What Drives Corporate Tax Rates Down? A Reassessment of Globalization, Tax Competition, and Dynamic Adjustment to Shocks*

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Abstract

We reassess the driving forces behind the recent decline of corporate tax rates in Europe. Using data for up to 32 countries from 1983 to 2006, we analyze the roles of economic and financial openness as well as tax competition while allowing for dynamic adjustment to shocks and period-specific and country-specific effects. While there is no evidence that countries that have become more open have reduced their tax rates more, our findings suggest that countries strongly compete over statutory tax rates. A simulation of tax rates in a scenario with no cross-sectional dependence in tax setting suggests that in the absence of tax competition, the mean statutory tax rate of Western European countries in 2006 would have been about 12.5 percentage points above its actual level. We conclude that the recent downward trend in corporate taxes is mainly due to tax competition.

Keywords: Corporate taxes; tax competition; openness

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I. Introduction

Over the past 25 years, corporate tax rates in Europe show a remarkable downward trend. In 1983, the mean statutory corporate tax rate of thirteen Western European countries was 49.2%. As of 2008, the average tax rate of these countries had declined to 27.2%. In a recent contribution, Devereux et al. (2008) have argued that tax competition for mobile capital generated by the relaxation of capital controls can almost entirely explain the downward trend in taxes among OECD countries. The underlying model has governments behaving strategically when setting their tax policies. This gives rise to tax reaction functions describing optimal responses to tax policies of competing countries. For positively sloped reaction functions, governments will find it optimal to reduce their tax rates in reaction to tax cuts by competitors. It thus seems natural to ask whether the decline of corporate tax rates in Europe can be explained as a "race to the bottom", fueled by individual governments' incentives to lure investors and taxable profits by competitive tax policies.

Focusing on a rich data set of up to 32 European countries, we re-examine the determinants of business income taxes. The main contribution of the study is twofold. First, we use distance-weighted measures of neighbors' taxes. In contrast to Devereux et al. (2008), this allows us to include year effects in our regressions. By netting out time effects, we separate common shocks potentially affecting tax policies in all countries from the country-specific and time-variant effects of interest. Second, we allow for a sluggish adjustment of tax rates by including the one-period lag of a country's rate as an additional explanatory variable. This specification makes our framework

flexible enough to compare strategic (short-run) tax competition effects to long-run effects working through the interplay of direct tax competition and the sluggish adjustment of taxes over time.

Our main results are as follows. First of all, like Devereux et al. (2008), we find that competition over statutory tax rates significantly affects national tax policies. Because current tax rates are strongly affected by past tax levels, the moderate short-run effects of tax competition contribute to substantial long run effects. As the complexity of a dynamic model with cross-sectional dependence precludes a straightforward evaluation of the long-run effects of changes in exogenous variables, we run a simulation to assess the contribution of tax competition to the observed downward trend in corporate taxes. The logic of the simulation is to consider a scenario with no cross-sectional dependence in tax setting and to compare the evolution of tax rates in this scenario to the real world data. The striking outcome of this exercise is that in the absence of tax competition the mean statutory rate in 2006 would have been 40.0%, compared to the actual level of 27.5%. Hence, the recent negative trend in tax rates seems to be mainly due to tax competition among governments.

The increasing openness of economies, and particularly, the enhanced mobility of capital, is expected to lower corporate tax rates because tax bases of more open economies can respond more strongly to tax rate differentials. Based on our sample of European countries, however, we find no evidence that countries that have become relatively more open (through the relaxation of capital controls, stronger financial integration with other countries, or more international trade) have made

greater reductions in their corporate taxes. Moreover, while our results suggest that governments compete over statutory tax rates, we do not find significant competition over marginal tax rates.

Apart from Devereux et al. (2008), the study relates to a number of other recent contributions addressing the determinants of corporate income taxes in a cross-country perspective. Closely related are Slemrod (2004), who focuses on the role of economic openness, and Winner (2005), who estimates dynamic panel data models of corporate tax rates but does not distinguish between openness and strategic tax competition. While both studies report evidence suggesting that more open economies tend to set lower tax rates,[1] we do not find any direct effect of openness once we account for a separate tax competition effect and for time effects to capture any global trend toward increased economic integration. Recent work addressing strategic tax competition among governments includes Redoano (2007), Egger et al. (2007), and Davies and Voget (2008). While Redoano (2007), like Devereux et al. (2008), makes use of measures of neighbors' taxes that preclude the identification of tax competition separately from period effects, Egger et al. (2007) and Davies and Voget (2008) estimate static models that ignore the fact that national tax policies are often characterized by substantial inertia. Moreover, none of these studies accounts for common period-specific shocks.

The remainder of the paper is organized as follows. In Section II, we discuss recent trends in corporate tax rates in Europe. The estimation approach and the data are

[1] See also Swank and Steinmo (2002) and Schwarz (2007) for related evidence.

discussed in Section III. Section IV presents the results, and Section V concludes.

II. Trends in Corporate Taxation in Europe

Figure 1 summarizes the trends in corporate taxation in Europe since 1983. In the top left panel, the graph shows the statutory corporate tax rate (STR). This is the statutory headline rate of the corporate income tax adjusted for surcharges and the average of local income tax rates. Furthermore, the figure shows cross-country averages for the effective marginal tax rate ($EMTR$) and the effective average tax rate ($EATR$). Unlike the statutory tax rate, effective tax rates reflect all relevant income and non-income taxes imposed on corporate investments as well as all rules affecting the tax base.[2]

Figure 1 about here

Figure 1 shows the striking decline of both statutory and effective tax rates since 1983. Starting in the mid 1980s with tax reforms in the UK, statutory tax rates went down considerably, whereas the effective marginal tax rates only decreased slightly due to tax base broadening. During the early 1990s, countries in northern Europe reduced their corporate tax levels by introducing some form of dual-income tax systems, which impose significantly lower tax rates on capital income relative to labor income.

Since the fall of the Iron Curtain, the former communist countries in Eastern Europe

[2]The effective tax rates are calculated following Devereux and Griffith (2003). We refer the reader to Section III for a detailed description of effective tax rates.

have become increasingly popular locations for multinationals. The graphs show that the countries in Eastern Europe have significantly contributed to the overall decline of tax rates.[3] In 2006, the average statutory tax rate of the eleven considered former transition economies in Eastern Europe amounted to 19.3%. In comparison, the average of the remaining European countries was 27.5%, a difference of 8.2 percentage points.

In the lower left-hand panel, the graph shows a less dramatic decline in effective marginal tax rates in comparison to the other tax measures. This is due to several reforms broadening the tax base, effectively compensating for part of the drop in statutory tax rates. Overall, the negative trend reveals that cuts in statutory tax rates have only partially been compensated by base broadening.

