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Involuntary Unemployment and the Marginal Welfare Cost of Taxation in Belgium

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I. INTRODUCTION

The theory of optimal taxation in a second best-world offers an interesting possibility to integrate efficiency and equity considerations in a coherent framework. Empirical application of the optimal taxation-approach is not without its problems, however. Indeed, when authors began actually computing optimal tax schemes, it soon became clear that the results of these computations were heavily dependent on the choice of functional form for the individual utility functions and the resulting demand system (Deaton (1981),(1987))[1]. Partly as a consequence of this finding, recent empirical work puts more emphasis on the welfare evaluation of marginal tax reform. A straightforward methodology, based on cost-benefit principles, was proposed and applied for India by Ahmad and Stern (1984). The main advantage of this approach is its theoretical interpretability. It stays firmly within the stylised Walrasian model and the effects of increasing equality aversion or increasing price elasticities show up immediately in the results.

The attractiveness of this approach has led to analogous calculations for the indirect tax structures of Western European countries (Decoster and Schokkaert (1989),(1990), for Belgium; Kaiser and Spahn (1989), for West Germany). It can be doubted, however, whether

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this work has given useful insights into the policy problem for these countries. The simplifying assumption of the Ahmad/Stern-model (a Walrasian economy with fixed producer prices and fixed and untaxed factor incomes) hardly makes sense for countries with an elaborated system of income taxes and a high degree of involuntary unemployment. Some important policy questions in these countries cannot even be asked within this framework: would a shift from direct to indirect taxes be welfare-improving? how must the tax structure be reshuffled to mitigate unemployment? To answer these questions, it is necessary to introduce into the model a system of income taxation and a labour market in disequilibrium.

The theoretical structure of second-best analysis in a non-Walrasian world has been explored in a pathbreaking article by Drèze (1985). He shows how macro-economic considerations can be introduced into the welfare analysis in a straightforward way. A first empirical application of this approach for Belgium has been presented by Wibaut ((1987),(1989)). We work further in this direction and present some empirical calculations with Belgian data for a linear wage tax and a 15 commodities-classification of indirect taxes. Our paper differs from Wibaut's approach in two respects.

First, he starts from the assumption that a Keynesian regime prevails. In his model, the gross wage rate and the producer prices are exogenously fixed. In our model, these crucial variables are endogenized by assuming that the goods markets are in equilibrium and that wages are determined within a process of bargaining between trade unions and employers[2]. This leads to the occurrence of involuntary unemployment.

Second, in Wibaut's model there is only one aggregate private sector, producing the different commodities. Hereby an important source of differential impact of taxes is neglected. We calibrate different production technologies for 15 sectors, which implies that there is a quite complex general equilibrium structure underlying our computed marginal welfare costs. To illustrate the importance of the general equilibrium structure, especially for the direct-indirect taxation debate, some simulations using different assumptions on the shifting of the labour tax will be performed.

The structure of the paper is as follows. In section II we present the concept of the marginal welfare cost of taxation in a general and abstract form. The following sections describe our model of the economy: household behaviour is discussed in section III, the private production sector in section IV and the labour market in section V. Making use of the information available for Belgium, we have estimated some parameters of that model and calibrated the others. The description of these empirical approximations is integrated in the theoretical discussion. All this information is collected in section VI. Results for Belgium in the reference year 1980 are reported and discussed in section VII. Section VIII concludes.

II. THE MARGINAL WELFARE COST OF TAXATION

We define the social welfare function $W(z)$ and total government revenue $S(z)$ as a function of the vector of endogenous variables z.

The content of the vector z will be determined by the choice of social welfare function and by the specification of the economy: this specification will determine how the tax rates t influence the z-variables. Let us remain for the moment at a general and abstract level and represent this model of the economy as

$$F(z,t)=0 \tag{1}$$

If the assumptions underlying the implicit function theorem are met, it is straightforward to compute from (1) the matrix of tax multipliers:

$$\frac{dz}{dt'} = -\left[\frac{\partial F}{\partial z'}\right]^{-1} \frac{\partial F}{\partial t'} \tag{2}$$

The *problem of optimal taxation* is then traditionally written as

$$\max_{t} \quad W(z) \quad s.t. \quad S(z) \geq \overline{S}$$

leading to the first order conditions

$$\left(\frac{\partial W}{\partial z'}\right)\left(\frac{dz}{dt'}\right) = -\lambda\left(\frac{\partial S}{\partial z'}\right)\left(\frac{dz}{dt'}\right)$$

where λ stands for the Lagrange-multiplier of the government revenue constraint.

For reasons described in the introduction, recent empirical work centers more on the *tax reform problem,* which tries to identify a direction dt such that $dW > 0$ (welfare improvement) and $dS \geq 0$ (budgetary feasibility). A simple and transparent approach to assess the desirability of tax changes has been proposed by Ahmad and Stern (1984). They define MC_i, the marginal cost in terms of social welfare of an extra unit of revenue raised via the i-th tax rate, as:

$$MC_i = -\frac{\left(\frac{\partial W}{\partial z'}\right)\left(\frac{dz}{dt_i}\right)}{\left(\frac{\partial S}{\partial z'}\right)\left(\frac{dz}{dt_i}\right)} \tag{3}$$

It is obvious that all these marginal costs will have to be equal, i.e., $MC_i=\lambda, \forall i$, for the tax structure to be optimal. Welfare improving reforms can also be detected immediately: if $MC_i<MC_j$, social welfare will be increased by lowering the tax rate t_j with an offsetting increase in the tax t_i, so as to keep global tax revenue constant.

Of course, to give further content to (3) we will have to specify the social welfare function and the model (1). For our welfare analysis we will work with a traditional welfaristic social welfare function $W(v^1,...,v^H)$, where v^h is the indirect utility of household h. Our model of the economy will be described in the following sections. We will first sketch the model of household behaviour, then the specification of the production sector and finally the labour market assumptions.

