Do EU15 countries compete over labour taxes?

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Abstract

Because of the high international mobility of firms, empirical research on international tax competition has mainly considered corporate taxation. Competition in labour taxation tends to be overlooked, Altschuler and Godspeed (2003) being the exception. We see three arguments why this may be unjustified. First, the tax base in labour taxation is the wage mass, which depends on employment. While labour is largely internationally immobile, jobs are not, because of the international mobility of goods or firms (capital). Second, corporate taxation represents a much smaller share of total taxation compared to labour. Hence, labour tax competition could have more important consequences for the provision of public goods or income redistribution than corporate tax competition. Third, ongoing economic integration raises the concern that, on the one hand, the demand for income redistribution or social spending would increase but, on the other hand, the ability of the government to raise taxes to this aim may be constrained. Increased taxation of immobile production factors is considered as the “synthesis” of this dilemma. This may be obstructed if in addition, trade liberalisation implies strategic tax setting in labour taxation.

We model the possibility of labour tax competition using a standard Dixit-Stiglitz two-country model with transportation costs in exporting goods, to which we add the assumption of non-clearing labour markets and income redistribution by the government, financed by a tax on labour income. Based on this model, we derive an empirical specification of the labour tax reaction function, which is subsequently estimated for the EU15 member states, using two sources of data: effective labour tax wedges and implicit labour tax rates for. The tax reaction function is specified as a spatial lag panel and is estimated using an instrumental variable approach, in which the one and two period spatially lagged explanatory variables are used as instruments. We define four different weight matrices of the spatially lagged dependent variable of which the elements are a combination of the inverse of the distance between major cities and the number of years of common EU membership.

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Using the implicit tax rates as the empirical proxy of the dependent variable, the spatial lag coefficient is not significant. However, the estimation results are in contradiction with the theoretical expectations for almost all the control variables and the common findings in the literature, which questions the adequacy of the use of implicit tax rates as empirical proxy. In the estimations using the effective tax wedges, we obtain a significant positive effect of the spatially lagged dependent variable for all the considered weight matrices and with correct signs of almost all the significant control variables. We re-estimate a model with a weight matrix composed of uniform elements, i.e. a specification consistent with yardstick competition or common intellectual trends as explanation of the spatial interaction effect. In this specification, the coefficient of the spatially lagged dependent variable is not significant. Our results point to the presence of small but significant competition over labour taxes within the EU15 countries.

1 Introduction

Whereas in the past, the empirical research on tax competition considered almost exclusively the local or regional policy level (see Brueckner, 2003), in the last ten years an increasingly number of studies concern tax competition between countries, in particular within the EU. These studies consider the question whether tax rates at the national level are strategically set, as a consequence of market integration and the removal of barriers to factor mobility.

Because of the high international mobility of firms (capital) relative to workers, empirical research on international tax competition has almost exclusively considered corporate taxation, in line with the definition of Wilson and Wildasin (2004) of tax competition as "...noncooperative tax setting by independent governments under which each government's public choices influence the allocation of a mobile tax base among 'regions' represented by the governments...", in short "competition for mobile factors". Competition in taxation of immobile production factors is neglected in almost all the (theoretical and empirical) studies, Altshuler and Goodspeed(2003) being one of the exceptions as regards the empirical analysis and Andersen (2003) as regards the theoretical analysis. However, we see three arguments why the analysis of tax competition should be extended to the taxation of labour, even if it is a to a large extent immobile production factor¹.

- The tax base of labour taxation is the wage mass, which depends on employment. While labour is not mobile, jobs are, as a consequence of goods or capital mobility. To the extent that jobs mobility depends on production costs, labour taxation will influence the allocation of jobs.

- Corporate taxation represents only a limited share of government revenue in the industrialised countries. Hence, even in the presence of corporate tax competition, resulting in a suboptimal level of corporate taxation, the

¹See also Andersen (2003) for similar arguments
effects on the level of provision of public goods or on the distortion of the tax structure could remain rather small. On the other hand, given its weight in government finance, the welfare consequences of labour tax competition could be by far more considerable.

- Taxation of immobile production factors is seen as the possible synthesis of the "compensation" and the "efficiency" hypothesis concerning public spending (social security spending in particular) and globalisation. Since Rodrik (1997), the relation between globalisation and social protection is considered in terms of two contradicting tendencies. On the one hand, globalisation may increase the risk of unemployment and income inequality and hence, the demand for social spending as compensation or insurance. On the other hand, globalisation may constrain the government in raising the necessary funds for social compensation because of the increased capital mobility it implies. The "synthesis" of the two hypotheses is therefore a higher taxation of immobile production factors (labour). Yet, this synthesis would be obstructed if in addition globalisation would imply the strategical setting of taxation rates on labour.

We notice two strands in the literature as regards the empirical relation between economic integration and tax policy at the national level. First, studies that attempt to estimate tax reaction functions and second, studies that analyse the effect of globalisation (proxied by an openness indicator) on tax receipts or on public (social) spending. This difference almost parallels the distinction in the literature between the analysis of corporate taxation (using the reaction function approach, e.g. Devereux et al. 2008, Bénassy-Quéré et al 2007, Casette and Paty 2008) and the analysis of social spending (using the globalisation impact approach, e.g. Rodrik 1997, Bretscher and Hettich 2002, Dreher 2006, Garrett and Michell 2001, Hauffer et al. 2009).