Regarding the evolution of tax rates over time, Figure 1 suggests that actual tax policies are strongly affected by inherited tax levels. Therefore, apart from the dependence of tax rates across countries, our empirical approach should be designed to account for the sluggish adjustment of tax rates over time.

III. Empirical Approach

An Empirical Model for the Corporate Tax Rate

As outlined in the introduction, the key innovations of our approach relative to

[3]Note that the effective tax rates of the eastern European countries do not reflect the various tax incentives such as tax holidays, that were available before joining the EU.

previous work on the subject are the inclusion of common time effects and a lagged dependent variable to account for the sluggish adjustment of corporate tax rates over time. In addition, the model also features the lagged average tax rate of neighbors, which allows for potential strategic tax competition effects. With τ_{it} denoting the corporate income tax rate of country $i = 1, \ldots, N$ in period $t = 1984, \ldots, 2006$, the tax competition effect is defined as a linear combination of other countries' tax rates in $t-1$, $\tau_{-i,t-1} = \sum_{j=1}^{N} w_{ij}\tau_{j,t-1}$, with weights $w_{ij} \geq 0$ if $i \neq j$ and $w_{ij} = 0$ if $i = j$. The model of interest is thus given as

$$\tau_{it} = \lambda\, \tau_{i,t-1} + \phi\, \tau_{-i,t-1} + x_{it}\beta + \theta_t + c_i + u_{it}, \tag{1}$$

where x_{it} represents a vector of additional explanatory variables. Common period effects are captured by θ_t, and the time-invariant country characteristics enter the model through country fixed effects, c_i. We thus account for unobserved common shocks and country-specific effects that may influence tax rates. Note that we assume c_i and the residual, u_{it}, to be i.i.d. across i and t, independent of each other and among themselves. This seems justified because the aim of the model is to directly estimate time correlations (through the lagged dependent variable) and spatial correlations (through the spatial variable).

As has been recently stressed by Slemrod (2004) and Winner (2005), tax rates should negatively depend on the elasticity of capital supply with respect to the tax rate. Empirically, we therefore expect τ_{it} to be negatively related to measures of economic and financial openness. By including among the regressors the average tax rate of

neighbors together with an openness measure, *OPENNESS*, we allow for two closely related, but conceptually distinct factors to affect the choice of the tax rate. The inclusion of measures of economic openness considers that countries may react to the mobility of capital without any strategic interaction among themselves. In contrast, the tax competition effect explicitly accounts for interdependencies that result from a strategic behavior of governments. While the former effect captures the general difficulty for governments to tax an increasingly mobile factor, the latter describes the effect that each government, operating in a setting with a limited number of countries competing for profits and investment in Europe, has an incentive to play a best response to tax policies set by other countries. In our analysis, we use a common trade-based measure of openness, namely, the sum of imports and exports divided by GDP. We also experimented with a variety of alternative measures, among them measures relating FDI flows to a country's GDP as well as the financial openness index provided by Chinn and Ito (2008).[4] We comment on the performance of these alternative measures as independent regressors in the results section. There, we also discuss an interaction between *OPENNESS* and $\tau_{-i,t-1}$ to see whether more open economies react differently to tax adjustments of other countries. This would be the case if more open countries were more vulnerable to tax differentials.

As in most empirical studies of corporate tax setting, we include a measure for country or market size among the control variables. While using GDP is most common, it most likely burdens the empirical analysis with an additional endogeneity problem.

[4]The index suggested by Chinn and Ito (2008) measures the extent of openness in capital account transactions based on the information from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. A recent update provides data for 182 countries from 1970 until 2007.

We therefore opt for population in logs, *LOGPOP*, as a measure for country size that is more likely to be exogenous to national tax policies. Furthermore, the age structure of the population could influence tax policy due to the budgetary effects of demographic changes. We therefore consider the fraction of young (below 15 years), *% YOUNG*, and elderly (above 65 years) people, *% OLD*, as additional control variables. An increasing gap between personal and corporate income taxes may lead to an incentive to defer taxes by means of excessive retention of capital income at the corporate level. As a consequence, the corporate income tax may serve as a backstop for the personal income tax level within the tax system of a country (Slemrod, 2004), and we account for this by including the top personal income tax rate (*PITR*) among our controls.[5]

Based on the descriptive evidence presented in Section II, we expect λ to be positive, i.e., that governments are sluggish in adjusting their tax rates to changes in domestic conditions. Furthermore, we expect ϕ also to be positive, which would point to governments adjusting their respective tax rates toward levels chosen by neighboring countries. The globalization effect (which is part of β because economic openness is included in x) is expected to carry a sign indicating that a country's openness is limiting the government's ability to tax mobile capital.

We refer the reader to Korniotis (2009) for a detailed discussion of the long-run representation of equation (1). For our purpose, it is sufficient to note that along with

[5]We use lagged levels for population, measures of openness, and the variables describing the age distribution of the population to account for the time lag between the political decision regarding taxes and the actual implementation of the new tax rate. However, using contemporary values for all control variables does not affect any of our findings.

a number of regularity assumptions on the matrix of weights, we need to assume $|\lambda| + |\phi| < 1$ to make sure that τ is stationary.[6]

Econometric Issues

We are not aware of an estimation approach for unbalanced panels solving all identification problems in a dynamic model accounting for both fixed and spatial effects. The first thing to note is that for finite T the fixed effects (FE) estimator is not consistent in autoregressive panel data models. However, as first discussed by Nickell (1981) for the case of the autoregressive model without a spatial effect, the bias diminishes as T grows, and the same holds for the more general model with cross-sectional dependence (Korniotis, 2009). Because we are using a long unbalanced panel with 24 out of 32 countries contributing a minimum of fifteen annual observations to the data set,[7] we expect the Nickell-bias of the FE estimator to be modest.

For alternative estimators, we considered a variety of instrumental variables (IV) procedures to estimate dynamic panel data models in the tradition of Anderson and Hsiao (1982) and Arellano and Bond (1991) as well as FE estimators with bias correction as suggested by Bruno (2005) and Korniotis (2009). Noting that IV estimators are biased in finite samples, the choice between Anderson and Hsiao (1982) or Arellano and Bond (1991) as opposed to the FE estimator boils down to an efficiency tradeoff between estimators known to be biased. Generally, we found that after taking first

[6]The analogous assumption for a model with a lagged dependent variable but no cross-sectional dependence is that the parameter of the lag is smaller than one in absolute value.