III. COMMODITIES AND HOUSEHOLD BEHAVIOUR

We consider an economy with G commodities, indexed i= 1,...,G, with corresponding producer prices $p = (p_1,..., p_G)$[3], indirect taxes $t=(t_1,...,t_G)$ and consumer prices $q=(q_1,...,q_G)$, where

$$q = p + t \tag{4}$$

The first G-1 commodities are produced by the private sector, whereas commodity G is supplied by the government. Furthermore, there is a single labour market where the net wage q_l is determined (see Section V). Social security contributions and income taxes, captured by t_l, drive a wedge between the net wage q_l and the wage cost p_l. Hence,

$$q_l=p_l-t_l \tag{5}$$

The vector of tax rates to be included in the welfare analysis consists of the indirect taxes and the tax on labour[4].

Household h consumes a bundle $x^h = (x^h_1, \ldots, x^h_G)$, supplies a quantity of labour l^h, receives a net wage q^h_l and non-wage income r^h. Wage differentiation across households results from exogenous differences in capability or productivity, captured by the efficiency parameters e^h, such that $q^h_l = e^h q_l$. Preferences are represented by a utility function $u^h(x^h, -l^h)$ with the usual properties. Household h faces a budget constraint

$$q'x^h = q^h_l l^h + r^h \qquad (\phi^h)$$

and a constraint on labour supply[5]

$$l^h = \bar{l}^h(L) \qquad (\Psi^h)$$

where L stands for aggregate employment in the economy, and Φ^h and Ψ^h are Lagrange multipliers associated with the respective constraints. It is assumed that households willingly supply any demand for labour at the going wage, i.e.,

$$\sum_h \frac{\partial l^h}{\partial L} = \sum_h \frac{\partial \bar{l}^h}{\partial L} = 1 \tag{6}$$

Non-wage income is made up of an exogenous component ρ^h, a share θ^h in net private sector profits and unemployment compensation:

$$r^h = \theta^h (1 - t_\pi)\Pi + b^h (l^{*h} - \bar{l}^h) + \rho^h \tag{7}$$

where Π denotes private sector profits, t_π the profit tax rate, l^{*h} the full employment level of labour supply and b^h the unemployment benefit of household h per unit of unemployment. The solution of the constrained utility maximization problem for household h yields the following commodity demand and labour supply functions:

$$x^h = x^h(q, q^h_l, r^h, \bar{l}^h) \tag{8a}$$

$$l^h = \bar{l}^h(L) \tag{8b}$$

Total consumption of commodity j is given by

$$x_j = \sum_h x_j^h$$

This total consumption will determine the revenue from indirect taxes.

Using (8a) and (8b) we can derive the indirect utility function $v^h\ (q, q_l^h, r^h, \bar{l}^h)$. The following properties of v^h will prove useful:

$$\frac{\partial v^h}{\partial q} = -\phi^h x^h; \qquad \frac{\partial v^h}{\partial r^h} = \phi^h; \qquad \frac{\partial v^h}{\partial \bar{l}^h} = \Psi^h; \qquad \frac{\partial v^h}{\partial q_l^h} = \phi^h l^h \tag{9}$$

Excess supply in the labour market implies that the net wage q_l^h exceeds the reservation wage $\hat{q}^h$, defined as

$$\hat{q}^h = -\frac{\partial u^h / \partial l^h}{\partial u^h / \partial r^h} = \frac{-\Psi^h + \phi^h q_l^h}{\phi^h} \tag{10}$$

The individual indirect utility functions will be introduced in the social welfare function *W*. Distributional considerations will be captured by the concavity properties of the social welfare function and the individual utility functions. They can be represented by the vector β, where

$$\beta^h = \phi^h \left(\frac{\partial W}{\partial v^h} \right) \tag{11}$$

This can be interpreted as the marginal social value of one unit of income accruing to household h. With a utilitarian social welfare function and utility functions, which are linear in income, one gets $\beta^h = 1$, $\forall$ h, i.e., distributional considerations are neglected in the welfare evaluation. At the other extreme, a maximin social welfare function would imply $\beta^h = 0$ for all individuals, except the poorest.

Empirical application

The reference year for our application to the Belgian tax system is 1980[6]. For the indirect tax system, we use a 15 commodities-classification. In Table 1 we give an overview of these commodities. The first column gives the indirect tax rate (composed of VAT and excises) as a percentage of the consumer price and the second column gives the average budget shares in 1980. The tax wedge on labour in the base year is taken to be 0.767 and the (fixed) tax rate on profits is taken to be 0.50.

TABLE 1

Commodity classification

commodities	t	s	e_y	e_q	e_l
food (FOOD)	5.7	.183	0.69**	-0.61**	0.38**
beverages (BEVE)	29.3	.044	1.29**	-0.42**	-0.81**
tobacco (TOBA)	65.1	.016	0.94*	-1.20**	0.06
clothing (CLOT)	14.7	.084	1.67**	-0.81**	0.12
rent (RENT)	1.4	.103	-0.01	-0.07**	-0.08*
heating (HEAT)	7.9	.044	1.59*	-0.30**	0.40
lighting (LIGH)	13.8	.018	0.16	-0.64**	-0.28
durables (DURA)	13.8	.099	2.18**	-0.36**	0.33
maintenance (MAIN)	5.2	.042	1.02**	-0.93**	0.28*
personal care (HYGI)	2.1	.104	0.83**	-0.39**	-0.58**
private transport equipment (BUYT)	21.8	.038	1.71**	-0.73**	-0.40
use private transport (USET)	28.1	.067	0.65**	-0.22*	-0.31*
public transportation (PUBT)	5.7	.011	0.12	-0.80**	0.98**
leisure goods (LEIS)	10.5	.089	0.92**	-0.35**	-0.11
services (SERV)	1.9	.059	0.95**	-0.43*	-0.01

t: indirect tax rate (VAT+excises) as a percentage of consumer price;
s: budget share;
e_y: total expenditure elasticity;
e_q: uncompensated own price elasticity;
e_l: elasticity with respect to rationing variable.