Given its better link with a structural model of tax competition and hence its better theoretical foundation, we prefer the first approach. Therefore, we estimate labour tax reaction functions of the EU15 countries in a spatial econometrics framework. We concentrate the analysis on the EU for three reasons. First, because of the far-reaching economic integration of the goods as well as of the capital markets in this area in the last decades. Second, because of the comparison with the existing literature this allows: the estimation of (corporate) tax reaction functions at the country level mainly concerns this area. Third, given the relevance of the question for economic policy in the EU, where tax competition and the threat of race-to-the-bottom tax dynamics is intensively debated.

In the next section, we give a brief presentation of the theoretical background on which the analysis is based and which is used to define the elements of the spatial weight matrix in the estimations. In the third section, we discuss the

\footnote{In 2007, at the level of the EU15, taxes on labour represented about 45% of total taxation (based on European Commission, 2009)}
empirical model specification and the data used to estimate the model. In the fourth section, the estimation methodology and the estimation results are dealt with. Finally, in the fifth section, we draw our conclusions.

2 Theoretical background

To our knowledge, the theoretical literature on competition in the taxation of (immobile) labour is quite limited. Andersen (2003) seems one of the few who analyses this issue. We consider the possibility of competition in labour taxation using a standard Dixit-Stiglitz two-country framework with transportation costs in exporting goods, to which we add the assumption of non-clearing labour markets and the possibility of equilibrium unemployment. In this framework, tax competition is intuitively conceivable as follows. Because of unemployment, the government may want to redistribute income by providing unemployment allowances that are financed by a tax on labour. The labour tax affects the wage cost and hence the output prices and the market shares of the firms. The firms’ market shares determine production and employment. Assuming that the government considers the foreign tax rate as independent from its decisions, it will set a tax rate below the pareto optimum, because it doesn’t take into account the consequences of its tax decisions on foreign social welfare. This results in tax rates which behave as strategic complements.

More formally, based on Rayp and Vanbergen (2009), we use a modified version of the footloose capital (FC) model of Martin and Rogers (1995) in which we include unemployment via efficiency wages and an optimizing government that provides unemployment benefits. There are two regions, north (N) and south (S), symmetric in terms of consumers’ tastes, technology, openness to trade and factor supplies. Each region is endowed with a fixed number of immobile consumers $L$. As is custom in a FC-setting, we assume that each region has half of the worldwide capital endowment ($K_W$): $s_K = \frac{K}{K_W} = \frac{1}{2}$. The north (south) produces $n_N$ ($n_S$) units of differentiated goods under increasing returns to scale using a linear technology. Because we consider symmetrical regions, $n_N = n_S = n$ and hence $s_N = \frac{n_N}{n_W} = \frac{n_N}{(n_N + n_S)} = \frac{1}{2}$. More specifically, we assume that the production of each kind of variety $i$ ($i = N,S$) requires a fixed amount $k$ (= 1) of capital and a variable unit input requirement involving $\frac{1}{a(w_i)}$ units of labour $l_i$. $a(w_i)$ indicates the worker’s effort as function of the wage received. The total output of a firm $x_i$ equals $a(w_i)l_i$ and the total cost function for a variety $i$ is equal to $\pi_i + l_iw_i$, with $\pi_i$ and $w_i$ respectively are equal to the reward to capital and to labour. The export of goods is inhibited by iceberg type of trade costs which imply that $\tau$ ($> 1$) units have to be shipped to get one unit at destination. Market clearing implies that the total production of a (northern) firm $x_N$ is equal to the sum of the total consumption of the good in the north $C_{NN}$ and the consumption of its good in the south $C_{NS}$ multiplied by the trade costs: $x_N = C_{NN} + \tau C_{NS}$.
2.1 Consumers’ choice

The constrained optimization problem for a typical northern consumer with an expenditure level \( e \) who consumes an amount \( c_i \) (at the price \( p_{iN} \)) of a good \( i \) is given by:

\[
U = \left( \int_0^{n_{N} + n_{S}} c_i^{\frac{\sigma - 1}{\tau}} \, di \right)^{\frac{1}{\tau}}, \quad \text{s.t.} \quad \int_0^{n_{N} + n_{S}} p_{iN} c_i \, di = e. \tag{1}
\]

Standard utility maximization and aggregating the \( j \) consumers’ demand lead to the following result for the northern market demand of a variety \( i \)

\[
C_{iN} = \left( \frac{p_{iN}}{P_N} \right)^{-\sigma} \left( \frac{E_N}{P_N} \right). \tag{2}
\]

where \( E_N \) stands for the total northern expenditures and \( P_N = (\int_0^{n_{N} + n_{S}} p_{iN}^{1-\sigma} \, di)^{\frac{1}{1-\sigma}} \) is the northern price index.

2.2 Producers’ choice

Under the Chamberlinian large group assumption profit maximization with respect to the price that a northern firm applies in the north \( p_{NN} \) and in the south \( p_{NS} \), leads to the typical Dixit-Stiglitz monopolistic competitive price that is a fixed mark-up over marginal labour costs:

\[
p_{NN} = \frac{\sigma}{\sigma - 1} \frac{w_N}{a(w_N)}, \quad p_{NS} = \frac{\sigma}{\sigma - 1} \frac{w_N}{a(w_N)} \tau = \tau p_{NN}. \tag{3}
\]

Similar mill pricing applies for the prices charged by southern firms. Based on these expressions, we can work out the (northern) price index:

\[
P_N = \alpha \left( \frac{w_S}{a(w_S)} \right) \left( \frac{\epsilon + \phi}{2} \right)^{\frac{1}{\tau}} = \alpha \frac{w_S}{a(w_S)} \Delta_N^{\frac{1}{\tau}}, \tag{4}
\]

with \( \alpha = \frac{\sigma}{\sigma - 1} \frac{1}{a(w)} \phi \). \( \phi = \tau^{1-\sigma} \) represents the well-known freeness of trade and \( \epsilon = \left( \frac{w_N}{a(w_N)} \right)^{1-\sigma} \) is a function of the relative unit production cost \( \frac{w_N}{a(w_N)} \). When the north has lower (higher) production costs than the south, \( \epsilon \) is larger (smaller) than 1. So \( \epsilon \) can serve as a measure of the competitiveness of the northern region versus the southern region. We also introduced the short-hand notation\(^3 \Delta_N \).

