

# ARE CORPORATE TAXES RACING TO THE BOTTOM IN THE EUROPEAN UNION?

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**JEL Classification:** H2; F2; F36

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## 1. Introduction

The theoretical literature on tax competition predicts that increases in capital mobility, such as that observed during the last couple of decades within the European Union, generates a race to the bottom in taxes on mobile capital taxed at source<sup>1</sup>. This tax competition effect is often accused of hampering efforts to balance public finances, of hindering the adequate provision of public goods, or of leading to an undesirable shift in the tax burden on to less mobile tax bases. It has also led to numerous calls for tax harmonization in the European Union. There seems to be an overall consensus, or at least perception, that tax competition is currently taking place and sharpening in the EU. This perception is generally based on different sources of information. Such sources include anecdotal evidence suggesting that corporate income taxes are occasionally lowered – or not increased – due to tax competition pressures, evidence that governments engage in strategic interaction in tax rates, and evidence on how capital flows are found to respond to tax differentials across countries.

But if tax competition is in fact intensifying along with the recent increases in capital mobility, thus leading to a lower tax burden on mobile capital, it should be possible to find a negative relationship between tax burdens on mobile capital and the degree of capital mobility. However, studies that estimate the relationship between capital mobility and capital tax burdens in cross-country panel datasets, with a few exceptions, fail to find any such significant effects. In fact, a few studies find that as capital mobility increases, so do capital or corporate income tax burdens. There are several possible explanations for the lack of strong empirical evidence. One explanation could be that the theoretical result of a race to the bottom in corporate tax burdens is based on highly restrictive assumptions, and that taking into account more nuances in the

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<sup>1</sup> See Wilson (1999) for a review of the theoretical tax competition literature.

modeling of tax competition shows us that we should not expect a race to the bottom in the first place. It is well known that companies do not only locate in low-tax countries, since many other factors, notably infrastructure, market access, access to an educated workforce, etc., can be equally or more important in the location decision of a company. Such other factors are often provided by the public sector, and may therefore be positively correlated with the tax level of the country in question, which therefore would suggest a higher tax burden in attractive investment locations. Moreover, theory shows that if increasing returns are allowed for, as in the new economic geography literature, or if political economy mechanisms are introduced, capital mobility may result in an increase in capital taxation rather than a race to the bottom<sup>2</sup>. These points show that the theory of tax competition is far from clear on whether we should expect to see capital taxes being competed downward as economic integration increases. Another reason for the weak empirical evidence could be that tax competition might only be taking place for a limited segment of corporations, usually large multinational and internationally highly mobile firms, while the much larger group of small and medium sized companies with a highly domestic focus are not yet mobile enough to challenge national tax authorities in the European Union. But it is also possible that the predicted race to the bottom is actually taking place, and that earlier empirical studies have failed to capture it due to problems in the design of the empirical methodology. An obvious pitfall in such exercises is the complication involved in measuring corporate tax burdens and the degree of capital mobility. Moreover, earlier studies have not taken into account such potential problems as endogeneity and non-stationarity, and there are no earlier panel studies exclusively studying the situation in the European Union – surprising in the light of the political urgency of the issue in a European Union context.

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<sup>2</sup> See for example Baldwin and Krugman (2004) and Persson and Tabellini (1992).

This paper addresses the mismatch of theory and empirics from the empirical side, with a focus on the European Union. This is done by conducting a panel data analysis of the hypothesis of a race to the bottom in corporate tax burdens, taking into account the problems and pitfalls of the previous literature, to the extent that this is feasible. Most of the improvements relative to earlier studies carried out here are merely fine-tuning of the methodology – panel regression analysis – which is adopted due to the lack of sufficiently long time series of the relevant variables for any individual country. As will be argued below, however, the prime suspect of being the source of the theory-empirics mismatch in the earlier literature is that of the use of inaccurate, even biased, measures of capital tax burdens. This study has a particular advantage in that regard, due to timing. A panel dataset on corporate tax burdens is now available, which on a priori grounds can be argued to have less sources of inaccuracy that could bias the results toward rejection of the hypothesis, than previously used measures of tax burdens. It turns out that implementing these adjustments to the methodology leads to robust evidence in favor of a tax competition effect on corporate tax burdens in the European Union during the 1980s and 1990s.

The structure of the paper is the following. Section 2 takes a look at the results of the previous empirical literature on tax competition. Section 3 identifies problems and pitfalls in designing the tests of a negative relationship between measures of capital mobility and measures of the corporate tax burden using panel data. The setup and results of the empirical analysis of the paper are described in Section 4. The final section concludes.