*(**) indicates that the estimated coefficient is greater than (twice) its standard error.

To estimate the revenue from indirect taxes, we need information on aggregate consumer behaviour allowing us to predict the effect of changes in the consumer prices on total consumption x. For this purpose we have estimated a complete demand system for 1953-1988 with National Accounts data, taking into account rationing on the labour market. We compared the results for the Rotterdam, AIDS and CBS-specifications and finally preferred the Rotterdam functional form[8]. The rationing variable is defined as yearly effective man-hours per capita, and hence captures the effect of variations in hours as well as in the rate of unemployment[9]. A likelihood ratio test indicated that including the rationing variable in the demand system increased the fit significantly. To introduce the estimated information in the tax analysis, all estimates of behavioural reactions have been expressed in terms of elasticities and the levels of all variables were calculated (and made consistent) for the year 1980. The last three columns of Table 1 give the income elasticities, uncompensated own price elasticities and elasticities with respect to the rationing variable, all evaluated for 1980.

The evaluation of the marginal welfare cost of the various taxes with a welfaristic and individualistic social welfare function requires additional, *household specific information* on consumption, employment, profit share, unemployment benefit, reservation wage and the efficiency parameters. For our empirical exercise we consider ten households, corresponding to the deciles of the Belgian consumer budget survey. This survey gives us immediately the data on disposable income and consumption: income data are given in the first column of Table 2. On the basis of the budget survey, we can also easily calculate the profit shares θ^h, shown in the second column of the table. The reservation wages are taken to be equal to zero[10].

The most difficult part of the exercise was the construction of employment and efficiency data: these had to be consistent with the production side of the model. Starting from the given distribution of unemployment over the deciles and assuming that full time-employment was proportional to the number of active people in the decile[11], we could derive employment and wage figures from the (given) data on total labour income. Resulting unemployment figures and household efficiency parameters are given in the third and fourth column of Table 2 respectively. The same calibration procedure also yields the level of the unemployment benefits of the different deciles and the efficiency parameters for the different production sectors. We will return to these efficiency parameters in the following section.

TABLE 2

Information about households

decile	disposable income	θ^h	unemployment rate	e^h
1	171 541	.012	.30	0.343
2	270 739	.031	.23	0.562
3	348 663	.061	.16	0.785
4	416 209	.048	.13	0.813
5	486 045	.060	.11	0.844
6	555 656	.044	.13	0.883
7	625 792	.083	.06	0.887
8	704 682	.067	.07	1.010
9	815 619	.176	.05	1.048
10	1 203 589	.420	.03	1.473

θ^h: share of decile in total profits (computed on the basis of the Budget Survey);

e^h: calibrated efficiency parameter.

The *value judgments* incorporated in the parameters β^h should also be made explicit. These are derived from the traditional iso-elastic form of the social welfare function and normalized such that the weight of the poorest decile equals one (see also Ahmad and Stern (1984)). This yields

$$\beta^h = \left(\frac{r^{*h}}{r^{*1}} \right)^{-\varepsilon}$$

where r^{*h} denotes *total income* per equivalent adult[12] of household h and ϵ represents the inequality aversion parameter. We will do sensitivity analysis with respect to this parameter ϵ.

IV. THE PRODUCTION SIDE OF THE ECONOMY

We assume that prices clear the G-1 private goods markets. The government sector sets its price and then supplies what is demanded by the other agents in the economy. There is involuntary unemployment since a non-market clearing wage is determined through bargaining between employers and trade unions.

The *private sector* j first decides on the allocation of total consumption *xj* over imported and domestically produced goods. We follow the standard procedure in general equilibrium modeling (see, e.g., De Melo and Robinson (1985)) and treat each commodity x_j as a composite good which is a function of two varieties: the imported variety m_j with producer price pm_j and the domestic variety d_j with producer price pd_j. The constrained cost minimization problem

$$\min_{d_j, m_j} p_j x_j = d_j pd_j + m_j pm_j \qquad s.t. \qquad x_j = x_j\ (d_j, m_j)$$

yields the following results:

$$\begin{aligned} d_j &= d_j\ (pd_j,\ pm_j, x_j) \\ m_j &= m_j\ (pd_j,\ pm_j,\ x_j) \\ p_j &= p_j\ (pd_j,\ pm_j) \end{aligned} \tag{12}$$

Final demand of domestically produced sector j-goods then equals the sum of domestic demand d_j and exports $ex_j(pd_j,\ \omega)$, where ω is an exogenous (and fixed) indicator of demand conditions on the world market.

Gross output of sector j requires the input of imported resources r_j with price p_r (the numéraire) and of labour l_j with wage cost $e_j p_l$, where e_j is a sector-specific efficiency parameter[13]. Total output y_j is assumed to be a Leontief function of gross output and of domestically produced intermediate goods purchased at a price pd_i, i= 1,...,G. Profits of sector j can then be defined as

$$\Pi_j = pd_j y_j - e_j p_l l_j - p_r\ .\ r_j - \sum_i pd_i a_{ij} y_j \tag{13}$$

where A = $[a_{ij}]$ is the matrix of fixed input-output coefficients. Profit maximization yields the following output supply and input demand functions:

$$y_j = y_j(pd, p_r, e_j p_l) \tag{14a}$$

$$l_j = l_j\,(pd, p_r, e_j p_l) \tag{14b}$$

$$r_j = r_j\,(pd, p_r, e_j p_l) \tag{14c}$$

$$V_{ij} = a_{ij} y_j \tag{14d}$$

where V_{ij} stands for the intermediate goods demand by sector j of the commodity produced by sector i. We also have the following market equilibrium conditions for j=1,...,G-1

$$y_j(.) = d_j(.) + ex_j(pd_j, \omega) + a_{jG} y_G + \sum_{k}^{G-1} a_{jl}\, y_k\,(.) \tag{15}$$

where $y_j(.)$ and $y_k(.)$ are the functions defined in (14a), $d_j(.)$ is the function defined in (12), and y_G is production by the government sector.