In a next step we determine the sales of a firm in function of the share of expenditures \( s_E \). The total sales of a northern firm \( S_N \) equals the sum of his sales in the north \( (p_{NN}C_{NN}) \) and the sales in the south \( (p_{NS}C_{NS}) \). Using (3) and (2) it is easily derived that the northern sales equals:

\[
S_N = \frac{E_W}{a_W} \left[ \frac{s_E}{\Delta_N} + \frac{\phi(1 - s_E)}{\Delta_S} \right] = \frac{E_W}{a_W} B_N, \tag{5}
\]

\(^3\text{Similarly to } \Delta_N, \text{ we also define } \Delta_S = \left( \frac{1 + \epsilon \phi}{2} \right) \)
This result and our technology assumption lead to a very simple expression for the northern operating profit $OP_N = SN - w_Nl_N = \frac{E_W}{\sigma W} B_N$. Since physical capital is only used in the fixed cost component of industrial production (and $k = 1$), the operating profit of a typical variety is also equal to the reward to capital\(^4\).

$$\pi_N = \frac{E_W}{\sigma W} B_N = \frac{E_W}{\sigma W} e \left[ \frac{s_E}{\Delta_N} + \phi(1 - s_E) \right].$$ \hspace{1cm} (6)

### 2.3 Labour market and share of expenditures

We introduce unemployment via efficiency wages, where the delivered effort by a worker is positively correlated with the difference between the net wage $w_N(1 - z_N)$ and a reference wage $w_R$ (Stiglitz 1976, Summers, 1988):

$$a(w_N) = (w_N(1 - z_N) - w_R)^\beta,$$

in which $z_N$ represents the tax rate set by the northern government on the gross wage $w_N$. The strength of the productivity enhancing effect of higher wages is characterized by $\beta$ and lies between 0 and 1. The reference wage $w_R$ represents the outside option for the worker.

(Northern) Firms determine the wage $w_N$ employees receive by maximizing their profit. The first-order condition resulting from this optimization is the well-known Solow condition (Akerlof and Yellen, 1986) that states that the elasticity of the efficiency function with respect to the wage equals one:

$$w_N \frac{\partial a(w_N)}{\partial w_N} = 1.$$ \hspace{1cm} (8)

The firm keeps hiring additional people as long as the wage per unit of effort is falling. Substituting (7) in (8) leads to the wage paid to northern employees $w_N$:

$$w_N = \frac{w_R}{(1 - \beta)(1 - z_N)}.$$ \hspace{1cm} (9)

A similar expression holds for the southern region. Net wages are invariant to tax rates and only depend on the efficiency enhancing effect and the reference wage. Hence, for given reference wages and productivity parameter(s), the competitiveness variable $\epsilon$ and the relative product prices will only depend on the tax decisions of the governments and the trade freeness $\phi$.

The amount of labour each firm employs is easily derived from the zero pure-profit condition as $l_N = \frac{(\epsilon - 1)\pi_N}{w_N}$. Assuming that all inhabitants of a region (inelastically) supply labour and confining our analysis to situations labour supply exceeds demand, we can write the unemployment rate as $u_N = 1 - \frac{\pi_N}{L}$, which equals, using the definition of the amount of labour each firm employs $l_N$ and the wage $w_N$:

$$u_N = 1 - \frac{(\sigma - 1)(1 - \beta)w_N}{L w_R} (1 - z_N) \pi_N.$$ \hspace{1cm} (10)

\(^4\)Southern capital reward equals $\pi_S = \frac{E_W}{\sigma W} B_S = \frac{E_W}{\sigma W} \left[ \frac{s_E}{\Delta_N} + \frac{(1 - s_E)\phi}{\Delta_S} \right]$.
Next, we determine the share of expenditures $s_E$. There are no savings, which implies that the total expenditures of a region is equal to its total income. We distinguish two components of the regional income: the income of the employed and unemployed, and the total capital reward. The combined (northern) income of labourers and unemployed is equal to $T_{LRN} = n_l N w_N (1 - z_N) + (L - n_l N) b_N$, in which $b_N$ stands for the northern unemployment benefit. Applying the balanced budget restriction of the government and the expression for the employment level in a northern firm, $l_N \equiv \frac{(\sigma - 1) \pi_N}{w_n}$, allows us to rewrite $T_{LRN}$ in terms of the northern capital reward:

$$T_{LRN} = n_l N w_N = (\sigma - 1) \frac{w_n}{2} \pi_N.$$  

(11)

The second component of total regional income is the capital reward that accrues to the residents of a region. Under the assumption of Martin and Rogers (1995) that half of the capital used in each region belongs to the northern capital owners regardless of $s_N$, each unit of capital earns the world average reward to capital $ACR_N = \frac{TCR_N + TCR_S}{K_w}$, with $TCR_N = n \pi_N$ ($TCR_S = n \pi_S$) the total northern (southern) capital reward. Substituting the expressions for the capital reward in $ACR_N$ and multiplying this with the total number of units of capital owned by the north, $K$ gives us the following result for total (northern) capital reward:

$$TCR_N = \frac{E_{W}}{2 \sigma}.$$  

(12)

