Spatial tax competition in the EU15

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Abstract

Tax competition in the European Union is fierce. Especially since the entry of the new member States, tax reforms in the "old" Europe are frequent. In this paper we formally test the presence of strategic tax setting in the old EU15 as a reaction to the tax rates in the new EU10 using a fiscal reaction function. We first develop a simple model of spatial tax competition that predicts an inverse relationship between distance and toughness of tax competition. Empirically we find indeed that tax competition is stronger for countries relatively closer to the low tax region of the EU10 like Germany and Austria than for old member States further away from the new member States such as Spain, UK and Portugal.

1 Introduction

Over the past decade, corporate tax rates decreased in the enlarged Europe. The average corporate tax rate in the EU25 dropped from 38.24% in 1993 to 25.77% in 2006. The introduction of the euro in 2002 and the accession of 10 new member states in 2004 seem to have contributed to increased tax competition in the 'old' Europe. Within the EU15, Ireland, Germany and Italy have known the largest decrease in their corporate tax rates during the period 1993-2006. Perhaps not surprisingly, two of these countries are 'neighbors' of the new EU10 countries[1]. The literature on FDI location decisions shows that Eastern European countries can use corporate tax rates as an effective instrument to attract FDI (Disdier & Mayer (2004) and Bellak & Leibrecht (2005)). As a consequence, a multinational from outside Europe can decide to locate in a low tax country within Europe and export goods to a high tax European country instead. Thus, EU integration may have intensified EU tax competition between neighboring countries. Some earlier studies find that EU15 countries set their corporate tax rates interdependent (Devereux. Lockwood & Redoano (2002), Altshuler & Goodspeed (2002), Redoano (2003) and Ruiz & Gerard (2007)), but none of these studies has investigated spatial tax competition between the 'old' EU15 and the 'new' EU10. This is where the aim of this paper lies: we study to what extent geographical proximity to the low tax areas of the new EU10 members affects corporate tax rates in the former EU15 countries[2].

For this purpose, we develop first a spatial tax competition model à la Hotelling (1929) and d'Aspremont et al. (1979) with countries competing to attract a multinational. The model predicts that tax competition is more intense between geographically close countries. Second, the outcome of the theoretical model is tested

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[1]Ireland is a special case. It has a different tax rate development than the rest of Europe. Since 1997 onwards, the Irish corporate tax rate decreased tremendously and dives under the average tax rate of the EU10.

[2]The EU15 includes Germany, Austria, Italy, Spain, Portugal, Belgium, Luxembourg, the Netherlands, Finland, Sweden, Denmark, UK, France, Greece and Ireland.

using a fiscal reaction function[3]. We test whether and which EU15 countries respond to changes in the tax rates of EU10 countries. The results indicate that distance matters for tax competition i.e. EU15 countries closer to the EU10 like Germany and Austria are more responsive than countries further away from the EU10 such as France, Belgium and the Netherlands.

The paper is organized as follows. First, section 2 shows some stylized facts of corporate taxes in Europe. Section 3 reviews the related literature on tax mimicking and section 4 develops a theoretical framework. Section 5 explains the methodology and the data. Section 6 shows the results and 7 discusses the robustness checks. Finally, section 8 briefly concludes our main results.

2   Corporate taxes in Europe: stylized facts

Although traditional tax competition theories predict a downward pressure on corporate taxes when capital mobility increases (for an overview see Wilson (1999) and Bretschger & Hettich (2002)), empirical studies do not find evidence of a race to the bottom in corporate taxes (Krogstrup (2004), Baldwin & Krugman (2004), Salvatore (2002), Bénassy-Quéré et al. (2007), Desai (1999), Mendoza & Tesar (2004) and Stewart & Webb (2006)). While statutory taxes fell down in the EU, tax bases were broadened such that tax revenues on corporate incomes remained stable (Devereux. Griffith & Klemm (2002), Buijinck et al. (2002) and Vandenbussche & Crabbé (2006)). Previous studies investigated corporate tax rates according to the traditional classification of EU15 and EU10 countries. In contrast, Vandenbussche & Crabbé (2006) group EU15 countries in neighbors and non-neighbors of the EU10. Ireland and the EU10 are presented separately. Neighbors are defined as countries with a common land or water border with one or more countries of the EU10. We