The *government* sets the price p_G of commodity G, and production y_G is determined by demand: final demand by households, exports and intermediate demand by private producers

$$y_G = \sum_h x_G^h(q, q_b^h\, r^h, \bar{l}^h) + ex_G(p_G, \omega) + \sum_j a_{Gj}\, y_j\,(pd, p_r, e_j p_l) \tag{16}$$

Note that this good is delivered to households by domestic producers only. Government production requires the input of labour, imported resources and domestically produced intermediate goods. Cost minimisation then leads to the following input demand functions:

$$\begin{aligned} l_G &= l_G\,(y_G, p_r, e_G p_l) \\ r_G &= r_G\,(y_G, p_r, e_G p_l) \\ V_{jG} &= a_{jG} y_G \end{aligned} \tag{17}$$

Empirical application

Since the classification of commodities at the consumer side is not the same as the sectoral classification at the production side, a transition matrix was needed to link both sides. We therefore made use of the work performed by Van Regemorter (1990). Even then, we lack sufficient information at the sectoral level to estimate all behavioural reactions. We therefore resorted to a calibration of the parameters. A part of the relevant information is shown in Table 3. Note that "railways" (closely linked to public transportation in the consumer commodity classification) is the public sector commodity. The last column of Table 3 gives the efficiency parameters, calibrated so as to be consistent with the employment levels and the efficiency parameters for the individual households.

TABLE 3

Production side of the economy

production sector	σ_i	ν_i	e_j
agriculture	1.00	0.40	0.60
energy	0.78	0.53	1.73
metals	0.81	0.48	1.34
chemical sector	5.49	0.52	1.28
machinery	5.62	0.48	1.13
manufacturing of transportation equipment	2.01	0.44	1.14
food	0.03	0.53	1.07
textile	2.20	0.58	0.70
other manufacturing	4.76	0.52	1.04
construction	1.00	0.50	0.96
retailing services	1.00	0.50	0.96
railways	1.00	0.50	1.27
other transport	1.00	0.50	1.12
other services	1.00	0.50	0.91

σ_i: substitution elasticity domestic production-imports (taken from Shiells, Stern and Deardorff, 1986; missing values put equal to 1.00);

ν_i: substitution elasticity primary production factors (taken from Ballard et al., 1985; missing values put equal to 0.50);

e_j: calibrated efficiency parameter.

We assume that the allocation of consumer demand over domestic and imported varieties is based on cost minimization and that each composite commodity can be represented as a CES-aggregate of these varieties. The problem then can be written as

$$\min_{d_i m_i} \quad p_i x_i = d_i pd_i + m_i pm_i$$

$$s.t. \qquad x_i = (\alpha_i m_i^{-\rho i} + (1-\alpha_i) d_i^{-\rho i})^{-\rho i^{-1}}$$

and the functional form for (12) becomes

$$m_i = \left(\frac{pm_i}{\alpha_i p_i}\right)^{-\sigma_i} x_i \qquad\qquad d_i = \left(\frac{pd_i}{(1-\alpha_i)p_i}\right)^{-\sigma_i} x_i$$

$$p_i = \left(\alpha_i^{\sigma_i} pm_i^{1-\sigma_i} + (1-\alpha_i)^{\sigma_i} pd_i^{1-\sigma_i}\right)^{(1-\sigma_i)^{-1}}$$

where $\sigma_i = 1/(1 + \rho_i)$ is the elasticity of substitution between the imported and the domestic variety of commodity i. Values for these elasticities were taken from the study by Shiells, Stern and Deardorf (1986) and, if not available from that source, were taken to be 1. An overview of these figures is given in the first column of Table 3. Given these values of σ_i, the share parameters α_i and all relevant elasticities could be calibrated for the base year 1980. The elasticities of exports with respect to prices are all put equal to -1.

The technology of the production sectors is represented by a Leontief function in domestically produced intermediate goods and in gross output (denoted by yg_i), the latter being a CES-function of labour, capital and imported resources, i.e.,

$$y_i = \min\left(\frac{1}{a_{0i}} yg_i(k_i, l_i, r_i), \frac{1}{a_{1i}} V_{1i}, \ldots, \frac{1}{a_{Gi}} V_{Gi}\right)$$

$$yg_i = \chi_i\left(\gamma_l^i l_i^{-\mu_i} + \gamma_k^i k_i^{-\mu_i} + \gamma_r^i r_i^{-\mu_i}\right)^{-\mu_i^{-1}}$$

$$-1 \leq \mu_i \leq \infty \qquad\qquad \gamma_l^i + \gamma_k^i + \gamma_r^i = 1$$

where $v_i = 1/(1 + \mu_i)$ is the elasticity of substitution in production, assumed to be the same for any pair of inputs. Our theoretical model keeps capital fixed. This implies that within our calibration exercise we have to draw a distinction between the long run (with flexible capital) and the short run (with fixed capital). The share parameters of the complete CES-function are calibrated such that primary input demand by the various sectors can be explained exhaustively for the base year 1980. Otherwise stated, we assumed that the primary factor use in 1980 corresponds to a long run equilibrium and hence solved the following optimization problem, where $\bar{y}_i$ is the given level of production:

$$\min_{k_i, l_i, r_i} \quad p_k k_i + e_i p_l l_i + p_r r_i + \sum_j pd_j a_{ji} \bar{y}_i$$

$$s.t. \; a_{0i} \bar{y}_i = yg_i \, (k_i, l_i, r_i)$$

Again, for given values of the elasticities of substitution v_i, the first order conditions can be used to calibrate the other parameters. Our estimates of these elasticities are based on the results reported in Ballard et al. (1985) and Dixon et al. (1982). They are given in the second column of Table 3.