Given both components of income (or expenditures) in a region and using (6), the share of expenditure is easily derived as:

$$s_E = \frac{TCR + TLR}{E_W} = \frac{1}{2 \sigma} (1 + (\sigma - 1) B_N).$$  

(13)

Substituting $B_N$ by (5) and solving for $s_E$ gives a closed-form expression for the northern share of expenditures:

$$s_E = \frac{(\epsilon + \phi) ((2 \sigma - 1) \epsilon \phi + 1)}{2 \left[ \sigma (\epsilon + \phi) (1 + \epsilon \phi) - \epsilon (\sigma - 1) (1 - \phi^2) \right]}.$$  

(14)

(14) implies that (for given demand elasticity and efficiency wage parameters) the expenditure share will only depend on the tax rates and the trade freeness. Hence, in particular from (6) and (10), it follows that all the variables in the model are determined by the taxation decisions in the two countries and the trade freeness.

### 2.4 Redistribution and tax competition

For simplicity, the amount of taxes is determined by maximizing an ad hoc social welfare function in which the indirect utility of the unemployed is given a relative weight $\gamma$ with respect to the employed. In our model there are two individual sources of (real) income: labour income or unemployment benefits.
and capital rewards. To simplify the model, we assume that the capital rewards are evenly distributed between each individual whether he or she is employed or unemployed. The (northern) social welfare function becomes:

$$SW_N = (1 - u_N)(\frac{w_N (1 - z_N) + ACR_N}{P_N}) + \gamma u_N(\frac{b_N + ACR_N}{P_N})$$  \hspace{1em} (15)$$

After substituting the expressions for the northern profit \(6\), the northern share of expenditures \(14\), the budget constraint of the government \(u_N b_N = z_N (1 - u_N) w_N\) and ignoring the capital reward part of the indirect utility (since it is a constant), the social welfare function is just a function of the northern and southern tax rate:

$$SW_N = \frac{(1 - u_N) w_N (1 + (\gamma - 1) z_N)}{P_N}$$  \hspace{1em} (16)$$

After some straightforward transformations, the optimal northern tax rate follows from the first order condition:

$$\frac{\partial SW}{\partial z_N} \bigg|_{z_S=\text{cte}} = 0 \iff (\gamma - 1) + (1 + (\gamma - 1) z_N) \left( \frac{1}{\pi_N} \frac{\partial \pi_N}{\partial z_N} \right) = 0,$$

which represents the northern tax reaction function (in implicit form).

The slope of the reaction function follows from the total differentiation of (17):

$$d \left( \frac{\partial SW_N}{\partial z_N} \right) = \frac{\partial^2 SW_N}{\partial z_N^2} \frac{\partial z_N}{\partial z_S} + \frac{\partial^2 SW_N}{\partial z_N \partial z_S} = 0 \iff \frac{\partial^2 SW_N}{\partial z_N \partial z_S} = -\frac{\partial^2 SW_N}{\partial z_N^2}$$  \hspace{1em} (18)$$

Tax competition, i.e. tax rates that are strategic complements, will occur when \(\frac{\partial^2 SW_N}{\partial z_N \partial z_S} > 0\).

3 Empirical methodology and data

3.1 Econometric specification

We obtain an empirical specification from the theoretical model as a first order Taylor expansion at the Nash equilibrium. In addition, we allow for more than two countries and introduce control variables for other determinants than strategic interaction which may determine the equilibrium labour tax rate. The basic equation that is estimated, becomes:

$$z_{i,t} = \beta \sum_{j \neq i} \omega_{ij} z_{j,t} + \theta X_{i,t} + \alpha_i + \epsilon_{i,t}$$  \hspace{1em} (19)$$
where i and j represents a country index and t a time index. \( \omega_{ij} \) represent the elements of a weight matrix \( \omega \) and \( X_{i,t} \) the vector of control variables. \( \beta \) and \( \theta \) are the parameters which have to be estimated, together with \( \alpha_i \), which denotes the country specific effect we allow for to capture country specific unobservable determinants, like the Nash equilibrium tax rates (following Devereux et al. 2008) or cross-country differences in the relative preference parameter \( \gamma \). \( \epsilon_{i,t} \) is the error term. From the two strands of the literature to which was referred in the introduction, we include as elements of \( X_{i,t} \):

- civil employment;
- the young age dependency ratio;
- the old age dependency ratio;
- an indicator for the size of the public sector (the share of government expenditure in GDP or the share of public in total employment);
- the country share in the OECD GDP (as an indicator of size);
- the country’s GDP per capita;
- the real growth rate of GDP (in purchasing power parities);
- the public debt to GDP ratio;
- the openness rate with respect to the rest of the world, in terms of GDP\(^5\).