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[3]The terms fiscal reaction function, tax mimicking, spatial competition and strategic interaction will be used as synonyms explaining the event of countries reacting to tax changes in related other countries.

extended their data with tax rates for 2005 and 2006. The result is presented in Figure 1.
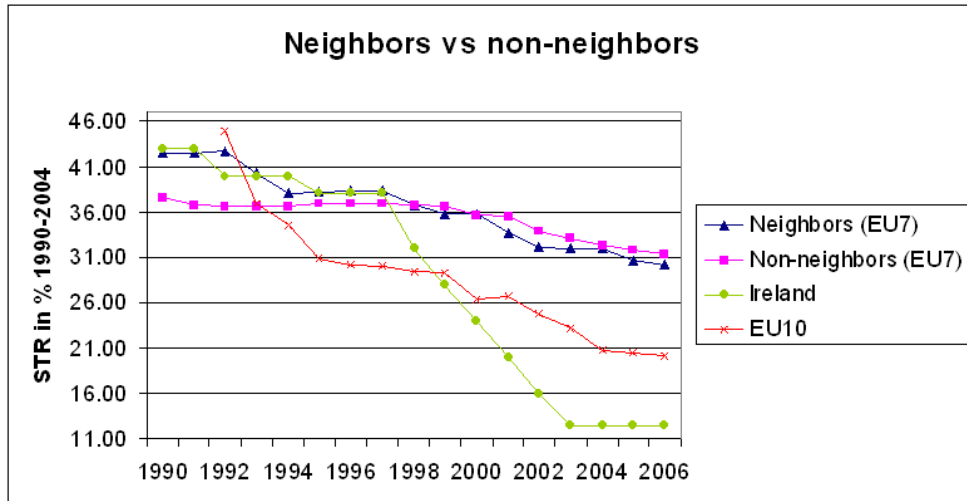

Figure 1: Neighbors versus non-neighbors of the new EU10 members, 1993-2006
Neighbors: Germany, Austria, Denmark, Finland, Sweden, Italy and Greece; Non-neighbors:
Spain, France, UK, Netherlands, Belgium, Luxembourg and Portugal
Source: Vandenbussche & Crabbé (2006), extra data included for 2005 and 2006.

This figure confirms previous findings that the average corporate tax rate in the EU10 is lower than in the EU15 and the gap in tax rates between the EU10 and EU15 even increased over the period 1993-2006. In addition, Figure 1 illustrates the fast decrease in tax rates of Ireland since 1997. As a consequence, two groups can be distinguished: a core and a periphery. The 'core' are the EU14 countries (neighbors and non-neighbors) and charges an average tax rate of 30.98%, the 'periphery' group consists of the EU10 and Ireland with an average tax rate of 20%. This tax difference is consistent with the theory of Baldwin & Krugman (2004) suggesting that firms in the core are willing to pay higher tax rates in return for better infrastructure, more high skilled labor and technological development. But the main observation from Figure 1 is that corporate tax rates decreased much faster in the neighbors compared to the non-neighbors of the EU10. While the average tax rate in the non-neighbors

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remained stable for a long period, the average tax rate in the neighbors decreased rapidly and dived under the average tax rate of the non-neighbors in 2000. These reforms could indicate that neighbors of the EU10 are subject of more intense tax competition as a result of their geographical proximity to the low tax areas of the EU10. The aim of this paper is to study the sharp decrease in corporate tax rates of the neighboring countries of the EU10 as a reaction to low tax rates in the EU10 more closely.