In the short run, however, with a fixed capital stock $(\bar{k}_i)$, private sector behaviour is described by profit maximization:

$$\max_{y_i, l_i, r_i} \quad pd_i y_i - e_i p_l l_i - p_r r_i - \sum_j pd_j a_{ji} y_i$$

$$s.t. \quad y_i = \frac{1}{a_{0i}} yg_i \, (l_i, r_i; \bar{k}_i)$$

The solution of this problem, together with the calibrated parameters of the production function, then yields empirically identified supply and variable input demand functions. The elasticities derived from these functions have been used in the tax calculations.

As to the public sector (railways), we assume that the government aims at producing a given, demand determined production level at minimal cost:

$$\min_{l_G, r_G} \quad e_G p_l l_G + p_r r_G + \sum_j pd_j a_{jG} \bar{y}_G$$

$$s.t. \quad \bar{y}_G = \frac{1}{a_{0G}} yg_G \, (l_G, r_G; \bar{k}_G)$$

from which the variable input demand functions can be derived in an analogous way.

V. THE LABOUR MARKET

While we have assumed clearing goods markets (15), we feel that wages react more slowly to changing economic conditions and we want to incorporate the possibility of involuntary unemployment. We therefore assume that a non-market clearing wage is determined through bargaining between trade unions and employers. More concretely, we resort to what is known as the "right to manage" model in the literature on trade union behaviour. In this framework, which has been elaborated by Nickel and Andrews (1983) and by Hoel and Nymoen (1988), the firm sets employment unilaterally but the firm and the union together bargain over the wage rate.

Our knowledge on the characteristics of the actual process of wage bargaining is rather limited. We therefore have opted for a very general specification. In De Bruyne and Van Rompuy (1991) it is shown that centralized wage bargaining between the union and the federation of employers results in the following structural wage equation:

$$q_l = q_l\ (L,\ qc,\ \Pi,\ t_l) \tag{18}$$

where $qc = \sum_i s_i q_i$ stands for the consumption price index, s_i being the average budget share of commodity i. It is obvious that our empirical results will crucially depend on the specification used to give operational content to (18). In section VII.C we will compare the results for different specifications of this wage equation.

Empirical application

The reference values for the elasticity of the net wage with respect to its various determinants are taken from the empirical study for Belgium of Van Rompuy, De Bruyne and Van de Voorde (1988) and are given in the first column of Table 4. The second column of Table 4 contains the elasticities for the case where the tax on labour has no effect on the wage cost, i.e., is shifted fully on the net (consumer) wage. The third column gives the elasticities for the opposite extreme case, where the net wage remains constant and the full burden of the tax on labour falls on the wage cost. These three possibilities will be compared in section VII.C.

TABLE 4

Elasticities of the wage equation

elasticity of the net wage with respect to	reference	shifting on net wage	shifting on wage cost
profits	0.2750	0.2750	0.2750
employment	2.1883	2.1883	2.1883
cost of living index	0.6900	0.6900	0.6900
tax on labour	-0.4410	-0.7056	0.0000

Reference values are taken from Van Rompuy, De Bruyne, Van de Voorde (1988).

VI. COLLECTING THE INFORMATION

We can now derive for the model, described in the previous sections, the budget surplus (or deficit) of the government S:

$$S = \sum_i (q_i - p_i)x_i + (p_l - q_l)L + t_\pi \Pi + p_G y_G - e_G p_l l_G - \sum_j pd_j a_{jG} y_G$$
$$-p_R r_G - \sum_h b^h(l^{*h} - \bar{l}^h(L)) - \tilde{G} \tag{19}$$

Revenues derive from indirect taxes on final demand, the tax on labour income, the tax on profits and the operating surplus of government production. Expenditures consist of unemployment allowances and an (exogenously given) amount of public good provision $\tilde{G}$. Total differentiation of (19), making use of (14)-(17) yields:

$$dS = (q - p + w\iota_G)'dx + x'dq + \left(p_l - q_l + \sum_h b^h \frac{\partial \bar{l}^h}{\partial L}\right)dL$$
$$-Ldq_l + t_\pi d\Pi + \left(L - e_G l_G - e_G p_l \frac{\partial l_G}{\partial p_l} - p_r \frac{\partial r_G}{\partial p_l} + w \sum_j a_{Gj} \frac{\partial y_j}{\partial p_l}\right)dp_l \tag{20}$$
$$+\sum_j \left(w \sum_k a_{Gk} \frac{\partial y_k}{\partial pd_j} - y_G a_{jG} - x_j \frac{\partial p_j}{\partial pd_j}\right)dpd_j$$

where 1_G is a vector with all elements equal to zero except the G-th one which is unity, and

$$w = p_G - \sum_j pd_j a_{jG} - e_G p_l \frac{\partial l_G}{\partial y_G} - p_r \frac{\partial r_G}{\partial y_G}$$

is the change in the public sector surplus due to a change in that sector's output.

We can also elaborate the social welfare term along the same lines. Making use of (7), (9), (10) and (11) we can derive

$$dW = \sum_h \beta^h \left[-x^{h\prime} dq + e^h l^h dq_l + \theta^h (1 - t_\pi) d\Pi + (e^h q_l - \hat{q}^h - b^h) \frac{\partial \bar{l}^h}{\partial L} dL \right] \quad (21)$$

As discussed in Drèze ((1985),(1987)), Drèze and Stern (1987) and Van de gaer, Schokkaert and De Bruyne (1993), equation (21) can be related in an intuitive way to the traditional objectives of economic policy: inflation[14], income growth (where labour and profit income are taken separately), employment. The use of the β vector makes it possible to integrate distributional considerations and macroeconomic objectives in a consistent welfarist framework.

Equations (20) and (21) give a more concrete content to the elements in the marginal welfare cost formula (3). The model in the previous sections is a concrete example of $F(z, t) = 0$ in (1). The vector of endogenous variables z consists of $(x, q, L, \Pi, p_l, q_l, pd)$. The effect of changes in the tax instruments on these variables can be found by solving the (linearised form) of the complete model, as given in (2).