## **2. Previous Empirical Evidence**

There is no doubt that corporate as well as other types of capital have become increasingly mobile across European Union member countries, notably since the inception of the European Single Market in the mid 1980s. Moreover, the empirical literature on the sensitivity of cross

border capital flows, including foreign direct investment flows and bank deposits, finds that capital flows are indeed sensitive to tax rates<sup>3</sup>. In particular, it has been rather robustly established that foreign direct investment flows are sensitive to host country capital taxation, while there is less empirical support for domestic investments and outward investments to respond to domestic tax treatment. This means that there is scope for using tax policy to attract foreign capital to the country, and hence, scope for tax competition to be taking place, but it does not tell us whether tax competition is taking place. To test the hypothesis of a downward pressure on corporate tax burdens due to higher capital mobility and tax competition, two predictions from the theoretical literature on tax competition are usually tested. The first hypothesis states that when capital is mobile, a policymaker choosing a country's tax rate will take into account the tax rates of other countries in setting their tax rate on capital, in order to compete for capital. More formally, the model allows the derivation of a tax reaction function, according to which the capital tax rate depends positively on tax rates in competing countries. Devereux, Lockwood and Redoano (2004) give an example of the derivation of such reaction functions. Moreover, in estimating these reaction functions using OECD data, they also show that national tax rates do seem to respond to taxes of neighboring countries, implying that strategic interaction in tax rates seems to be taking place<sup>4</sup>.

A second strain of the empirical literature sets out to estimate the relationship between corporate (or capital) tax burdens and the degree of capital mobility directly, using panel regression analysis. While the theoretical framework underlying these types of specifications is not explicitly discussed in studies of this kind, the empirical specification can be interpreted as being

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<sup>3</sup> See for example Hines (1996) for a review of the literature on the tax sensitivity of US FDI flows, and Bènassey-Quéré, Fontagné and Lahréche-Révil (2000), for a study of sensitivity of OECD FDI flows to tax rates.

<sup>4</sup> Other studies, using mainly regional data within countries, have carried out similar analyses and also find evidence of strategic interactions in tax rates on the sub-national level. See the review of the literature in Devereux, Lockwood and Redoano (2004).

based on a second prediction of the standard tax competition literature, which is derived from the expression of the Nash equilibrium tax rate resulting from the interaction between the various tax reaction functions of the competing countries. This Nash equilibrium tax rate can be shown to depend negatively on the degree of capital mobility as well as parameters of the model, as discussed in more detail in Section 4. A few studies find significantly negative parameter estimates, but not robustly so, when estimating this relationship between the corporate tax burden and capital mobility. In Bretschger and Hettich (2002), a negative parameter estimate obtains, but only when using a rather problematic measure of capital mobility, namely trade openness. Swank and Steinmo (2002) find a negative correlation, but only when using statutory tax rates as a measure of the tax burden. The negative correlation does not carry over when using implicit tax rates, however, which induces the authors to argue that what they find is most likely to be the result of market friendly policy changes leading to a simultaneous fall in marginal capital tax rates and restrictions to capital flows, rather than actual tax competition. Slemrod (2004) also finds the expected negative parameter estimate for capital mobility in a tax burden regression, but also when using statutory tax rates subject to the same critique as above. However, the estimated negative correlation does not survive when Slemrod estimates a fixed effects model rather than a pool with a common intercept. The bulk of the parameter estimates for capital mobility in corporate tax burden regressions found in previous panel studies are insignificant, however (Garrett and Mitchell, 2001; Garrett, 1995; and Bretschger and Hettich, 2002, and Swank and Steinmo, 2002 – the latter two when using other measures of the corporate tax burden and capital mobility than those leading to negative correlations mentioned above). Finally, and contrary to the standard tax competition theory, some studies carry out regressions which suggest that capital taxation has increased with the degree of capital mobility (Quinn, 1997; and alternative

regressions to the ones leading to zero or negative parameter estimates mentioned above in Garrett and Mitchell, 2001; and Slemrod, 2004).

With such ambiguous results, the question naturally arises as to which studies might actually say something about whether tax competition is taking place or not, and which studies might be capturing other features of the data. The answer to this question must necessarily depend on the design of the studies mentioned above, including choices or measures of corporate tax burdens and capital mobility, choice of estimation technique, control variables, etc. These issues are addressed below.

### 3. Problems and Remedies

First, and probably most importantly, is the problem of measuring the tax burden on mobile capital in previous studies estimating the relationship between corporate taxes and capital mobility. As argued in Devereux et al. (2002), the relevant measure of the tax burden when analyzing the discrete location decision of a firm is the average tax burden on capital<sup>5</sup>. The average tax burden is also the most relevant measure to analyze when evaluating whether corporate tax burdens are pressured downward due to tax competition, and it is hence this measure which will be used in the empirical analysis conducted here. While using measures of the average tax rate has also been the manifest strategy followed in previous empirical studies, there are two overall problems related to the measures used, which could lead to bias or substantial inaccuracy. Previous studies have used statutory tax rates or one of the two backward looking measures of corporate tax revenues in percent of GDP and implicit capital tax rates<sup>6</sup>. Consider first the problem of the tax base effect when looking at statutory tax rates. A negative

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<sup>5</sup> This is as opposed to the marginal tax burden, which is more relevant for evaluating incentives for firms to shift profits between locations through for example transfer pricing or thin capitalization.