[7]With ten observations, Turkey is the country with the shortest time series in our data. Thirteen countries contribute the maximum of 23 observations.

differences to wipe out the country-specific effects, using $\tau_{-i,t-2}$ as an instrumental variable for neighbors' taxes, $\Delta\tau_{-i,t-1}$, seemed to work reasonably well. However, neither lagged tax rates nor lagged differences performed sufficiently well as instrumental variables for $\Delta\tau_{i,t-1}$, leaving us with first-stage F-statistics well below ten. Taking all these considerations into account, we came to the conclusion that the FE estimator was the better choice in our application.[8]

Hence, after weighting all options, we selected the FE estimator as our preferred estimation procedure, treating the lagged dependent variable as an ordinary regressor. As regards the endogeneity of $\tau_{-i,t-1}$, however, relying on the family of FE estimators still gives us the option to compare the outcome from the simple FE procedure to the FE IV estimator. It should be noted that all of our main results are robust to whether we treat $\tau_{-i,t-1}$ as endogenous or not. For details, particularly regarding the choice of the instruments for the tax competition effect, we refer the reader to Section IV.

Data and Spatial Weights

Our database covers up to 32 European countries for the period from 1983 until 2006. Basically, our sample size depends on the availability of reliable tax data. Therefore, during the 1980s, the sample consists of Western and Northern European countries. Thereafter, the sample grows significantly. Beginning with 1996, it covers

[8]Among the bias-correction approaches, only Korniotis (2009) can deal with both a lagged dependent variable and a spatial effect. Unfortunately, the estimator can be applied only to balanced panels and is therefore of limited interest for this study.

32 European countries, including all 27 current EU member states. This database constitutes by far the most extensive panel of European countries among all existing studies on corporate tax setting. Note also that our study is the first one that, starting with 1992, includes an extensive number of countries in Central and Eastern Europe. Still, one might argue that tax policies in Eastern Europe after 1990 were determined differently than those in Western Europe, in which case using the full sample would perhaps be misleading. We therefore derive our basic results from the group of 21 western European countries and report the outcomes from the full sample as extensions of these baseline findings. Note, however, that we exploit the full information on tax rates (including those in Eastern Europe) when computing average tax rates of neighbors in all estimations.

The choice of meaningful tax measures is essential for our purpose. We therefore focus on tax measures that are well established in the theoretical literature as the relevant tax variables for multinational firms. Firms are typically assumed to consider expected future tax payments rather than historical tax payments when deciding on investments or profit assignments. Therefore, we use tax measures that convey information on expected future tax payments. The three different indicators used are the statutory tax rate (STR), the effective marginal tax rate ($EMTR$), and the effective average tax rate ($EATR$). The STR is the simplest indicator of expected tax payments, but it neglects any difference in the tax base and the existence of non-income taxes. We utilize the statutory headline tax rate of the corporate income tax adjusted to surcharges and typical local income taxes, which are imposed on

the same or a similar tax base. Effective tax rates are more complex and compress various aspects of the legal tax code at a respective location. The underlying idea is to determine effective tax levels of a hypothetical, standardized investment project. An advantage of using effective tax rates is that several relevant components of the tax system of a given country can be considered within one indicator. These tax measures reflect all relevant income and non-income taxes imposed on corporate investments, as well as all the rules determining the tax base such as depreciation rules. We compute effective tax rates in accordance with the methodology suggested by Devereux and Griffith (2003).[9]

Note that the *STR* is a good measure in cases where the way in which the tax base is being determined is not relevant for firms. Therefore, the *STR* is a well-suited indicator for competition for mobile paper profits.[10] In contrast, effective tax rates are relevant if governments compete for firms and capital investment. For instance, countries have incentives to compete for multinational investment if this raises the net value of domestic production (Haaland and Wooton, 1999). Because the *EMTR* indicates the tax burden attributable to marginal investments, it is the relevant tax instrument for governments competing for such investments. Finally, the *EATR* is the relevant indicator of the tax burden of profitable projects that generate economic

[9]Our specifications for computing the effective tax rates are similar to the assumptions in a comprehensive study about company taxation by the European Commission (2001). The standardized project contains investments in the following five asset types: industrial buildings, machinery, intangible assets, inventories, and financial assets. The project is equally financed by retained earnings, the issue of new shares, and debt. We assume an incorporated company. Only domestic taxes and only income and non-income taxes imposed at the corporate level are considered. Specific property taxes on real estate and special tax regimes available only to specific firms are not included. With regard to taxable bases, we consider the relevant rules concerning depreciation allowances, valuation of inventories and interest deductibility in case of debt financing.

[10]Recent evidence suggests that multinational firms allocate profits according to differences in statutory tax rates (see, e.g., Huizinga and Laeven, 2008).

rents due to firm-specific assets.[11] Consequently, the *EATR* should be the relevant tax measure if countries compete for firms or subsidiaries.[12]

Table 1 depicts, for the largest sample used for estimation (i.e., including Eastern Europe), descriptive statistics for the tax data as well as the explanatory variables discussed above.

Table 1 about here

Note that when estimating Equation (1), the weights w_{ij} have to be treated as predetermined. This brings up the question of how to specify a metric that provides us with suitable weights. Previous studies of international tax competition have extensively employed uniform weights, which put equal weight on each foreign country in computing the average tax rate of other countries (Devereux et al., 2008; Redoano, 2007). One conceptual problem of uniform weights is that if N is large, the weighted average $\sum_{j=1}^{N} w_{ij}\tau_{j,t-1}$ is almost the same for all countries. Consequently, it becomes (almost) collinear to a common period effect. Thus, in general, with uniform weights we cannot identify the tax competition effect separately from a common period-specific shock. The same argument holds if other countries' tax rates are weighted by some country characteristic such as GDP or population. Because common period-specific shocks such as, for instance, changing expectations regarding the world business cycle, may be important factors shaping governments' tax policies, we are well advised to choose weights that allow for a separate identification of tax competition effects.

[11] Like European Commission (2001), we assume a pre-tax rate of return of about 20%.

[12] Previous empirical studies confirm that the *EATR* is a suitable indicator in case of location decisions (Devereux and Griffith, 1998; Büttner and Ruf, 2007).

Given the concerns mentioned above, we define weights that are based on geographical distance. The literature provides clear-cut evidence for a negative effect of distance on FDI (e.g., see Carr et al., 2001). In the case of investment decisions, geographical distance drives transportation costs for produced goods and tends to increase information costs (Portes and Rey, 2005). Geographical distance should also negatively affect pure paper-profit shifting because the underlying transactions such as intra-firm trade should be inversely related to geographical distance as well. Therefore, it seems reasonable to assume that governments perceive tax policies of immediate neighbors to be more relevant than tax policies of more distant countries.