VII. RESULTS

To get a better insight into the structure of the results with respect to the marginal welfare cost of taxation, it is useful to look first at some elements of the matrix of tax multipliers *(dz/dt')*, as given in eq. (2). In Table 5, we give the multipliers of the (own) consumer prices, the government budget, profits and employment with respect to changes in the tax rates. Cross-effects on prices are negligible for the indirect tax rates. It is obvious that there are important differences between the effects of different tax rates on the government budget and on employment and profits. An increase in the tax rate on tobacco, for instance, hardly increases government revenue. The most striking feature of the results, however, is that producer prices and wage costs are nearly fixed. While this is often stated as an assumption in tax calculations, in our case it follows from the solution of our complete general equilibrium model[15].

TABLE 5

General equilibrium multipliers

TAX RATE	MULTIPLIER EFFECT ON			
	consumer price	**profits**	**employment**	**budget**
FOOD	0.95	-91968	-158782	260850
BEVE	1.00	-33579	- 27290	32106
TOBA	1.00	-10439	- 19954	513
CLOT	1.00	-50064	- 65106	99013
RENT	0.97	-52557	- 93301	155877
HEAT	0.99	-28874	- 34388	57684
LIGH	0.99	-20882	- 3037	16217
DURA	1.00	-60228	- 79693	122327
MAIN	0.99	-23484	- 35766	56077
HYGI	0.96	-51551	- 98666	163680
BUYT	1.00	-29230	- 24401	34319
USET	1.00	-40962	- 49958	57401
PUBT	0.99	- 449	- 16521	27894
LEIS	1.00	-56064	- 66691	103393
SERV	0.96	-28590	- 57997	91891
LABOUR	-0.95	-1299000	-1792000	3365317

Profits: in millions of Belgian francs;
Employment: hours per year worked in 1000^5;
Government budget: in millions of Belgian francs;
Producer prices: normalised (=1 in the base year). Consumer prices are obtained by means of equation (4).

A. *Results for* $\epsilon = 1.5$

Table 6 shows the results for a case of intermediate inequality aversion $\epsilon = 1.5$ (a reasonable value, if one believes the argumentation in Stern (1977)). The upper part of the table gives the values calculated

TABLE 6

Results for ϵ=*1.5*

TAX ON	**MC_i**	**inflation**	**net wage**	**profits**	**employment**
FOOD	**1.07**	0.96	-0.06	0.11	0.06
BEVE	**1.57**	1.36	-0.19	0.31	0.09
TOBA	**20.63**	17.62	-5.28	6.08	2.22
CLOT	**1.14**	1.02	-0.10	0.15	0.07
RENT	**1.00**	0.86	-0.02	0.10	0.06
HEAT	**1.12**	0.95	-0.04	0.15	0.06
LIGH	**1.70**	1.69	-0.39	0.38	0.02
DURA	**1.05**	0.89	-0.05	0.15	0.07
MAIN	**1.06**	0.90	-0.04	0.13	0.07
HYGI	**0.96**	0.81	-0.01	0.09	0.06
BUYT	**1.30**	1.12	-0.15	0.25	0.07
USET	**1.32**	1.16	-0.15	0.21	0.09
PUBT	**0.64**	0.56	0.02	0.00	0.06
LEIS	**1.17**	1.03	-0.08	0.17	0.07
SERV	**0.93**	0.74	0.03	0.09	0.07
LABO	**0.98**	-0.08	0.89	0.12	0.05

RANKINGS:

TOBA	TOBA	LABO	TOBA	TOBA
LIGH	LIGH	SERV	LIGH	USET
BEVE	BEVE	PUBT	BEVE	BEVE
USET	USET	HYGI	BUYT	BUYT
BUYT	BUYT	RENT	USET	CLOT
LEIS	LEIS	MAIN	LEIS	DURA
CLOT	CLOT	HEAT	CLOT	LEIS
HEAT	FOOD	DURA	HEAT	MAIN
FOOD	HEAT	FOOD	DURA	SERV
MAIN	MAIN	LEIS	MAIN	FOOD
DURA	DURA	CLOT	LABO	RENT
RENT	RENT	USET	FOOD	HEAT
LABO	HYGI	BUYT	RENT	HYGI
HYGI	SERV	BEVE	HYGI	PUBT
SERV	PUBT	LIGH	SERV	LABO
PUBT	LABO	TOBA	PUBT	LIGH

for (3) and the breakdown according to the four terms in (21). As argued before, these terms correspond to inflation, labour income, profit income and employment respectively. The lower part of the table ranks the different taxes according to their overall marginal welfare cost and according to their effect on the relevant variables of the social welfare function.

The results speak for themselves. A welfare improving tax reform could consist of a lowering of tax rates for tobacco, lighting and beverages with a compensating increase for public transportation, services and personal care. The marginal welfare cost of taxing tobacco is particularly high. To understand this result, one should take into account the high excises currently existing in Belgium for tobacco and alcoholic beverages (see Table 1). These excises are probably justified by external effects or merit good considerations. Since we have completely neglected (de)merit effects in our analysis, it is not surprising that this analysis leads to the result that the existing taxes on tobacco are too high[16]. One should also remember that public transportation is the public sector good, appearing directly in the government budget constraint (19) and (20).

A comparison of the different columns in Table 6 immediately shows that the overall ranking of welfare costs is dominated by the consumption price effect. This was to be expected since consumption prices are immediately and directly affected by a change in indirect taxes. Only two adjustments are needed to go from the ranking in the inflation column to the ranking of the total costs. The tax on food switches with the tax on heating, due to the effect on profits. The tax on labour is costly mainly because its effect on net wages. However, the observation of a high correlation between the welfare costs and their inflation components does not mean that the calculation of the general equilibrium effects does not matter: the marginal welfare costs heavily depend on the budget effects and it has already been shown in Table 5 that these strongly differ for different commodities.