<sup>6</sup> See Sørensen (2004) for backward looking and forward looking measures of capital tax burdens.

correlation between statutory tax rates and measures of capital mobility could be expected as a result of the general lowering of statutory tax rates and the simultaneous widening of the tax base which took place in many industrialized countries in the 1980s and 1990s<sup>7</sup>. This would, however, not imply anything about what happened to the average tax burden during these years. Two of the three studies that found negative correlations mentioned in the previous Section have used statutory tax rates. The measure of corporate tax revenues in percent of GDP is designed to take the tax base into account from a macro perspective. The main problem with using corporate tax revenues in percent of GDP is that GDP is too broad and crude a proxy for the corporate tax base to be appropriate. If, for example, the corporate income tax base is positively correlated with economic integration, a positive relationship between the tax burden measure and the capital mobility measure, and hence an increase in corporate tax revenues to GDP during the last few decades, should be expected. While it is not straightforward to directly verify, the corporate tax base could for example very well have been increasing during the latter part of the 1990s along with the degree of economic integration and equity prices. Whether or not such a potential tax base effect may have outweighed potential tax competition pressures and hence account for the increase in corporate tax revenues in percent of GDP over the last decades is uncertain, but it certainly cannot be excluded. Two of the three studies finding a positive relationship between capital mobility and the corporate tax burden use corporate tax revenues in percent of GDP as a measure of the corporate tax burden. A second way of dealing with the tax base issue is proposed in Mendoza et al. (1994), and provides a more sophisticated way of computing the capital tax base by splitting up income from national accounts data between capital, labor and consumption tax base. The computation of the capital tax base is still very crude, however, and involves a high degree of approximation, suggesting that it is likely that the tax base problem discussed above is

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<sup>7</sup> See Devereux, Griffith and Klemm (2002) for the stylized facts on corporate taxation in the 1980s and 1990s.

not entirely solved by the implicit tax rate measure. Moreover, implicit capital tax rates include taxes on bases such as savings and wealth, which are not taxed at the source, and more importantly, include taxes on tax bases which are not mobile, such as property income and profits from natural resource extraction activity. Attempts at solving some of these problems by constructing a narrower implicit *corporate* tax rate have not yet amounted to a satisfactory implicit measure of the corporate tax burden which can be applied across countries<sup>8</sup>. Sørensen (2004) discusses a multitude of other problems with the use of backward looking measures based on data on tax revenues. While having other shortcomings, a third measure of the average corporate tax burden, referred to as average effective corporate tax rates in the following, is directly targeted to the cost of capital of a firm, and provides a remedy for the tax base effect. Average effective corporate tax rates measure the corporate tax burden on a hypothetical investment project using country specific tax code and various underlying assumptions regarding economic depreciation rates, inflation, type of financing, time horizon and profitability, etc. A drawback of the average effective tax rate measure is that it does not take into account enforcement issues, specially granted tax holidays and so forth, and might hence overestimate the actual effective tax burden somewhat. This would be a problem in the present analysis if tax competition is manifested mainly in such types of special tax reductions or weak enforcement rather than changes in tax code, in which case it would tend to reject the tax competition hypothesis when it might in fact be taking place. Another drawback is that average effective tax rates are found to be highly sensitive to the underlying assumptions. But, as a mitigating factor, robustness of results to changes in these underlying assumptions can be tested. Average effective corporate tax rates have not previously been employed for testing the tax competition hypothesis in panel regressions. The main reason for this is the fact that such data has not previously been

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<sup>8</sup> Some developments in this direction have been taking place. Devereux and Klemm (2004) have constructed an implicit corporate tax rate measure solving some of the problems of constructing a corporate implicit tax rate measure. This measure is presently only available for the UK, however.

computed consistently for a sufficient time horizon and for a sufficient panel of countries. But this situation has changed with the data produced by Devereux et al. (2002) on average effective corporate tax rates from 1979<sup>9</sup> to 2003 for a group of countries which includes all EU15 countries less Denmark and Luxembourg. This measure of the average effective corporate tax rate is used as a measure of the corporate tax burden for testing the race to the bottom hypothesis in the empirical analysis below.

A second problem in previous studies is the use of imprecise or poor measures of capital mobility. Earlier studies have used FDI stocks or flows in percent of GDP, deviations from covered interest parity on 3 month interbank deposit rates, trade openness, or dummy-type measures for whether capital controls are in place or not. Each of these measures have shortcomings which are important in the present context. FDI stocks or flows are clearly endogenous to tax rates, and moreover, GDP is not appropriate for scaling such stocks or flows. Differentials from covered interest parity could in principle be useful, but it is not possible to get data collected at the exact same time each day, month or even year, which make them inaccurate. They moreover measure short term financial capital mobility rather than long term real capital mobility. Trade openness obviously does not accurately measure capital mobility as current account and capital account openness may differ substantially. Trade openness is, moreover, usually used to control for the empirical regularity that more open countries have larger public sectors, and hence higher overall tax burdens, and will be used for this purpose in the empirical analysis below. Finally, using a simple dummy taking the value one when a capital control is in place and zero otherwise will not provide enough variation to be useful in a panel regression analysis, and moreover, does not capture the intensity (enforcement, etc.) of controls. A more

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<sup>9</sup> With the exception of Austria, Belgium, Portugal and Sweden, for which the series start in 1982.

sophisticated version of a dummy-type measure of capital mobility is Quinn's 14 point index of financial liberalization (described in Quinn, 1997). Quinn's 14 point index (henceforth Quinn14) is constructed using a scoring system to translate restrictions on capital into a quantitative measure ranging from 0 (financially closed) to 14 (financially open). As such, it provides a substantial amount of both time and cross-country variation, and is as accurate as possible while still suffering from the problem of not capturing the intensity of controls. Considering the shortcomings of the various measures described above, the drawback of Quinn14 seem to be the least problematic, and Quinn14 is hence used as a proxy for capital mobility in the analysis below. A final remark concerning the use of Quinn14 as a measure of capital mobility is that Quinn14 and the average effective corporate tax rate, which both are based on national laws governing capital transactions, are based on strictly different information sets (national tax code on the one hand, and exchange restrictions on the other), i.e. without overlaps. There should therefore be no risk that correlations between the measures will be capturing some hidden identity between the underlying data of the two measures.