Denoting the geographical distance between countries i and j by d_{ij}, a straightforward way to operationalize the above arguments is to set $w_{ij} = 0$ if $j = i$ and

$$w_{ij} = \frac{1/d_{ij}^2}{\sum_{k \neq i} 1/d_{ik}^2} \quad \forall\ j \neq i. \tag{2}$$

Note that using some inverse distance measure to derive the weights can be understood as a generalization of the contiguity criterion frequently used in studies of cross-sectional dependence at a more local level.[13] Despite the fact that weights that are defined geographically are conceptually time-constant, the weights in our application show some variation over time. This variation, however, comes only from the fact that the cross-section of countries for which sufficient tax information is available increases over time. Note also that it is straightforward to vary a pure distance-based

[13]See Case et al. (2003) for an early example. Apart from technical difficulties, it is common to consider the contiguity criterion as fulfilled in the case of a shared land border. For many pairs of countries, e.g., Denmark and Sweden, applying the criterion results in a weight matrix contradicting simple economic intuition.

scheme by adjusting the weights by some measure of country size. We comment on the robustness of our findings regarding such alternative weighting schemes in the results section and refer the reader to Overesch and Rincke (2009b) for a more extensive discussion and additional results.

IV. Results

Main Results

Our main results for the statutory tax rate are displayed in Table 2. Columns 1 to 6 report regressions using the unbalanced panel data for 21 Western European countries. All estimations include a full set of country and year effects, but for the sake of brevity, we report the period effects only for selected years (1990, 1998, and 2006). Column 1 is a baseline estimation to test for the impact of our trade-based openness measure on statutory tax rates. Although the model is certainly simplistic, it is revealing to see that tax rates do not seem to be linked to openness once country-specific and year-specific factors are netted out. This finding might be questioned as being specific to the chosen trade-based measure for openness. We therefore performed a robustness check using five alternative openness measures: the share of inward FDI flows in GDP, the corresponding share for outward FDI, the combined share of inward and outward FDI, a Feldstein-Horioka type measure[14] relating the difference between savings and investment (in absolute value) to output (GDP), and

[14]See Winner (2005) for a detailed investigation using this measure of openness.

the Chinn and Ito (2008) index of financial openness. We did not find a statistically significant effect of any of these measures in any of the reported specifications. In contrast to the insignificant openness variable, the year effects pick up a substantial fraction of the overall variation in tax rates. The year-2006 effect, for instance, indicates that the parsimonious specification from Column 1 attributes an average decline of 18.4 percentage points (relative to the year 1984) to common effects.

Table 2 about here

Column 2 adds the top personal income tax rate, population, and the variables describing the age structure. Among the added variables, the coefficients of the top income tax rate, $\%\,YOUNG$ and $\%\,OLD$ prove to be significantly different from zero, and all carry the expected sign. It is worth noting that even with the additional regressors included, the year-2006 effect is still significant at the one percent level, indicating that the set of year effects accounts for an average cut in the statutory rate of about 15.2 percentage points relative to the year 1984. We conclude that the regressors in (2) alone cannot explain the downward trend in statutory tax rates, and we seem well advised to take seriously the issue of identifying potential tax competition effects separately from common period effects.

The lagged own tax rate is added in Column 3. Confirming the results of Winner (2005) for OECD countries, we find that corporate tax rates strongly depend on past levels. We return to a model without the lagged dependent variable in Column 4 to add the lagged tax rate of neighbors before reporting in Column 5 the fixed-effects regression with both $\tau_{i,t-1}$ and $\tau_{-i,t-1}$ included among the regressors. We note that

the estimate for λ is again highly significant and that the effect of the lagged tax rate of neighbors is positive and significantly different from zero at the one percent level.[15] It is instructive to see that the estimated long-run one-way spillover effect from Column 5 equals $\hat{\phi}/(1-\hat{\lambda}) = 0.55$, which is very close to the tax competition coefficient from Column 4. Note also that as in Column 2, we find that the top income tax rate, *% YOUNG*, and *% OLD* significantly affect the statutory tax rate.

While treating the lagged dependent variable as an exogenous variable seems to be less of a problem given the considerable length of the panel, the endogeneity of the lagged tax rate of neighbors is partly driven by cross-sectional dependence. This certainly warrants a robustness check involving instrumental variables for $\tau_{-i,t-1}$ to reduce the bias that might result from treating neighbors' taxes as an exogenous regressor. If the likely endogeneity of $\tau_{-i,t-1}$ is mainly due to two-way causality, the bias should be positive. If, however, endogeneity is mostly the effect of unobserved time-varying factors correlated across countries, the direction of the bias depends on whether this correlation is positive or negative. Hence, we do not have a strong prior about the direction of the bias of the tax competition effect in the simple FE model. We construct two instrumental variables by applying the same set of spatial weights that was used to compute the average tax among neighbors to the explanatory variables that are arguably exogenous and strongly related to taxes, namely, the percentage of young and the percentage of elderly people.

The results for the 2SLS regression are reported in Column 6. As regards the per-

[15] Using a Wald-test, we can reject the null that $\phi + \lambda = 1$ at the one percent level of significance.

formance of the instruments, we obtain an F-statistic of 45.3 for the instruments in the first-stage regression together with a partial R^2 of almost 0.35. Together with a p-value of the Hansen test indicating that the overidentifying restrictions cannot be rejected, these statistics suggest that the selected instruments are strong and valid. Most importantly, the FE IV estimation confirms all findings from the simple FE model in Column 5. While the coefficients of the lagged dependent variable and the controls are almost unchanged, the tax competition effect is now estimated to be 0.184, somewhat larger than before. In light of the performance of the instruments in the first-stage regression, the FE IV estimator is our preferred estimation procedure.

Despite the differences in terms of model setup and specification, the results obtained so far confirm the main finding of Devereux et al. (2008) regarding the presence of strategic tax competition in statutory rates. However, our results differ from Devereux et al. (2008) in that we separate a moderate short-run response to neighbors' taxes from substantial long-run effects. National governments are estimated to react to tax policies in other countries by directly compensating about 18.4 percent of changes among competing countries. The sluggish adjustment of tax rates over time, however, leads to substantial long-run effects of tax competition. Finally, it is worth noting that the long-run one-way spillover of 0.69 obtained from Column 6 is well in line with the best comparable estimate for the static tax competition effect from Devereux et al. (2008), which is 0.68 for the specification with uniform weights.

The series of estimations for the statutory tax rate is completed in Columns 7 and 8, showing the FE and the FE IV estimation using the full sample of 32 countries (in-

cluding Eastern Europe).[16] Qualitatively, we find all previous results confirmed, but including Eastern Europe slightly reduces the estimates of both λ and ϕ. Moreover, the tax competition effect is only weakly significant if we choose the FE IV estimator.