B. *The effects of changing* ϵ

Table 7 gives the results for the marginal welfare costs for different values of ϵ. It is remarkable that the taxes on tobacco, lighting and beverages have a relatively high marginal welfare cost, whatever the degree of inequality aversion. This implies that there can almost be consensus about the welfare improving effect of a decrease in these tax rates (if one neglects the externality component mentioned in the previous subsection).

TABLE 7

Sensitivity analysis with respect to ϵ*: rankings and welfare costs*

$\epsilon=0$	$\epsilon=1$	$\epsilon=1.5$	$\epsilon=2$	$\epsilon=4$	$\epsilon=9$	$\epsilon=16$
TOBA/30.7	TOBA/23.5	TOBA/20.6	TOBA/18.2	TOBA/11.6	TOBA/4.68	TOBA/3.10
LIGH/2.53	LIGH/1.94	LIGH/1.70	LIGH/1.51	LIGH/0.96	LIGH/0.41	LIGH/0.20
BEVE/2.36	BEVE/1.79	BEVE/1.57	BEVE/1.39	BEVE/0.87	BEVE/0.36	HEAT/0.17
BUYT/2.13	BUYT/1.53	USET/1.32	USET/1.15	USET/0.68	HEAT/0.31	BEVE/0.17
USET/2.06	USET/1.53	BUYT/1.30	BUYT/1.11	HEAT/0.66	FOOD/0.26	FOOD/0.13
LEIS/1.81	LEIS/1.35	LEIS/1.17	LEIS/1.03	LEIS/0.62	USET/0.23	RENT/0.11
CLOT/1.75	CLOT/1.31	CLOT/1.14	HEAT/1.00	BUYT/0.62	LEIS/0.23	MAIN/0.11
MAIN/1.64	HEAT/1.26	HEAT/1.12	CLOT/1.00	FOOD/0.61	RENT/0.23	HYGI/0.10
DURA/1.64	MAIN/1.22	FOOD/1.07	FOOD/0.95	CLOT/0.60	CLOT/0.22	LEIS/0.10
HEAT/1.63	DURA/1.21	MAIN/1.06	MAIN/0.92	MAIN/0.56	MAIN/0.22	CLOT/0.09
LABO/1.58	FOOD/1.21	DURA/1.05	DURA0.91	RENT/0.56	HYGI/0.21	SERV/0.09
FOOD/1.57	LABO/1.14	RENT/1.00	RENT/0.88	DURA/0.55	SERV/0.20	USET/0.08
RENT/1.51	RENT/1.41	LABO/0.98	LABO/0.84	HYGI/0.53	DURA/0.19	DURA/0.07
HYGI/1.43	HYGI/1.09	HYGI/0.96	HYGI/0.84	SERV/0.51	BUYT/0.1]	PUBT/0.06
SERV/1.40	SERV/1.06	SERV/0.93	SERV/0.81	LABO/0.48	LABO/0.14	BUYT/0.04
PUBT/0.97	PUBT/0.73	PUBT/0.64	PUBT/0.56	PUBT/0.35	PUBT/0.14	PUBT/0.04

For other commodities there are important changes, however, and they go in the expected direction. A higher degree of inequality aversion leads to a relative increase in the marginal welfare cost of taxing heating, food and rent and to a relative decrease in the welfare cost of taxing private transportation (both purchases and use) and labour. The divergence between the results for private transportation and heating points to the difficulties attached to an overall policy of energy taxation.

C. *The importance of the process of wage formation*

Tables 6 and 7 seem to suggest that increasing the tax on labour would entail a relatively low welfare cost. This may seem surprising, as it goes directly against the widely heard opinion that Belgium should reorient its tax structure partly from direct to indirect taxation. Our conclusion has to be interpreted carefully, however. Indeed, it depends crucially on the assumptions made about tax shifting in the wage formation process. Consider the three possible cases summarized in Table 4. The first column gives the elasticities for the reference solution as described in the previous tables. The second reflects the assumption that the tax on labour is fully shifted on the net wage. The third implements the other extreme assumption that the burden of the labour tax is borne completely by the wage cost.

Changing the assumptions about the shifting of the labour tax in the wage formation process of course has no influence at all on the welfare cost of the various indirect tax rates, but only matters for the relative ranking of the labour tax itself. This relative ranking for the different shifting assumptions is shown in Figure 1. It is clear that the (relative) welfare cost of taxing labour is much higher when the tax burden falls on the wage cost. In the latter case, we have strong effects on employment and profits, as shown by the relevant multipliers in Table 8. Therefore the increase in government revenue is much lower in this case. These general equilibrium effects largely dominate the direct net wage-component in the social welfare calculations.

FIGURE 1

Ranking of the welfare cost of the labour tax

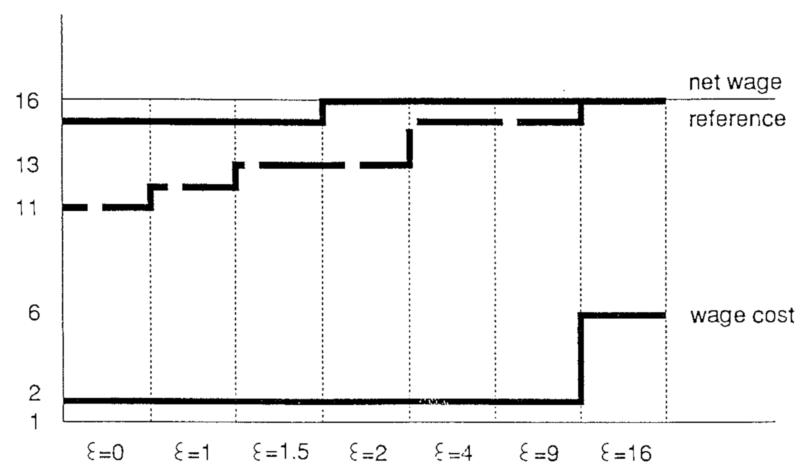

TABLE 8

General equilibrium multipliers of the tax on labour

EFFECT ON:	Reference solution	Shifting on net wage	Shifting on wage cost
net wage	-0.95	-1.10	-0.70
profits	-1 299 000	551 070	-4 383 000
employment	-1 792 000	-712 059	-3 592 000
budget	3 365 317	4 592 907	1 319 333

It then turns out that the characteristics of the wage formation process are crucial to evaluate the trade-off between direct and indirect taxes. At present, our knowledge of this process is rather limited. More empirical research is needed before we can take a firm position in this debate.