A third problem with the design of previous studies is that a positive correlation of measures of capital mobility and tax burdens could be due to an omitted variables bias, in that previous studies do not all control for a number of potentially important factors. As noted in the introduction, the presence of increasing returns, or taking into account political economy factors, may reverse the race to the bottom result entirely. Both agglomeration economies or political economy factors could be correlated with the degree of capital mobility. The robustness of the results to controlling for such factors is therefore checked in the analysis below.

A fourth issue which is not addressed in earlier studies is that of unit roots. Most of the variables used in the regressions are likely to exhibit unit roots, implying that there is a potential risk of spurious correlations, although the risk of spurious regressions due to nonstationary data is lower in panel data than in traditional time series analysis. The stationarity of included variables is therefore checked, and the regressions are estimated in first differences.

Fifth, it is possible that the effect of tax competition pressures on capital tax burdens varies across countries, and across time – for example depending on institutional factors or differences in preferences across countries. If this is the case, then the parameter estimates for capital mobility variables in tax burden regressions give an average of the individual country parameter estimates. The panels studied in the previous literature use OECD countries<sup>10</sup>. The analysis below is instead carried out using only EU countries, which is probably a more homogenous group. The drawback of this approach is of course that it implies using a smaller sample of countries and hence fewer observations than in previous studies.

Finally, there is the issue of endogeneity. Capital taxes may have an effect on economic activity, and in turn, on some of the explanatory variables included in the test regression. This has not been taken into account in previous studies, but will be corrected for – as far as this is possible – in the analysis below.

#### **4. Empirical Analysis**

##### **Specification and Estimation**

Deriving a Nash equilibrium tax rate which depends on the degree of capital mobility on which to base an estimating equation requires a model with imperfect capital mobility. The standard tax

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<sup>10</sup> With the exception of Slemrod (2004) who also includes developing countries.

competition model a la Zodrow and Miezskowski (1986) does not have an explicit degree of capital mobility, but their model can easily be augmented with a capital mobility cost term, as shown in Rasmussen (2001). Rasmussen takes the standard tax competition model for  $N$  competing countries and uses simple functional forms (linear-quadratic) in order to solve the model explicitly. Augmenting the model with an explicit degree of capital mobility, he then shows that the resulting Nash equilibrium corporate tax rate,  $t^N$ , depends negatively (and under certain assumptions linearly<sup>11</sup>) on the degree of capital mobility. This is the negative relationship which is captured by including a measure of capital mobility in the regression of corporate tax burdens in the previous literature, and in the empirical analysis below<sup>12</sup>. Note, that in order to solve for the Nash equilibrium, the degree of capital mobility is assumed common for all competing countries due to symmetry of the competing countries. Obviously, capital mobility differs across EU countries. Taking into account this empirical asymmetry in the model would yield a Nash tax burden which depends on the degree of capital mobility of all competing countries, and not just that of the country in question. Hence, while for comparison reasons the basic specification of this empirical model is kept in line with the previous literature by including only the country specific degree of capital mobility, robustness is checked with respect to including the average degree of capital mobility of the sample countries along with, and instead of, the country specific degree (see the section on sensitivity of results)<sup>13</sup>.

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<sup>11</sup> The impact of capital mobility on the Nash equilibrium tax rate depends on constant parameters and the number of countries competing in the tax game. It is therefore necessary to assume that the number of countries in the tax competition game is constant. Assuming that  $N$  is constant might be slightly problematic for the period 1980-2000, but a clear interpretation of what  $N$  should refer to is equally problematic. If  $N$  is, for example, interpreted as the number of countries which are members of the European Community at any point in time, and this number is interacted with the capital mobility measure and inserted by itself in the estimating equation (this is done in regressions not shown here), both additional terms come out insignificant and the parameter estimate of the capital mobility term stays significantly negative. The inclusion inflates the standard errors in general, however, due to increased multicollinearity, and has hence been left out.

<sup>12</sup> See Rasmussen (2001) for the derivation of this result. The Nash equilibrium tax rate also depends on the number of countries competing in the tax game, see footnote 11.

