in a Multicountry AGE Model," in *Policy Simulations in the European Union*, ed. by A. Fossati, and J. P. Hutton, chap. 4, pp. 59–78. Routledge.
- ERNST, AND YOUNG (1995): *VAT and Sales Taxes Worldwide*. John Wiley and Sons.
- EUROSTAT (1996): *Yearbook 96*. Eurostat.
- FEHR, H., C. ROSENBERG, AND W. WIEGARD (1995): *Welfare Effects of Value-Added Tax Harmonization in Europe*. Springer.
- FORTIN, B., AND G. LACROIX (1997): "A test of the unitary and collective models of household labour supply," *Economic Journal*, 107, 933–955.
- KNOESTER, A., AND A. V. DE WINDT (1987): "Real wages and taxation in ten OECD countries," *Oxford Bulletin of Economics and Statistics*, 49(1).
- LAMBERT, P. (1993): *The Distribution and Redistribution of Income: A Mathematical Analysis*. Manchester University Press, Manchester, UK, 2nd edn.
- LOCKWOOD, B., AND A. MANNING (1993): "Wage setting and the tax system: theory and evidence for the United Kingdom," *Journal of Public Economics*, 52, 1–29.

- NICKELL, S. J. (1998): "Unemployment: questions and some answers," *Economic Journal*, pp. 802–816.
- OECD (1995): *The OECD Jobs Study: Taxation, Employment and Unemployment*. OECD, Paris.
- (1997): *Employment Outlook*. OECD, Paris.
- RUOCCO, A. (1996): "A multi-country general equilibrium model for the European Union: the basic features and the coding structure," Discussion Paper 83, Wirtschaftswissenschaftliche Fakultät, University of Tübingen.
- SHAPIRO, C., AND J. STIGLITZ (1984): "Equilibrium Unemployment as a Worker Discipline Device," *American Economic Review*, 74, 433–444.
- SHOVEN, J. B., AND J. WHALLEY (1984): "Applied general equilibrium models of taxation and international trade: an introduction and survey," *Journal of Economic Literature*, 22, 1007–1051.
- STATISTISCHES-BUNDESAMT (1996): *Statistical Yearbook for Foreign Countries*. Metzler-Poeschel.