In principle, our model can be used to evaluate the long-run effects of changes in exogenous components and the contribution of tax competition to the evolution of tax rates. We first deal with changes in exogenous country characteristics and address the long-run effect of tax competition thereafter. Due to complex feedback effects, evaluating the long-run effects of changes in exogenous components in the presence of cross-sectional dependence is much more involved than in a simple non-spatial framework. A straightforward way to analyze changes in exogenous conditions in a stylized setting is to consider a case with just two countries, $i = 1, 2$, and a single exogenous country characteristic, x. Using the notation of Section III, we then have spatial weights $w_{11} = w_{22} = 0$ and $w_{12} = w_{21} = 1$. With bars now indicating that the various variables have attained their equilibrium levels, the steady-state tax rate of country 1 is determined by

$$\bar{\tau}_1 = \frac{\phi\bar{\tau}_2 + \beta\bar{x}_1}{1-\lambda}. \tag{3}$$

Substituting for $\bar{\tau}_2$ and solving for $\bar{\tau}_1$ provides us with

$$\bar{\tau}_1 = \frac{\beta(1-\lambda)}{(1-\lambda)^2 - \phi^2}\,\bar{x}_1 + \frac{\beta\phi}{(1-\lambda)^2 - \phi^2}\,\bar{x}_2. \tag{4}$$

The latter equation shows that the effect of changes in exogenous country charac-

[16]The countries coded as belonging to Eastern Europe are Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, and Slovenia.

teristics on equilibrium tax rates depends on multipliers comprising the coefficients λ and ϕ. For changes in $\bar{x}_1$, the multiplier is $(1-\lambda)/((1-\lambda)^2-\phi^2)$. Substituting the estimated coefficients from our preferred model for Western Europe, Column 6 of Table 2, yields a value of 7.1. The multiplier for changes in $\bar{x}_2$ is $\phi/((1-\lambda)^2-\phi^2)$, which is estimated to attain a value of 4.9. Hence, our estimations imply that permanent changes of relevant country characteristics have long-run effects, which are a multiple of the direct effects, on corporate taxes. Moreover, in contrast to models without cross-sectional dependence, tax policy reacts to permanent shocks in other countries because the tax response of the country affected by a shock is transmitted to other locations. While the multipliers seem large, one should keep in mind that some of the effects work in the opposite direction. For instance, the effects of the average changes in the thirteen Western European countries included in the sample for the whole period 1984-2006 (-2.5 percentage points for $\%\,YOUNG$ and $+2.4$ percentage points for $\%\,OLD$) almost exactly cancel each other out.[17] Moreover, our parameter estimates have been derived with a specific spatial structure imposed on the model and should therefore be used with caution for evaluation purposes in a highly stylized setting with just two countries. Among the countries in our sample, the long-run effects of changes in exogenous conditions will be smaller than in the two-country example because the distance-decay in the spatial structure imposed effectively isolates countries from changes occurring in more distant countries.

We started out with the observation of a significant and more or less steady decline

[17] A one percentage-point decrease in $\%\,YOUNG$ is predicted to decrease the own tax rate by 3.2 percentage points in the long run, whereas a one percentage-point increase in $\%\,OLD$ is estimated to drive up the long-run tax rate by 3.8 percentage points.

of corporate income tax rates over the past 25 years. Given the findings obtained so far, it seems natural to consider in more detail the contribution of tax competition to that decline. We do this by means of a simulation. The simple logic of the simulation exercise is to consider a hypothetical scenario with no cross-sectional dependence in tax setting (i.e., with ϕ set to zero) and to simulate the evolution of taxes using as inputs the actual tax rates of all countries in the first year observed, the actual levels of control variables, and the estimated values for the model parameters. The simulation will thus provide us with an estimate of tax rates for all years considered in our empirical analysis, under the hypothesis of no tax competition among countries and the assumption that we have correctly estimated the parameters of the underlying model. Comparing simulated to actual tax rates then informs us about the contribution of tax competition to the evolution of the actual series.

We perform the simulation exercise for our sample of 21 Western European countries, using again the parameters from Table 2, Column 6.[18] The outcome is displayed in Figure 2, where the solid line shows the average of actual tax rates between 1984 and 2006, and the dashed line indicates the evolution of statutory tax rates in the hypothetical scenario with ϕ set to zero.[19]

Figure 2 about here

The result of the simulation is striking. In the absence of tax competition, the mean

[18]The simulation is done step by step. Using taxes as of 1984 as initial conditions, the values for 1985 are obtained by adding to the vector of initial conditions the vector of simulated changes in taxes, which are obtained from multiplying the vector of explanatory variables in first differences with the vector of estimated parameters from Table 2, Column 6, including the year effects. Repeating this procedure gives a series of simulated tax rates for all years up to 2006.

[19]Because the mean residual is zero, the average of actual tax rates is equal to the mean fitted value from the regression in Table 2, Column 6.

statutory rate in 2006 would have been 40.0%, compared to the actual level of 27.5%. It is particularly noteworthy that the average simulated rate is roughly constant for the period starting with the mid-1990s. We conclude that to a significant extent, the recent negative trend in tax rates is due to tax competition among governments. Moreover, for the period from the mid-1990s, tax competition explains virtually all of the decline in statutory rates.

Table 3 depicts actual and simulated tax rates for those thirteen European countries which are present in our data for the whole period 1984-2006. The last column shows the difference between the actual statutory rate and the simulated rate for the year 2006. The countries for which the aggregated tax competition effect on corporate tax rates is highest are Austria (-0.290), Finland (-0.290), and Germany (-0.239). The fact that all of these countries are, in geographical terms, directly exposed to Eastern Europe points to the importance of the integration between Eastern and Western Europe for corporate tax rates in western European countries and relates our findings to Overesch and Rincke (2009a).

Table 3 about here

Effective Tax Rates

Table 4 extends our analysis by reporting selected specifications for the *EMTR* (Columns 1-5) and the *EATR* (Columns 6-10). As before, all regressions account for a full series of year effects. Again, we find no evidence that countries that have

become more open have reduced their effective taxes more significantly.[20] While the strong dependence on lagged levels of a country's own tax rate is present in both effective tax measures, we do not find significant tax competition effects once we account for the likely endogeneity of neighbors' lagged taxes by instrumental variables. However, with *EATR* as the dependent variable, the coefficient of $\tau_{-i,t-1}$ is significantly different from zero in the simple FE model (Column 8). It is worth noting that in contrast to Table 2, the 2SLS estimates for ϕ are smaller than the ones obtained in the OLS model. We conclude that there is no evidence for competition in effective marginal tax rates and at best weak evidence for competition in effective average rates. European governments seem to compete over statutory rates rather than over effective tax rates.

Table 4 about here

Alternative Spatial Metrics

As our results depend on the specification of spatial weights, it is natural to consider the robustness regarding alternative metrics. As discussed above, using uniform weights, as does much of the previous literature on European tax competition, is problematic as the tax competition effect cannot be identified separately from common period effects. Contiguity-based weights are not applicable without further assumptions because many countries in Europe are islands. Moreover, in many cases (i.e.,

[20] As in Table 2, we report results for the trade-based openness measure only. We cross-checked our findings with all other openness measures discussed earlier and did not find significant coefficients for any of them.

country-pairs) applying the criterion gives weights that contradict intuition. Consequently, employing some inverse function of distance to construct weights seems to be a natural choice for our application.