<sup>13</sup> The dimensions of the data used here unfortunately do not allow for the estimating equation to contain the degrees of capital mobility of all other countries separately, in addition to that of the country in question, as explanatory

The main control variables used in the previous empirical literature estimating Nash equilibrium tax burdens are also used here, again in order to allow a degree of comparison with previous results. Thus, the basic estimating equation is specified as follows:

$$CORPTAX_{it} = \mathbf{a} + \mathbf{b} \cdot Quinn14_{i,t-1} + \mathbf{g}' [GDP\_C_{i,t-1}, INFL_{i,t-1}, OPEN_{i,t-1}, PART_{i,t-1}, UN_{i,t-1}] + \mathbf{u}_i + \mathbf{e}_{it}, \quad (1)$$

where the dependent variable, *CORPTAX*, measures the corporate tax burden,  $\mathbf{a}$  is a 5-dimensional vector of parameters for control variables,  $\mathbf{u}_i$  is a country specific error term, and  $\mathbf{e}_{it}$  is the country and time specific error term. Real gross domestic product per capita (*GDP\_C*) is included to capture the proposition that higher income leads to a higher demand for public goods, also called “Wagner’s Law”, and is expected to be positively related to overall taxation in the country, and therefore also to the tax burden on capital. Inflation (*INFL*) proxies for money growth and hence controls for monetary financing of the budget, and is expected to be negatively related to the corporate tax burden. The participation rate (*PART*) is included to account for the effect of demographic changes on the government budget. *PART* is defined as the labor force divided by the population between 15 and 65 years old, and expected to be negatively related to the tax burden. Openness (*OPEN*) of the country to trade (the imports and exports to *GDP* ratio) is included to take into account changes in preferences for public good provision and taxes as a response to changes in the degree of openness, and is expected to be positively related to the degree of trade openness of the country. *OPEN* is cleaned of country size effects as proposed by Bretschger and Hettish (2002) by using the residuals from a regression of trade openness on

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variables. Including a cross country average degree of capital mobility amounts to restricting the country specific degrees of capital mobility of countries to be equal.

country size as explained Table 3 in appendix<sup>14</sup>. The unemployment ratio (*UN*) is included to capture discretionary countercyclical fiscal policy measures, and is therefore expected to have a negative effect on corporate income taxes. On the basis of both visual inspection and formal tests, it cannot be rejected that most of the included variables have unit roots<sup>15</sup>. Hence, equation ( 1) is estimated in first differences, which also has the advantage of eliminating the fixed effects. The regressions are estimated using OLS with White robust standard errors, with the explanatory variables entered with a one year lag. Even though the regression is estimated in first differences with lagged explanatory variables, it cannot be entirely excluded that causality runs on both directions with the result that regressors are correlated with the error terms. This may particularly be the case if the first differences exhibit some degree of persistence. In an attempt to correct for this potential remaining endogeneity, the regressions are also estimated using two stage least squares instrumental variable estimations (henceforth IV)<sup>16</sup>. Table 1 provides tests for overidentifying restrictions and the notes under the table provide information on the instruments used.

### The Data

The dataset used for the panel regression analysis contains data for 13 EU countries (EU15 less Denmark and Luxembourg) from 1980 to 2001<sup>17,9</sup>. Average effective tax rates (CORPTAX) are computed by Devereux, Griffith and Klemm (2002), and data on Quinn's 14-point index, are constructed by Quinn (1997). The larger part of the control variables are from OECD revenue statistics and OECD Economic Outlook, with a few exceptions. Details on sources are given in Table 3 in Appendix.

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<sup>14</sup> Using the raw data on openness or the residuals from the regression of openness on size is of no consequence for the results of the estimations.

<sup>15</sup> The results of Dickey Fuller tests for all country specific time series are not shown, but can be obtained from the author.

<sup>16</sup> 2SLS rather than the more general GMM has been used due to too few degrees of freedom to start iterating over the weighting matrix.

<sup>17</sup> The sample ends in 2001 due to lack of data for Quinn's 14 point index after this date.

## Results

The basic regression results are shown in the first and second columns of Table 1. The parameter estimates of the control variables of the basic regressions are insignificant, with the exception of gross domestic product per capita, and the participation ratio. Both come out significant, but have signs which are opposite to expectation. The positive sign for the participation ratio and the negative sign for income per capita both are in line with the findings of the previous empirical literature, however<sup>18</sup>. The  $R^2$  of the OLS regression is rather low, and this as well as the few significant explanatory variables relative to the findings of previous studies is due mainly to the fact that the estimations are carried out in first differences and with lagged regressors<sup>19</sup>. The regressions are found to be significant however, and the main variable of interest, Quinn14, is significantly negative in all regressions.

(Insert Table 1 around here)

The hypothesis of a negative relationship between the corporate tax rate and Quinn14 is thus supported by the data, irrespective of whether OLS or IV is used to estimate the regression. The effect of capital mobility on the corporate tax rate is, however, found to be substantially more important when IV is used, implying that endogeneity might still be an issue<sup>20</sup>. The IV estimation method is therefore kept in the following analysis. The parameter estimate implies that a one point increase in Quinn14 leads to a reduction in the corporate tax rate of 2.031 percentage points. Since the EU average of Quinn14 increased by approximately 4 points between 1980 and 2001 and the EU average of the average effective corporate tax rate was 40 percent in 1980, a

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<sup>18</sup> All other studies mentioned in the literature review, a part from Slemrod (2004) for which the control variables used are entirely different, use growth rather than income per capita, in order to control for cyclical policy. The unemployment rate is capturing cyclical discretionary policy changes here. Including growth rather than income per capita does not change the conclusions or the parameter estimates of the other variables.

<sup>19</sup> Carrying out the regressions in levels with contemporaneous regressors (not shown) substantially increases the  $R^2$  and the significance of the control variables.