From the theoretical model, the weighting scheme of the foreign tax rates is determined by the distance between the countries and the trade freeness. As a proxy for the first, we took the distance between the major cities, whereas as a simple and exogenous way to take account of economic integration (trade freeness) is the number of year of common membership of the EU. With these two components, we constructed four (row normalised) weight matrices with typical elements:

\[
\omega_{ij,1} = \frac{1}{\sum_j \frac{1}{d_{ij}}} ;
\omega_{ij,2} = \left( \frac{1}{\sum_j \frac{1}{d_{ij}}} \right)^2 ;
\omega_{ij,3} = \frac{\min_{ij} (\#EU_i, \#EU_j)}{\sum_j \frac{\min_{ij} (\#EU_i, \#EU_j)}{d_{ij}}} ;
\omega_{ij,4} = \left( \frac{\min_{ij} (\#EU_i, \#EU_j)}{\sum_j \frac{\min_{ij} (\#EU_i, \#EU_j)}{d_{ij}}} \right)^2 .
\]

\( ^5 \)With the public debt to GDP ratio, we control for the balanced budget assumption in the model. The openness rate with respect to the rest of the world controls for possible spurious correlation between the tax rates, e.g. common trends in the tax policy as a consequence of world economic integration.
where $d_{ij}$ denotes the bilateral distance between country $i$ and $j$, and $\#EU_i$ the number of years country $i$ is member of the EU. Since Anselin (1988) it is stressed that weighting schemes of spatially correlated variables must be chosen judiciously, because misspecified weight matrices can yield biased results. Compared to other common weighting schemes in the literature (for example determined by trade intensity or GDP share), the weight matrices we propose here have the advantage that they can be theoretically motivated and are less affected by endogeneity.

From the theoretical model, the hypothesis we will test is $H_0 : \beta \leq 0$, which, in fact, requires a one-sided test.

### 3.2 Data

#### 3.2.1 Tax rate data

To identify the data sources for labour taxation, we draw a comparison with the sources used in corporate tax analysis. Obviously, statutory tax rates cannot be used, given the progressivity of most labour tax schemes. Often, an implicit tax rate is used as a proxy for corporate tax rates (e.g. total amount of taxes related to a macroeconomic aggregate, as close as possible to the tax base), which can be considered for labour taxation as well. As they are computed from total tax receipts, implicit tax rates have the advantage to take into account the full set of characteristics of the taxation system and to include information on the tax rate as well as on the tax base. However, the macroeconomic aggregate to which the tax receipts are related, can deviate substantially from the effectively used tax base. In addition, implicit tax rates attribute to tax changes all kinds of economic influences, like business cycle effects and changes in the income structure. Hence, by definition it measures taxation rates and its dynamics with error. A frequently used source for implicit tax rates is Mendoza et al. (1994), but for the EU countries, more recent data according to this methodology are available from European Commission (2009) for the period 1995-2007.

An alternative to the use of implicit tax rates is the calculation of effective tax wedge rates, by applying the taxation rules in the different countries to a given income in a specific situation. Since the tax rates are determined from the tax amount one is due from a given income and personal situation, they better reflect the microeconomic characteristics of the tax systems in different countries and their variation is more likely to be determined by changes in the taxation rules. However, effective tax wedges require that specific assumptions must be made regarding a set of parameters needed to compute the tax amount. Therefore, they are only calculated for a limited number of standard situations and do not take all possible information into account. In this sense, their representativeness is not warranted. For corporate taxation, it is sometimes objected that considering a common set of parameters across countries is misleading, because profit maximising firms will optimise the financial characteristics of their investment projects to the tax rules in each country, hence, that the finance structure of an investment project is endogenous to the tax scheme. However,
this may matter less for labour taxation, given the much more limited scope to adjust the revenue structure to the tax scheme.

Because their main source of variation is more certainly exogenous changes of the tax scheme, we prefer effective tax wedge rates as data source for labour tax rates. In this respect, we can use the effective tax wedges of labour income that the OECD calculates in collaboration with the national tax administrations since 1979 and which are made available in the Taxing Wages database. Because of a recent change of the reference income, the series show a break with available data in the old definition for 14 of the EU15 countries from 1979 to 2004 and, in the new definition for all the EU15 countries from 2000 to 2008. In the old definition, the average income of a blue collar worker was taken as reference income. Based on this, two effective tax wedges were computed: for a single person without children and a married couple with two children having the reference earnings. The new definition of the reference income is the average earnings of an employee in the private business sector, based on which eight tax wedges are determined depending on family and income situation. By considering tax wedges for several socially representative family and income situations, the lack of overall representativeness can be met to some extent. Yet, for our econometric analysis we took the data for which the longest time series were available, i.e. based on the blue collar average wage as reference income. As a proxy for the average national effective tax wedge, we took the simple arithmetic mean of the effective tax wedge by family type.

3.2.2 Data of the control variables

Empirical data for the control variables are taken from the National Accounts (share in the OECD GDP, the GDP per capita and the share of public expenditure in GDP), the Labour Force Survey (the activity ratio, the young and old age dependency ratio and the share of public employment) and the Economic Outlook database of the OECD (public debt, proxied by the general government gross financial liabilities), except for the real GDP growth rate, for which the Penn World Tables was the source. Openness with respect to the rest of the world was determined from the International Trade by Commodities Statistics database, also of the OECD.

3.3 Estimation issues

Spatial interaction effects are typically included in an empirical model at the level of the explanatory variables (by extending the set of determinants with the spatially lagged dependent variable), at the level of the residual error term, or even at both the level of the explanatory variables and the error term (the general spatial model). Since the estimation of the general spatial model in a panel data framework is still in its first stages\(^6\), an assumption has to be made at which level spatial autocorrelation can occur. The empirical specification (19) we derived from the theoretical model is a tax reaction function, i.e. a function

\(^6\)See Lee and Yu (2010) and Mutl and Pfaffermayer (2008) for recent contributions
in which the spatially lagged dependent variable is included. Therefore we opt for the estimation of a spatial lag model.