We experimented with a number of alternative specifications, varying both the role of distance and the weighting by country size. Generally, we found our results to be robust to such changes as long as weights are defined such that they decline with distance quickly enough. This is intuitive, as a weak impact of distance on weights limits the effective cross-sectional variation in linear combinations such as $\tau_{-it} = \sum_{j=1}^{N} w_{ij}\tau_{jt}$. Hence, in a model with a full series of period effects, it is hopeless to identify the tax competition effect if the weights do not decline quickly enough with distance.

Including country size in the computation of weights generally gives very similar results to those reported above. For instance, if we use population figures (in logs) to adjust the weights according to

$$w_{ij} = \frac{LOGPOP_j/d_{ij}^2}{\sum_{k\neq i} LOGPOP_k/d_{ik}^2} \quad \forall\ j \neq i, \tag{5}$$

we find all main results confirmed, although the overall impact of small countries like Luxembourg on other countries' tax policies is greatly diminished. For a detailed discussion of results obtained using population-adjusted weights, we refer the reader to the working paper version of the study, Overesch and Rincke (2009b).

The results reported so far suggest that after netting out country and period-specific effects, changes in economic openness do not contribute much to understanding corporate income tax rates. However, given that a certain extent of openness is a prerequisite for any competition for tax bases, it seems warranted to investigate the role of openness a bit further.

Again Devereux et al. (2008) provide a point of reference. They analyze whether the extent of capital account liberalization affects the response to tax policies of other countries. Using a measure of the intensity of capital controls suggested by Quinn (1997), they find strategic tax competition to be present between relatively open economies, whereas no interdependence in tax setting is found between countries which are financially less open. To run a similar test on our data, we define a dummy variable, c_{it}, indicating relatively open economies, and interact it with the tax competition effect, $\tau_{-i,t-1}$. We then include c_{it} and $c_{it} \times \tau_{-i,t-1}$ as additional regressors while excluding the continuous measure of openness. Through the interaction with $\tau_{-i,t-1}$, we are now able to capture a potential impact of openness even if the variation over time is insufficient to identify its impact in the regressions reported before.

Although we experimented with all the aforementioned measures of economic openness (including the index of financial openness introduced by Chinn and Ito, 2008) and, for each of these variables, with different cut-off points to separate "open" from "closed" countries, we could not reject the null of no difference in tax responses be-

tween more and less open economies in any of these regressions.[21] In contrast to Devereux et al. (2008), we thus conclude that in our data, changes in economic and financial openness do not seem to impact corporate tax rates once we account for forces that affect all countries equally.[22]

V. Conclusion

Since the mid-eighties, European countries have significantly lowered their statutory and effective tax rates on corporate income. We have analyzed the degree to which tax competition and the increased economic and financial openness of countries have contributed to this decline. Regarding methodology, the key differences from previous studies on corporate tax setting are the following. First, we use distance-weighted measures of neighbors' taxes to model strategic tax competition. This allows us to include year effects in our regressions and, thereby, to separate common shocks potentially affecting tax policies in all countries from the country-specific and time-variant effects of interest. Second, we use a dynamic model of corporate tax setting that allows for a sluggish adjustment of tax rates over time. Thus, our framework incorporates strategic (short-run) tax competition effects as well as long-run effects working through the interplay of tax competition effects and the sluggish adjustment of tax rates over time. Finally, we present the first study of corporate tax setting in

[21] For brevity, we do not report the results here. A complete set of regression outputs is available from the authors upon request.

[22] It might still be true that increased openness at the global level has affected corporate tax rates. In our model, such global effects are captured by the year effects.

Europe that includes data for eastern European countries.

We obtain the following results. First, we find strong evidence for competition over statutory tax rates, but no evidence for competition over effective marginal tax rates and at best weak evidence for competition over effective average rates. This relates our results to different dimensions of tax competition and supports the view that countries compete for paper profits and profitable firms rather than for marginal investments. Moreover, we find no evidence that countries that have become relatively more open have reduced their corporate taxes more significantly. From a policy-perspective, our main finding is that international tax competition seems to be the major force behind the recent decline in corporate tax rates in Europe. A simulation of statutory rates in a hypothetical scenario with no tax competition for the period 1984-2006 reveals that the mean statutory rate in 2006 would have been 40.0%, compared to the actual level of 27.5%. In particular, the average simulated rate is roughly constant for the period starting with the mid-1990s. Hence, for the past 15 years, tax competition explains virtually all of the decline in actual statutory rates.

Relating our work to the recent contribution of Devereux et al. (2008), we would like to stress two points. First, although our model setup, estimation strategy, and data are different, our finding that strategic tax competition among governments contributes to a "race to the bottom" in corporate tax rates confirms the evidence reported by Devereux et al. (2008). However, our results differ in that we separate a moderate short-run response to neighbors' taxes from substantial long-run effects.

We estimate the short-run response of governments to compensate about 18.4 percent of tax changes in neighboring countries. Due to the sluggish adjustment of tax rates over time, however, tax competition has substantial long-run effects. For our preferred specification, the long-run one-way spillover of 0.69 is very close to the best comparable estimate for the static tax competition effect reported by Devereux et al. (2008), which is 0.68. Our findings also differ with regard to the role of economic and financial openness as a prerequisite of tax competition. While Devereux et al. (2008) find that tax competition takes place only between relatively open economies, we do not observe any difference in our data in the intensity of tax competition that might be related to different degrees of openness.

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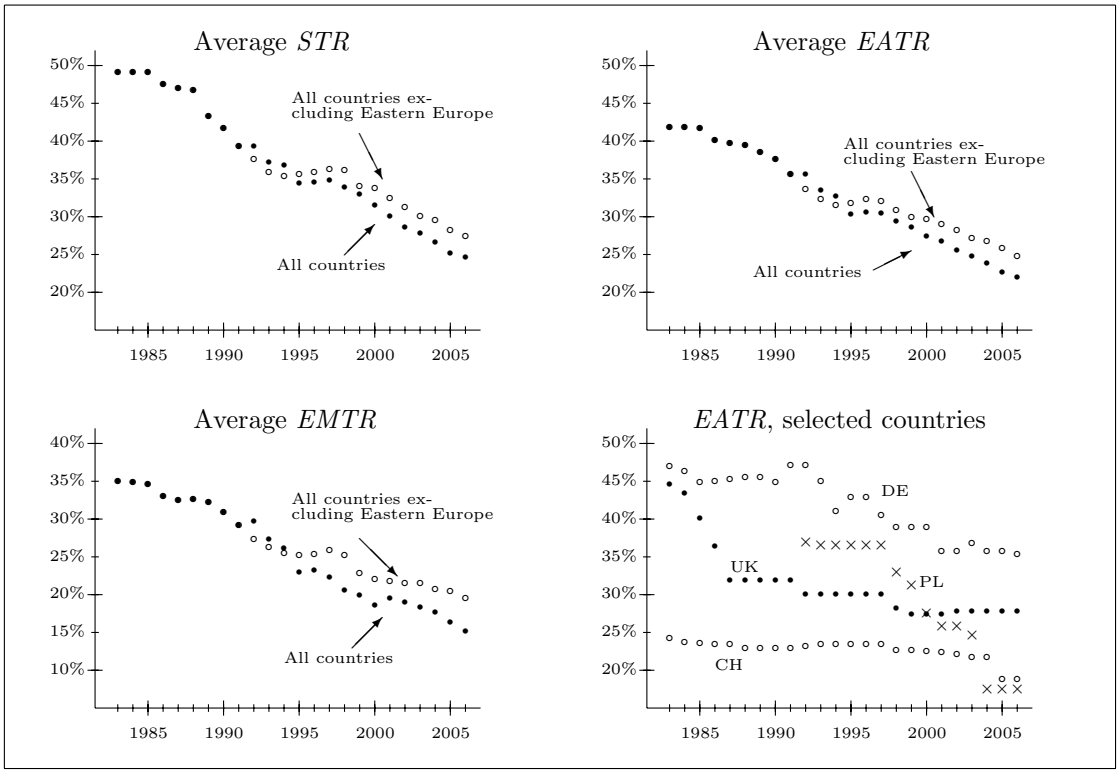
Figure 1: Trends in corporate taxation in Europe, 1983-2006