<sup>20</sup> A higher parameter estimate on Quinn14 in the IV regression than in the simple OLS regression does not necessarily mean that the reverse relationship between CORPTAX and Quinn14 is positive – which would be rather counterintuitive. The endogeneity captured may also derive from reverse causality of other explanatory variables, which are correlated with Quinn14. A panel VAR approach would give more information on this issue, but such an approach is prevented by data constraints.

back-of-the-envelope calculation implies that the EU average effective corporate tax rate has fallen by about 8 percentage points, or about 20 percent of the average EU effective corporate tax rate between 1980 and 2001, due to tax competition pressures. While 20 percent might not constitute a “race to the bottom”, it implies that capital mobility has been an important factor shaping corporate taxes in the last two decades. The average corporate tax burden for the EU fell by a total of 30 percent between 1980 and 2001 according to the Devereux, Griffith and Klemm (2002) data, implying that the entire fall in corporate income taxes during this period cannot be attributed to rising capital mobility according to the results of the panel regression.

### **Sensitivity**

The significantly negative tax competition effect is robust to a variety of sensitivity tests. The third column of Table 1 shows the regression results when taking into account additional control variables which may have an influence on the corporate tax rate, namely political economy influences and agglomeration variables. Concerning political economy variables, Persson and Tabellini (1992) illustrate how the tax competition outcome may be mitigated when allowing for elections and changing preferences for social security in a tax competition model. The robustness of the results to political economy influences is therefore checked by including a dummy for partisanship, which takes the value one when the government in power is defined as being to the left in the political spectrum. This dummy is called *LEFT* (see details on construction in appendix). A leftwing government is a priori expected to prefer higher capital taxes, all else equal, thus implying that the expected sign of *LEFT* is positive. Moreover, the contemporaneous values of a dummy for parliamentary election years (referred to as *ELEC*) is included to account for election year cycles. The sign of *ELEC* is expected to be negative. Regarding the control variables for agglomeration economies, Baldwin and Krugman (2004) show that when agglomeration rents are allowed for, as done in the new economic geography literature, attracting

industry to one location creates agglomeration rents, which can then be taxed without capital fleeing, in spite of capital being perfectly free to move. Capital becomes a quasi-fixed factor. Allowing for agglomeration forces hence has the potential to reverse the results of the standard tax competition model. More importantly, the degree of agglomeration economies may be correlated with capital mobility, and hence, may be a source of unobserved heterogeneity which is directly correlated with the central explanatory variable (which should be expected to downwardly bias the parameter estimate, however). Whether or not a reversal of the standard tax competition result will take place in a model including agglomeration economies depends on the discrete cross country differential in the returns to capital employed in the corporate sectors. Since including a measure of the return to capital would give rise to substantial endogeneity problems in the regressions, agglomeration economies are instead proxied by real value added in manufacturing and services per capita (this measure is henceforth referred to as *AGGL*). Inspired by the empirical literature on agglomeration economies, another measure of agglomeration economies is also included, namely that of market size (henceforth *MS*) measured as total real GDP. The results show that none of the two agglomeration variables are significant, and their presence in the regression does not change the finding of a significantly negative effect of capital mobility on the corporate tax burden in European Union countries.

Since the implicit average corporate tax burden measure is often criticized for being highly sensitive to the underlying assumptions, the robustness of the results to changes in the underlying assumptions is tested. Devereux, Griffith and Klemm (2002) provide six alternative series for the average effective corporate tax rate measure, each with different underlying assumptions regarding type of financing (debt or equity and retained earnings), inflation (fixed or country and time specific), type of investment project (industrial buildings or plant and machinery) and

economic rent of the investment project (10, 20, 30 or 40 percent). Table 3 in the appendix spells out the change in underlying assumptions for each of the six alternative series. The six series have been used as dependent variables in turn, and the resulting parameter estimates for the capital mobility index in the resulting regressions are given in Table 2.

(Insert Table 2 here)

The parameter estimates vary slightly according to which underlying assumptions are used, but the support of the tax competition hypothesis found in the data is quite robust to changes in these underlying assumptions.

Finally, two additional regressions are estimated to allow for the degree of capital mobility of other countries in the sample to affect each country's corporate tax burden, along with the capital mobility of the country in question. This is done by first including the average degree of capital mobility of all other competing countries along with the country specific degree of capital mobility, and second, by including the average degree of capital mobility for all countries, including the country in question, rather than the country specific capital mobility. The results are shown in the last two columns of Table 1. When the average of competing countries' capital mobility measure is included in the regression along with the country specific degree, column 4 of Table 1 shows that the parameter estimate of the country specific degree of capital mobility is slightly lower, but remains significant, while the competing country average is insignificant. When only the overall average of the degree of capital mobility is included as in column 5 of Table 1, this measure of the degree of capital mobility is higher, and significant. All in all, these changes in the specification of the tax competition hypothesis do not qualitatively change the overall conclusion that capital mobility feeds tax competition pressures.

There still remains the possibility that the significantly negative parameter estimate is driven by a simultaneous capital market liberalization and reduction in business taxes due to more market and business friendly domestic policies rather than actual tax competition<sup>21</sup>. Since the regressions are estimated in first differences with lagged regressors, and using two stage least squares on the lagged first differences, the likelihood of this seems lower than in previous papers which have used uninstrumented, and often contemporaneous, levels of the regressants. But it cannot be dismissed entirely, and further research on this issue is therefore warranted.