In a panel data framework, the spatial effects are combined with another component of cross-sectional or spatial heterogeneity, which is typically modelled as a fixed or random component of the error term, specific for each observation unit (i.e. country, in our analysis). From the theoretical model, unobserved country heterogeneity can be linked to differences in inequality aversion ($\gamma$) or the Nash equilibrium tax rate, which are intuitively likely to be fixed components, correlated with the explanatory variables included in the model. In addition, Elhorst (2009) questions the appropriateness of the random effects specification in a framework with spatial interaction. In the commonly considered spatial sample design the population units (i.e. regions, states, countries,...) are more or less sampled exhaustively and they are not straightforwardly representative for a larger population. Almost by definition, spatial units are fixed and inference is conditional on the observed units.

There are two main approaches to estimate a model with spatial correlation, either as explanatory variable or in the error term: an approach based on the principle of maximum likelihood (ML) or an instrumental variable (IV) approach. A preferred approach is difficult to determine, in particular in the estimation of spatial panel models of which the methodology is still in its early stages. Elhorst (2009) mentions that there are indications that the ML-approach of the spatial lag model (weakly) outperforms the IV-approach, though in a panel framework without other sources of cross sectional heterogeneity (random or fixed effects). However, the ML-estimates may be less consistent than the IV-estimates when the spatial interaction effects are rather small. In addition, the ML-estimation assumes normality and homoscedasticity of the error term.

Given that we can expect the presence of heteroscedasticity of the error term and anticipating on an at most fairly weak spatial interaction effect, we estimate the model by IV. A panel spatial lag model can be estimated by an instrumental variable approach as a straightforward extension of the cross-section panel IV-model, using the spatially lagged explanatory variables as instruments (Anselin et al., 2006). In addition, in this approach a heteroscedasticity and autocorrelation consistent estimate of the error variance-covariance matrix can be obtained in the lines of White (1980) and Newey and West (1987). This allows to take account of spatial dependence in the error term in a non parametric way and can as such constitute an alternative for a spatial error modellisation (see Anselin, 2006), which, in addition, moderates the consequences of the a priori assignment of the spatial interaction effect to the level of the explanatory variable, indicated above.

3.4 Results

We estimated equation (19) using effective tax wedges, based on the old reference wage (the average earnings of a blue collar worker in the manufacturing sector), for the EU15 countries, with the exception of France and Luxemburg, in the
Table 1: Estimation Results for Effective Tax Wedges, 13 Countries, 1979-2004

<table>
<thead>
<tr>
<th>Variable</th>
<th>( \omega_{ij,1} ) Coefficient</th>
<th>SE</th>
<th>( \omega_{ij,2} ) Coefficient</th>
<th>SE</th>
<th>( \omega_{ij,3} ) Coefficient</th>
<th>SE</th>
<th>( \omega_{ij,4} ) Coefficient</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>W*Y</td>
<td>0.34 **</td>
<td>0.15</td>
<td>0.16 **</td>
<td>0.07</td>
<td>0.27 **</td>
<td>0.13</td>
<td>0.15 **</td>
<td>0.07</td>
</tr>
<tr>
<td>Civil employment</td>
<td>0.06</td>
<td>0.11</td>
<td>0.06</td>
<td>0.11</td>
<td>0.06</td>
<td>0.11</td>
<td>0.05</td>
<td>0.11</td>
</tr>
<tr>
<td>Old age dep. ratio</td>
<td>-0.71 **</td>
<td>0.30</td>
<td>-0.73 **</td>
<td>0.31</td>
<td>-0.72 **</td>
<td>0.30</td>
<td>-0.74 **</td>
<td>0.31</td>
</tr>
<tr>
<td>Young age dep. ratio</td>
<td>-0.02</td>
<td>0.17</td>
<td>-0.03</td>
<td>0.18</td>
<td>-0.03</td>
<td>0.18</td>
<td>-0.04</td>
<td>0.18</td>
</tr>
<tr>
<td>Share public employment</td>
<td>33.84 ***</td>
<td>10.21</td>
<td>34.07 ***</td>
<td>10.15</td>
<td>33.65 ***</td>
<td>10.3</td>
<td>33.75 ***</td>
<td>10.2</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>-0.49 ***</td>
<td>0.09</td>
<td>-0.48 ***</td>
<td>0.09</td>
<td>-0.46 ***</td>
<td>0.09</td>
<td>-0.47 ***</td>
<td>0.09</td>
</tr>
<tr>
<td>Share GDP OECD</td>
<td>76.83</td>
<td>52.14</td>
<td>82.1</td>
<td>52.79</td>
<td>75.68</td>
<td>51.85</td>
<td>80.78</td>
<td>51.89</td>
</tr>
<tr>
<td>Public debt ratio</td>
<td>0.14 ***</td>
<td>0.02</td>
<td>0.14 ***</td>
<td>0.02</td>
<td>0.14 ***</td>
<td>0.02</td>
<td>0.14 ***</td>
<td>0.02</td>
</tr>
<tr>
<td>Openness ROW</td>
<td>23.84 ***</td>
<td>4.87</td>
<td>22.63 ***</td>
<td>4.82</td>
<td>22.6 ***</td>
<td>4.87</td>
<td>22.02 ***</td>
<td>4.84</td>
</tr>
</tbody>
</table>

Number of obs: 169
Number of countries: 13
\( F(10,146) \): 19.38 ***
\( R^2 \): 0.66

Underidentification test: 71.35 *** (Kleinbergen-Paap rk LM)
Weak identification test: 104.59 *** (Kleinbergen-Paap rk Wald F)
Hansen J statistic: 9.67

Note: *, ** and *** indicate significance at the 10%, 5% and 1% level.