Graphs for average tax rates show unweighted averages. Countries in sample (period) are: Austria (83-06), Belgium (83-06), Switzerland (83-06), Cyprus (91-06), Denmark (83-06), Spain (91-06), Finland (83-06), France (83-06), Germany (83-06), Greece (90-06), Ireland (83-06), Iceland (90-06), Italy (83-06), Luxembourg (83-06), Malta (94-06), Netherlands (83-06), Norway (90-06), Portugal (90-06), Turkey (96-06), Sweden (83-06), UK (83-06). Eastern Europe: Bulgaria (93-06), Czech Rep. (92-06), Estonia (95-06), Croatia (95-06), Hungary (92-06), Latvia (95-06), Lithuania (95-06), Poland (92-06), Romania (94-06), Slovenia (95-06), Slovak Rep. (92-06).

Table 1: Descriptive Statistics

Variable	Definition	Mean	Std.Dev.	Min.	Max.
STR	Statutory corporate income tax rate	0.341	0.102	0.100	0.631
EMTR	Effective marginal tax rate	0.230	0.094	-0.196	0.488
EATR	Effective average tax rate	0.301	0.083	0.104	0.555
$\sum_j w_{ij} STR_j$	Average of other countries' *STR*	0.352	0.072	0.200	0.580
$\sum_j w_{ij} EMTR_j$	Average of other countries' *EMTR*	0.235	0.070	-0.021	0.482
$\sum_j w_{ij} EATR_j$	Average of other countries' *EATR*	0.310	0.062	0.175	0.507
OPENNESS	Sum of exports & imports as % of GDP	0.913	0.452	0.357	2.89
PITR	Personal top income tax rate	0.476	0.115	0.160	0.800
POPULATION	Population in 1,000 inhabitants	19080	23564	258	82520
% YOUNG	% of population below 15 years	0.187	0.031	0.137	0.324
% OLD	% of population above 65 years	0.142	0.022	0.046	0.197

Unbalanced panel with 551 observations (32 countries, years 1984-2006). Tax variables based on own calculations. Underlying tax information is from several databases provided by the International Bureau of Fiscal Documentation (IBFD), Amsterdam, and from annual surveys by Ernst&Young, PwC and KPMG. The other control variables are from Eurostat and the World Development Indicators of the World Bank.

Table 2: Determinants of statutory tax rates, 1984-2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LAGGED OWN TAX RATE	-	-	0.763***	-	0.740***	0.733***	0.717***	0.713***
			(0.037)		(0.042)	(0.039)	(0.034)	(0.031)
LAGGED TAX OF NEIGHBORS	-	-	-	0.525***	0.143***	0.184**	0.125***	0.155*
				(0.149)	(0.042)	(0.085)	(0.042)	(0.087)
OPENNESS	-0.114	-0.032	-0.019	-0.037	-0.021	-0.022	-0.010	-0.010
	(0.078)	(0.054)	(0.020)	(0.048)	(0.019)	(0.018)	(0.019)	(0.019)
PITR	-	0.444*	0.151	0.462**	0.165*	0.169*	0.139**	0.141**
		(0.245)	(0.097)	(0.217)	(0.095)	(0.089)	(0.065)	(0.060)
LOGPOP	-	-0.058	-0.025	-0.201	-0.065	-0.077	-0.045	-0.052
		(0.254)	(0.068)	(0.218)	(0.062)	(0.054)	(0.066)	(0.062)
% YOUNG	-	1.018*	0.430***	1.004*	0.444***	0.449***	0.451**	0.456**
		(0.549)	(0.144)	(0.533)	(0.152)	(0.140)	(0.180)	(0.166)
% OLD	-	2.64**	0.517**	2.435***	0.527**	0.529***	0.433*	0.431*
		(0.861)	(0.237)	(0.749)	(0.206)	(0.189)	(0.253)	(0.238)
Year 1990	-0.077***	-0.040*	-0.017*	-0.004	-0.008	-0.006	-0.013	-0.011
	(0.020)	(0.023)	(0.010)	(0.028)	(0.010)	(0.010)	(0.009)	(0.009)
Year 1998	-0.118***	-0.091***	-0.016	-0.009	0.004	0.010	-0.001	0.003
	(0.030)	(0.030)	(0.011)	(0.036)	(0.013)	(0.016)	(0.011)	(0.014)
Year 2006	-0.184***	-0.152***	-0.021	-0.011	0.013	0.023	0.002	0.009
	(0.032)	(0.040)	(0.156)	(0.056)	(0.018)	(0.024)	(0.016)	(0.022)
Estimator	FE	FE	FE	FE	FE	FE IV	FE	FE IV
N	416	416	416	416	416	416	551	551
R^2 (within)	0.583	0.670	0.885	0.702	0.888	-	0.873	-
First stage F-Statistic	-	-	-	-	-	45.3	-	40.4
Shea Partial R^2	-	-	-	-	-	0.347	-	0.323
Hansen J-Test (p-value)	-	-	-	-	-	0.412	-	0.258