## 5. Conclusions

Despite a widespread acceptance that a race to the bottom in corporate taxes in the European Union is taking place, the empirical support for this has not been strong. Several studies have even come to the opposite conclusion that capital mobility is positively correlated with capital taxation. This paper highlights some of the potential problems and pitfalls which should be addressed in the design of panel regression tests of the correlation between capital mobility and the corporate tax burden, and which might account for the lack of or unexpected results of the earlier literature. In taking these problems into account, and in particular, in employing a more appropriate dataset for corporate tax burdens, the empirical analysis of this paper provides rather robust support for increased capital mobility to have been accompanied by a downward pressure on corporate tax burdens in the European Union since the early 1980s. The results moreover allow an assessment of the quantitative importance of such a tax competition pressures. Estimates suggest that increases in capital mobility has led to a reduction in corporate tax burdens of about one fifth between 1980 and 2001 on average in the European Union.

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<sup>21</sup> This possibility is pointed out in several other studies. See for example Swank and Steinmo (2002).

When interpreting these results, it is worth keeping in mind that whether tax competition pressures imply that corporate income taxes ought to be coordinated or harmonized in the European Union depends on several other factors which remain uncertain. Most importantly, the jury is still out on whether or not tax competition is harmful or improves public sector efficiency. Tax harmonization, rather than competition, may be harmful if the latter is the case. Theory suggests that both effects are possible, and there is no consensus, nor any consistent empirical evidence for either. It is also worth keeping in mind that it is unclear what the optimal form of tax coordination or harmonization would be.

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## **Appendix**

(Insert Table 3 and

Table 4 here)

## Tables

Table 1: The impact of capital mobility on the average effective corporate tax rate

	OLS <sup>a/d</sup>	IV <sup>a/b</sup>	IV <sup>a/b</sup>	IV <sup>a/b</sup>	IV <sup>a/b</sup>
Quinn14 <sub>1</sub>	-0.842** (0.392)	-2.031*** (0.732)	-1.939** (0.875)	-1.294* (0.733)	
GDP_C <sub>1</sub>	-0.724* (0.395)	-1.466* (0.863)	-1.883 (1.402)	-0.688 (0.835)	-0.661 (0.812)
INFL <sub>1</sub>	-0.017 (0.114)	-0.318 (0.247)	-0.269 (0.275)	-0.344 (0.246)	-0.337 (0.268)
OPEN <sub>1</sub>	-0.019 (0.014)	0.136 (1.080)	0.204 (0.148)	0.040 (0.089)	0.010 (0.081)
PART <sub>1</sub>	0.464** (0.228)	0.390* (0.234)	0.403** (0.157)	0.198 (0.191)	0.218 (0.191)
UN <sub>1</sub>	-0.333* (0.196)	-0.758 (0.465)	-0.821 (0.570)	-0.605 (0.409)	-0.613 (0.402)
ELEC			-0.114 (1.486)		
LEFT <sub>1</sub>			0.848 (0.563)		
AGGL <sub>1</sub>			-0.076 (0.142)		
MS <sub>1</sub>			0.009 (0.011)		
Quinn14 <sub>1</sub> (average1)				-1.801 (-1.447)	
Quinn14 <sub>1</sub> (average2)					-2.943** (1.173)
Obs.	241	195	182		
DW	1.98	2.03	2.07		
J-test <sup>c</sup>		18.5 (p=0.61)	14.5 (p=0.69)		

\*\*\* (\*\*\*) (\*): Parameter estimate equal to zero rejected on 1% (5%) (10%) significance level.

/a: Estimation carried out in first differences with White robust standard errors

/b: IV regressions are carried out using 2SLS. Instruments: 2<sup>nd</sup> and 3<sup>rd</sup> lag of first differences, 3<sup>rd</sup> lag of levels, and 1<sup>st</sup> and 2<sup>nd</sup> of the election year, a total of 27 instruments.

/c: J test for overidentifying restrictions, adapted from GMM to the 2SLS case by imposing the weighting matrix of 2SLS and no iterations. Under the null of no overidentification, J is chi-square distributed with 21 (17 in the last column) degrees of freedom.

/d: R<sup>2</sup>=0.02

Table 2: Robustness of CORPTAX parameter estimates to using alternative underlying assumptions for the effective average corporate tax rate<sup>a</sup>

	OLS <sup>b</sup>	IV <sup>b/c</sup>
CORPTAX1	-0.548** (0.273)	-1.331** (0.584)
CORPTAX2	-0.962** (0.432)	-2.058** (0.824)
CORPTAX3	-0.831** (0.413)	-1.900** (0.835)
CORPTAX4	-0.805* (0.416)	-1.973** (0.836)
CORPTAX5	-0.826** (0.414)	-1.845** (0.849)
CORPTAX6	-0.823** (0.415)	-1.815** (0.857)

\*\*\* (\*\*\*) (\*): Parameter estimate equal to zero rejected on 1% (5%) (10%) significance level.

/a: The assumptions underlying the 6 alternative measures of CORPTAX are laid out in appendix. Only parameter estimates for CORPTAX are reported. The complete regression output can be obtained from the author upon request.