Table 1: Estimation Results for Effective Tax Wedges, 13 Countries, 1979-2004

period 1979-2004. Because initially the effective tax wedges were computed only every two years, we used bi-annual data for the whole period. In this way, we obtained a balanced panel of 13 observations in time for 13 countries.

The empirical model was estimated using two sets of instruments for the spatially lagged dependent variable W*Y: the set consisting of the once spatially lagged explanatory variables W*X and, a more extended set of instruments composed of the once and twice spatially lagged dependent variables W*X and W^2*X. The estimation results for the two sets of instrumental variables differ marginally and therefore we only report the estimation results for the most parcimonious set of instruments. With both sets of instruments, we estimated the empirical model for four different definitions of the spatial weight matrix, i.e. with respectively \( \omega_{ij,1} \), \( \omega_{ij,2} \), \( \omega_{ij,3} \) and \( \omega_{ij,4} \) as typical elements. In Table 1, we report the results of these estimations. Country specific effects were included in all the estimations, but are not reported.

For all the estimations, the instruments seem appropriate in the sense underidentification and weak identification is rejected (the test statistics being significant), whereas the Hansen test for the validity of overidentifying restrictions is not. The spatial interaction term is positive and significant, in particular given that for the null hypothesis regarding the tax competition effect the one-sided test values are relevant. To the extent that unambiguous theoretical ex-
Table 2: Estimation Results for Implicit Tax Rates, 14 Countries, 1995-2007

<table>
<thead>
<tr>
<th>Variable</th>
<th>( \omega_{ij,1} ) Coefficient</th>
<th>( \omega_{ij,1} ) SE</th>
<th>( \omega_{ij,2} ) Coefficient</th>
<th>( \omega_{ij,2} ) SE</th>
<th>( \omega_{ij,3} ) Coefficient</th>
<th>( \omega_{ij,3} ) SE</th>
<th>( \omega_{ij,4} ) Coefficient</th>
<th>( \omega_{ij,4} ) SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>W*Y</td>
<td>-0.04</td>
<td>0.11</td>
<td>-0.02</td>
<td>0.04</td>
<td>-0.10</td>
<td>0.1</td>
<td>-0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Civil employment</td>
<td>0.37 ***</td>
<td>0.06</td>
<td>0.37 ***</td>
<td>0.05</td>
<td>0.37 ***</td>
<td>0.06</td>
<td>0.37 ***</td>
<td>0.06</td>
</tr>
<tr>
<td>Old age dep. ratio</td>
<td>-0.90 ***</td>
<td>0.23</td>
<td>-0.90 **</td>
<td>0.23</td>
<td>-0.90 ***</td>
<td>0.23</td>
<td>-0.90 ***</td>
<td>0.22</td>
</tr>
<tr>
<td>Young age dep. ratio</td>
<td>-0.47 **</td>
<td>0.21</td>
<td>-0.47 **</td>
<td>0.21</td>
<td>-0.48 **</td>
<td>0.22</td>
<td>-0.48 **</td>
<td>0.21</td>
</tr>
<tr>
<td>Share public expenditure</td>
<td>0.01 ***</td>
<td>0.00</td>
<td>0.01 ***</td>
<td>0.00</td>
<td>-0.01 ***</td>
<td>0.00</td>
<td>0.01 ***</td>
<td>0.00</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>-0.52 ***</td>
<td>0.09</td>
<td>-0.52 ***</td>
<td>0.09</td>
<td>-0.51 ***</td>
<td>0.09</td>
<td>-0.51 ***</td>
<td>0.09</td>
</tr>
<tr>
<td>Share GDP OECD</td>
<td>-62.63 ***</td>
<td>19.15</td>
<td>-61.75 ***</td>
<td>19.58</td>
<td>-59.15 ***</td>
<td>20.36</td>
<td>-60.53 ***</td>
<td>20.36</td>
</tr>
<tr>
<td>Growth rate GDP</td>
<td>-0.01</td>
<td>0.07</td>
<td>-0.01</td>
<td>0.06</td>
<td>-0.004</td>
<td>0.07</td>
<td>-0.01</td>
<td>0.07</td>
</tr>
<tr>
<td>Public debt ratio</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Openness ROW</td>
<td>11.18 ***</td>
<td>2.54</td>
<td>11.18 ***</td>
<td>2.53</td>
<td>11.22 ***</td>
<td>2.56</td>
<td>11.19 ***</td>
<td>2.53</td>
</tr>
</tbody>
</table>

Number of obs 182 182 182 182 182 182 182 182
Number of countries 14 14 14 14 14 14 14 14
F(10,158) 19.76 *** 19.95 *** 18.95 *** 20.16 ***
R² 0.44 0.44 0.43 0.44
Underidentification test 50.72 *** 56.25 *** 48.20 *** 53.41 ***
(Kleinbergen-Paap rk LM)
Weak identification test 26.95 *** 66.75 *** 31.71 *** 56.58 ***
(Kleinbergen-Paap rk Wald F)
Hansen J statistic 5.32 6.04 5.21 7.11

Note = *, ** and *** indicate significance at the 10%, 5% and 1% level.

Expectations can be formulated, most explanatory variables have the correct sign (i.e. the size of the public sector, the country’s share in the OECD GDP and the size of public debt), the coefficient of the old age dependency ratio, which is significantly negative, being the most important exception amongst the significant variables.