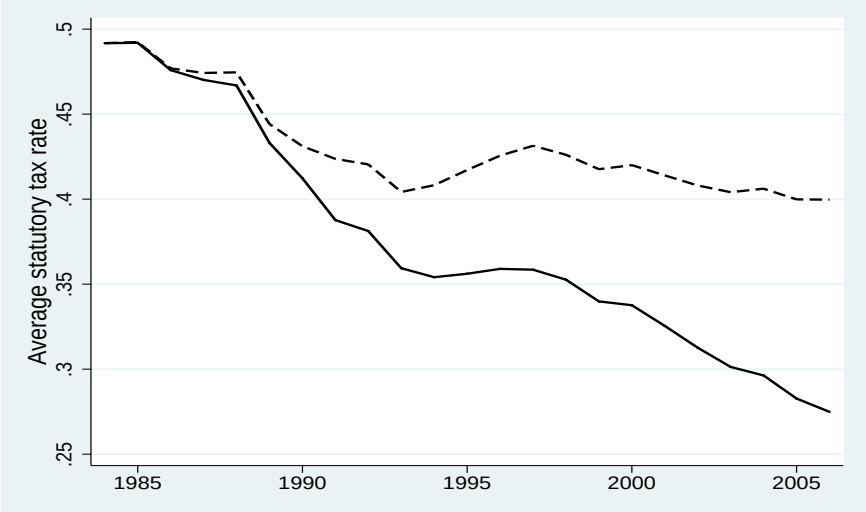
Columns 1-6 are based on unbalanced panel of 21 Western European countries. Columns 7 and 8 also include Eastern Europe (unbalanced panel with a maximum of 32 countries). Standard errors (robust to heteroscedasticity and clustering on countries) in parentheses. Columns 6 and 8 treat lagged tax rate of neighbors as endogenous, instrumental variables are neighbors' *% YOUNG* and neighbors' *% OLD*. All estimations include a full series of year effects. Significance levels: * 10%, ** 5%, *** 1%.

Table 3: Actual and simulated statutory tax rates

Country	STR_{1984}	STR_{2006}	Simulated STR_{2006}	ΔSTR_{2006}
Austria	0.615	0.250	0.540	-0.290
Belgium	0.450	0.340	0.385	-0.045
Denmark	0.400	0.280	0.395	-0.115
Finland	0.520	0.260	0.550	-0.290
France	0.500	0.344	0.494	-0.150
Germany	0.626	0.394	0.633	-0.239
Ireland	0.500	0.125	0.202	-0.077
Italy	0.464	0.373	0.501	-0.128
Luxembourg	0.469	0.293	0.370	-0.077
Netherlands	0.470	0.296	0.378	-0.082
Sweden	0.619	0.280	0.386	-0.106
Switzerland	0.260	0.213	0.236	-0.023
UK	0.500	0.300	0.362	-0.062

Simulated STR_{2006} is statutory tax rate simulated under $\phi = 0$, using the parameter estimates from Table 2, Column 6. ΔSTR_{2006} is difference between actual rate and simulated rate for 2006.

Figure 2: Impact of tax competition on average statutory tax rate



Graph based on 21 Western European countries. The dashed line shows the simulated level of average statutory tax rate in a scenario with no cross-sectional dependence in tax setting. The solid line depicts the actual level of the average statutory tax rate.

Table 4: Determinants of effective marginal and effective average tax rates, 1984-2006

Dependent variable	Effective marginal tax rate (EMTR)					Effective average tax rate (EATR)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
LAGGED OWN TAX RATE	-	0.723***	0.712***	0.717***	0.706***	-	0.749***	0.721***	0.734***	0.706***
		(0.030)	(0.032)	(0.028)	(0.025)		(0.032)	(0.037)	(0.030)	(0.033)
LAGGED TAX OF NEIGHBORS	-	-	0.089	0.052	0.026	-	-	0.142***	0.073	0.044
			(0.082)	(0.099)	(0.078)			(0.049)	(0.060)	(0.063)
OPENNESS	-0.028	-0.022	-0.022	-0.022	-0.020	-0.014	-0.014	-0.015	-0.014	-0.010
	(0.043)	(0.019)	(0.019)	(0.017)	(0.015)	(0.045)	(0.018)	(0.019)	(0.017)	(0.016)
PITR	0.456*	0.170	0.179*	0.175**	0.161***	0.416*	0.134	0.151	0.143*	0.127**
	(0.229)	(0.086)	(0.087)	(0.080)	(0.054)	(0.241)	(0.091)	(0.091)	(0.083)	(0.055)
LOGPOP	-0.335*	-0.104	-0.126*	-0.117*	-0.107*	-0.217	-0.078	-0.110*	-0.094*	-0.053
	(0.185)	(0.067)	(0.071)	(0.069)	(0.066)	(0.174)	(0.056)	(0.059)	(0.019)	(0.059)
% YOUNG	-0.460	0.024	0.024	0.024	0.127	0.569	0.319***	0.332***	0.325***	0.361***
	(0.374)	(0.113)	(0.115)	(0.104)	(0.128)	(0.435)	(0.106)	(0.109)	(0.096)	(0.127)
% OLD	0.538	0.095	0.097	0.097	0.163	2.00**	0.386*	0.413***	0.400***	0.339*
	(0.747)	(0.163)	(0.152)	(0.142)	(0.175)	(0.787)	(0.187)	(0.166)	(0.155)	(0.176)
Year 1990	-0.012	-0.010	-0.006	-0.008	-0.107	-0.012	-0.008	-0.001	-0.004	-0.008
	(0.021)	(0.010)	(0.010)	(0.011)	(0.066)	(0.020)	(0.009)	(0.010)	(0.010)	(0.008)
Year 1998	-0.061**	-0.022	-0.009	-0.014	-0.013	-0.062**	-0.013	0.004	-0.004	-0.009
	(0.028)	(0.018)	(0.013)	(0.017)	(0.014)	(0.025)	(0.011)	(0.012)	(0.012)	(0.011)
Year 2006	-0.079**	-0.014	0.005	-0.003	-0.009	-0.100***	-0.013	0.015	0.001	-0.011
	(0.035)	(0.018)	(0.026)	(0.031)	(0.023)	(0.030)	(0.014)	(0.017)	(0.018)	(0.016)
Estimator	FE	FE	FE	FE IV	FE IV	FE	FE	FE	FE IV	FE IV
N	416	416	416	416	551	416	416	416	416	551
R^2 (within)	0.583	0.814	0.815	-	-	0.652	0.871	0.873	-	-
First stage F-Statistic	-	-	-	27.5	37.2	-	-	-	43.2	55.4
Shea Partial R^2	-	-	-	0.328	0.315	-	-	-	0.342	0.339
Hansen J-Test (p-value)	-	-	-	0.259	0.190	-	-	-	0.306	0.228

Columns 1-4 and 6-9 based on unbalanced panel of 21 Western European countries. Columns 5 and 10 also include Eastern Europe (unbalanced panel with a maximum of 32 countries). Standard errors (robust to heteroscedasticity and clustering on countries) in parentheses. Columns 4-5 and 9-10 treat lagged tax rate of neighbors as endogenous, instrumental variables are neighbors' *% YOUNG* and neighbors' *% OLD*. All estimations include a full series of year effects. Significance levels: * 10%, ** 5%, *** 1%.