/b: Estimation carried out in first differences with White robust standard errors

/c: IV regressions are carried out using 2SLS. Instruments: 2<sup>nd</sup> and 3<sup>rd</sup> lag of first differences, 3<sup>rd</sup> lag of levels, and 1<sup>st</sup> and 2<sup>nd</sup> of the election year, a total of 27 instruments.

Table 3: Definitions and sources of data used in the panel regression analysis

Variable	Definition and Sources
AGGL	Real value added in manufacturing and services per capita, measured in millions of dollars in fixed 1995 prices. Source: Own calculations based on data from OECD Economic Outlook
CORPTAX	Average effective corporate tax rate are computed by and described in Devereux, Griffith and Klemm (2002) and downloaded from the Institute of Fiscal Studies Homepage: <a href="http://www.ifs.org.uk/publications.php?publication_id=3210">http://www.ifs.org.uk/publications.php?publication_id=3210</a> .
CORPTAX1	Alternative average effective corporate tax rate. Computed as CORPTAX, but debt financed investment instead of finance through equity or retained earnings. Source: Same as that of COPRTAX.
CORPTAX2	Alternative average effective corporate tax rate. Computed as CORPTAX, but country and time specific inflation rates are assumed instead of a fixed uniform inflation rate. Source: Same as that of COPRTAX.
CORPTAX3	Alternative average effective corporate tax rate. Computed as CORPTAX, but with an assumed 20% instead of 10% rent. Source: Same as that of COPRTAX.
CORPTAX4	Alternative average effective corporate tax rate. Computed as CORPTAX, but the investment is assumed done in industrial buildings instead of plant and machinery. Source: Same as that of COPRTAX.
CORPTAX5	Alternative average effective corporate tax rate. Computed as CORPTAX, but with the assumption of 30% rent instead of 10% rent. Source: Same as that of COPRTAX.
CORPTAX6	Alternative average effective corporate tax rate. Computed as CORPTAX, but with the assumption of 40% rent instead of 10% rent. Source: Same as that of COPRTAX.
ELEC	Dummy taking the value 1 in years of parliamentary elections of the given country, and zero otherwise. Source: Parties and Elections in Europe: <a href="http://www.parties-and-elections.de/">http://www.parties-and-elections.de/</a>
GDP_C	Real GDP per capita. Source: Computed on the basis of data from OECD Economic Outlook
INFL	Yearly percentage change in the consumer price index. Source: OECD Economic Outlook
LEFT	Dummy for the ideology of the government in power, based on data provided by Woldendorp et. al (2000), which classifies ideology of government into five cases based on the number of fraction of parliament and government made up by left and right wing parties. First case is when right wing parties dominate both government and parliament, and in the fifth case, left wing parties dominate government. The left wing dummy ( <i>LEFT</i> ) takes the value one in case 4 and 5.
MS	Market size: Constant GDP measured in US dollars. Source: OECD Economic Outlook
OPEN	Residuals of a regression of the sum of exports and imports divided by 1.000.000*GDP (all in current local currency) on the relative size of the country (size is measured as real GDP in percent of sum of real GDP of the panel countries). Own calculations based on data from OECD Economic Outlook
PART	The participation rate, constructed as the labor force in percent of the population between the age of 15 and 65. Data for Portugal are from the Ameco database. For other EU countries, data are from OECD Economic Outlook.
Quinn14 (+average1 and average2)	Quinn's 14 point index of financial liberalization as described in Quinn (1997). Source: Kindly provided by Dennis Quinn. Quinn14 (average1) is the country average of Quinn14 at time t excluding country i, and Quinn14 (average2) is the country average of Quinn14 at time t.
UN	Unemployment rate, percent. Source: OECD Economic Outlook

Table 4. Descriptive statistics

Variable	Mean		Std. Dev		Observations <sup>/a</sup>		
	Overall	Overall	Between	Within	N	n	T
AGGL	0.007	86.46	87.44	18.80	433	14	31
CORPTAX	33.417	11.43	8.78	7.47	309	13	24
CORPTAX1	12.241	6.59	4.64	4.77	309	13	24
CORPTAX2	33.607	11.95	9.06	8.03	300	13	23
CORPTAX3	35.735	11.89	9.08	7.83	309	13	24
CORPTAX4	36.839	12.31	9.77	7.74	313	13	24
CORPTAX5	36.774	12.05	9.22	7.98	313	13	24
CORPTAX6	37.393	12.17	9.30	8.06	313	13	24
ELEC	0.280	0.45	0.04	0.45	446	14	32
GDP_C	33272	488719	128270	473243	413	14	31
INFL	7.189	5.87	3.18	5.01	448	14	32
LEFT	0.534	0.52	0.27	0.45	379	14	27
MS	10486	211032	38356	207851	447	14	32
OPEN	4.880	31.95	28.04	17.05	433	14	31
PART	64.862	2.83	1.88	2.17	432	14	31
Quinn14	11.208	2.75	1.66	2.24	434	14	31
UN	7.272	7.28	2.83	6.75	447	14	32

a/: N is the total number of observations for the given series, n is the number of cross sections for which the series exists, and T is the maximum number of years for which the series is available. Thus, the total number of observations can be smaller than n\*T when some countries have a shorter time series dimension than the maximum.