VIII. CONCLUSION

In this paper, we presented a general theoretical framework that enabled us to evaluate marginal tax reforms, thereby integrating macroeconomic objectives and normative judgements. The crucial and novel feature of our approach is the modelling of endogenous wages and producer prices, and the introduction of taxes on labour income. Prices clear the goods markets and wages result from a bargaining process between trade unions and employers, capturing at least one potential reason for the occurrence of involuntary unemployment. Some interesting results are worthwhile recapitulating.

First, for a subset of indirect taxes, the ranking of the marginal welfare costs is robust and rather insensitive to the degree of inequality aversion. As a consequence, there certainly exist welfare improving marginal tax reforms on which people with different normative judgments can easily reach a consensus.

Second, our analysis has pointed out the importance of tax shifting in the process of wage determination. The welfare ranking of a tax on labour income versus an extensive set of indirect tax rates is highly dependent on this degree of tax shifting. This implies that considerably more attention should be devoted to the aspect of wage formation, especially if one wants to take a stand in the debate on the optimal mix of direct and indirect taxes. In the present state of our empirical knowledge, it is difficult to answer the question whether a shift from direct to indirect taxes would be welfare-improving.

Third, for the indirect taxes we found a high correlation between the rankings of the marginal welfare costs and of their inflation components. The "employment"-component in the marginal welfare cost is rather small and does not vary much over the different commodities. Therefore the effects on unemployment seem to be a less important factor in the determination of the optimal indirect tax structure.

Of course, the data being what they are, caution is needed with the interpretation of these results. Many questions can be raised concerning the empirical application, which we have documented quite extensively in this paper. Sometimes our calibration has been quite ad hoc. The effective profit tax rate is certainly lower than the one that we used in our simulations; the importance of the objectives other than inflation might become more important in case this profit tax rate is lowered. The same holds for the construction of household specific data on efficiency parameters, employment and unemployment benefits since these are crucial in determining the weight attached to the employment and labour income objectives in the welfare function. More empirical (and data collection) work is needed to improve the reliability of our findings.

There are also some remaining theoretical weaknesses. (De)merit good effects have been neglected. The static character of our exercise (with capital fixed) is a severe limitation. Moreover, it would be interesting to replace our assumption of market clearing prices with the more general assumption of price setting behaviour, possibly linked with a more elaborate model of international competition at home and in foreign markets. It is not a priori obvious that the general equilibrium tax multipliers for such more general model would be similar to the ones presented in this paper.

For all these reasons we emphasize that it would be dangerous to draw immediately strong policy conclusions from our analysis. However, we feel that our approach shows an interesting way to integrate macroeconomic and welfare considerations into tax analysis. Moreover, our analysis offers clear suggestions about the priorities for further empirical research.

NOTES

1. The basic reason for this problem is that one needs the functional forms to simulate situations which may be far removed from the range of actual observations.
2. The case of clearing goods markets with a labour market in disequilibrium has already been analysed by Drèze (1985) and by Marchand, Pestieau and Wibaut (1989). In their model, however, the wage is fixed. Van de gaer, Schokkaert and De Bruyne ((1992),(1993)) compare the results for different general equilibrium specifications of the economy and show that the specification of the general equilibrium model has a crucial influence on the marginal welfare costs.
3. The price of imported resources (to be introduced later) is the numéraire.
4. Later in the analysis we will also introduce a profit tax with a rate t_π. This profit tax rate is kept fixed and not included in the welfare analysis.
5. We assume that changes in total employment continuously affect the employment of all household (see also Drèze (1985)). It would have been more realistic, but analytically less convenient, to assume that some households become fully unemployed while others keep a full-time job.
6. For the empirical application we have to combine data on household behaviour and on the input-output-structure of the economy. The year 1980 is the most recent year for which this is possible.
7. This is the figure used by the Belgian Planning Office. Note that the tax wedge in our model includes the social security contributions.
8. All estimations were made with the DEMMOD-computer program, constructed by A.P. Barten. The differences between Rotterdam and CBS were rather small, while with AIDS there were problems with the negativity of the Slutsky-matrix. See Decoster and Schokkaert (1990) for a comparison of the results of tax reform analyses with the different demand systems.
9. Our definition of the rationing variable differs from the one used by Wibaut (1987), in that he uses the number of hours per employed person, thereby neglecting changes in employment.
10. Even then, it will turn out that the employment component plays only a minor role in the welfare evaluation of the different tax rates.
11. Of course, for this exercise we considered the unemployed as active. As non-active were considered the retired people, the invalids, the conscripts.
12. We use the equivalence scales from the Consumer Budget Survey.
13. Capital is fixed in our model: however, there are possibilities of substitution in production between labour and imported resources.
14. It is perhaps somewhat confusing to talk about inflation in a model without money. What we basically observe is an index of changes in relative prices, where the numéraire good is imported resources.
15. This does not imply that the assumption of price flexibility foes not influence the results and that we could as well have stuck to a Wibaut-type model: the increased price flexibility has a strong impact on profits and on the revenue effects of the tax changes (see Van de gaer, Schokkaert and De Bruyne (1993)).
16. In Decoster and Schokkaert (1989), an attempt has been made to integrate these effects into a marginal reform analysis of the Belgian tax system.

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