The positive and significant effect of the spatial interaction term would indicate that the labour tax rates of the considered EU15 countries are strategic complements and would suggest the presence of tax competition in the field of labour taxation. From our estimations, the direct effect varies between 0.34 and 0.15, i.e. an average labour tax rate increase of 1% in the EU15, induces a single country (directly) to increase its tax rate with 0.2 to 0.3%. Hence, though significant, the tax interaction effect does not seem very strong (which also motivated our choice for IV-estimation rather than ML).

In addition to the estimation of (19) using effective tax wedges as data for the labour tax rates, we estimated the model using implicit tax rates as data for the dependent variable. With these data a balanced panel was constructed for 14 countries (EU15 less Luxemburg) and 13 years (the period 1995 to 2007). We report in Table 2 the results of the estimations, again for the four possible definitions of the weight matrix that we distinguished and using the same sets of instruments (respectively W*X and W*X and W²*X).
Table 3: Estimation Results for Effective Tax Wedges, Homogenous Weights, 13 Countries, 1979-2004

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>( W^*Y )</td>
<td>0.27</td>
<td>0.40</td>
</tr>
<tr>
<td>Civil employment</td>
<td>0.04</td>
<td>0.12</td>
</tr>
<tr>
<td>Old age dep. ratio</td>
<td>-0.67 **</td>
<td>0.30</td>
</tr>
<tr>
<td>Young age dep. ratio</td>
<td>-0.03</td>
<td>0.17</td>
</tr>
<tr>
<td>Share public employment</td>
<td>30.57 ***</td>
<td>10.53</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>-0.46 ***</td>
<td>0.09</td>
</tr>
<tr>
<td>Share GDP OECD</td>
<td>74.4</td>
<td>47.96</td>
</tr>
<tr>
<td>Growth rate GDP</td>
<td>-9.63</td>
<td>12.97</td>
</tr>
<tr>
<td>Public debt ratio</td>
<td>0.14 ***</td>
<td>0.17</td>
</tr>
<tr>
<td>Openness ROW</td>
<td>23.60 ***</td>
<td>4.92</td>
</tr>
</tbody>
</table>

Number of obs: 169
Number of countries: 13
\( F(10,146) \): 19.76 ***
\( R^2 \): 0.65

Underidentification test: 61.47 ***
(Kleinbergen-Paap rk LM)
Weak identification test: 53.58 ***
(Kleinbergen-Paap rk Wald F)
Hansen J statistic: 21.66 ***

Note: *, ** and *** indicate significance at the 10%, 5% and 1% level.

The tests of underidentification and weak identification, as well as the test using the overidentifying restriction (Hansen J-test) indicate that the instruments used in these estimations can be considered as adequate. However, we notice that the coefficient estimates vary substantially compared to estimates using effective tax wedges as dependent variable. The spatial interaction effect is now insignificant, whereas almost all the control variables included are significant, the public debt to GDP ratio being the surprising exception. In addition, except for the public sector size (which is now proxied by the share of public expenditures in GDP), the sign of the coefficients of all the significant control variables, is contrary to the theoretical expectations and the common findings in the literature, e.g. the share in the OECD GDP and the (old and young) dependency ratios. Therefore, it is possible that the different results obtained with the implicit tax rate definition follow from the its endogeneity to economic determinants which are unrelated to the taxation system, economic business cycle effects in particular.

Finally, we explore further to what extent we are able to identify the spatial lag mechanism as an economic integration interaction effect. To this aim we verify if the data are consistent with an alternative explanation of the spatial lag effect, namely yardstick competition or common intellectual trends, by...
re-estimating the model with a spatial weight matrix with uniform elements \((\omega_{ij} = \frac{1}{(N-1)})\). In Table 3, we report the results of the IV-estimation of this model with the effective tax wedges as dependent variable. We notice that the estimation results are very similar to those with bilateral distance (and number of years of common EU membership) as elements, except for the coefficient of the spatial lag, which is now insignificantly different from zero. This would imply that is unlikely that the observed spatial interaction in labour tax rates can be explained by common trends or yardstick competition.

4 Conclusion

In recent years we witnessed an increase in studies concerning corporate tax competition between countries, in particular within in the EU. In this paper we investigated to what extent tax competition at the national level may also occur for an immobile production factor, labour in particular.

We derived a tax rate reaction function from a two-country model with transportation costs in which we allow for unemployment because of an efficiency wage mechanism and in which a national welfare maximising government can redistribute income between the employed and unemployed, financed by a tax on labour. Bringing the model to the data, we estimated the tax reaction function of the EU15 member countries in which we test for the significance of a positive spatial lag effect. The estimation of a tax reaction function implies a judicious choice of the tax rate variable as well as of the weighting scheme for the construction of the spatially lagged dependent variable. As regards the first, our preferred data source is the taxing wages data of the OECD. As regards the second, we chose for weight matrices of which the elements are based on bilateral distance and a simple, but fairly exogenous indication of economic integration, i.e. the number of common years of EU membership.

We found that the estimation results vary in function of the definition of the dependent variable. However, for our preferred variable and model definition, we obtained indications of a significant positive strategic interaction in labour tax rates. In addition, by varying the weighting scheme of the spatial lag matrix, we found that indications for alternative causal mechanisms, like yardstick competition or common trends, are absent. Thought the value of the estimated coefficient suggests that the spatial interaction effect remains rather small, this may indicate that in the EU, countries take strategic considerations into account when setting their taxes on labour.

References


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