3 Related Literature on Fiscal Reaction Functions

Generally, theoretical and empirical work point out that countries or regions do not set their tax rate independently, but take into account the tax rates in related countries or regions. Countries or regions do this according to two reasons: yardstick competition and capital tax competition. The first theory poses that voters judge policy-makers on their performance by comparing tax rates of neighboring countries. Therefore, politicians, to ascertain their re-election, will 'tax mimic' their neighbors' tax rate. The second theory argues that countries compete to attract capital by setting lower tax rates. It is not always clear whether the presence of 'tax mimicking' comes from yardstick or tax competition, since the empirical method for both theories is the same (Brueckner 2003).

Empirical studies estimate a fiscal reaction function of a certain jurisdiction which relates the tax rate of this jurisdiction to its own characteristics and to the tax rate in competing jurisdictions. When tax rates are chosen strategically, the reaction function has a nonzero slope indicating that competitors' tax rates influence the given jurisdiction's choice. The sign of the slope can be positive or negative depending on the specific parameter values. If strategic interaction is absent, the slope of the reaction function is not significantly different from zero (Brueckner & Saavedra 2001). This methodology has been used in many articles on local property, business or personal taxes (Besley & Case (1995), Bordignon et al. (2002), Heyndels

& Vuchelen (1998), Brueckner (1998), Brett & Pinkse (2000),Brueckner & Saavedra (2001), Carlsen et al. (2005), Buettner (2001), Ladd (1992), Allers & Elhorst (2005), Hayashi & Boadway (2001), Allers & Elhorst (2005), etc) and government expenditure levels (Solé-Ollé (2003), Figlio et al. (1999), Revelli (2003), Case et al. (1993), Geys (2006), Baicker (2005), Werck et al. (2007), etc) across jurisdictions within one country[4].

With regard to corporate taxes, Devereux. Lockwood & Redoano (2002) argue that yardstick competition can be eliminated as a possible explanation. The reason is that corporate taxes are not a critical topic for voters to evaluate policy-makers, certainly because most voters do not even know the domestic corporate tax rate. Devereux. Lockwood & Redoano (2002) investigate strategic tax competition in 21 OECD countries in the period 1982-1999. They find that countries strategically compete over the statutory tax rate and EATR[5] and that countries with relatively high effective tax rates react more strongly to tax rates in other countries. A second study examining strategic tax competition between countries and the first using only EU countries is Altshuler & Goodspeed (2002). They find that EU countries strategically compete with geographically close countries using corporate tax revenues over GDP, but not using personal income tax revenues. They also conclude that since the US tax reform of 1986, non-tax haven EU countries compete to a lesser extent with the US in corporate tax rates. A second study using exclusively European countries is Redoano (2003). She shows that tax competition mainly occurs between geographically close countries using statutory tax rates for 13 European countries during the period 1980-1995. Finally, Ruiz & Gerard (2007) find empirical evidence of limited 'tax mimicking' between neighboring EU15 countries using statutory and effective tax rates during the period 1989-2001. They argue that possible converging tax rates in the EU15 can explain their weaker result of spatial tax competition.

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[4]See Brueckner (2003) for an overview of empirical studies on strategic interaction

[5]EATR= effective average tax rate calculated using the forward looking method, see Devereux. Griffith & Klemm (2002).

This paper will extend the limited number of studies using fiscal reaction functions on exclusively European Union countries. In particular, the impact of changes in the tax rates of the EU10 on tax rates of the EU15 will be the focus. Furthermore, different definitions of neighbors will be used to gain insights in the spatial tax competition process in the EU25 during the period 1993-2006.

4   Theory

In the classic Hotelling (1929) model, two ice-cream sellers choose their location on the beach in order to maximize their sales. Each consumer buys one unit of ice cream based on the price and the cost of transporting the good home. d'Aspremont et al. (1979) improved this model and came to the conclusion that each ice-cream seller gains from moving away as far as possible from the other. Extending the intuition arising from their results on competition between firms to competition between countries suggests an inverse relation between distance and toughness of tax competition.
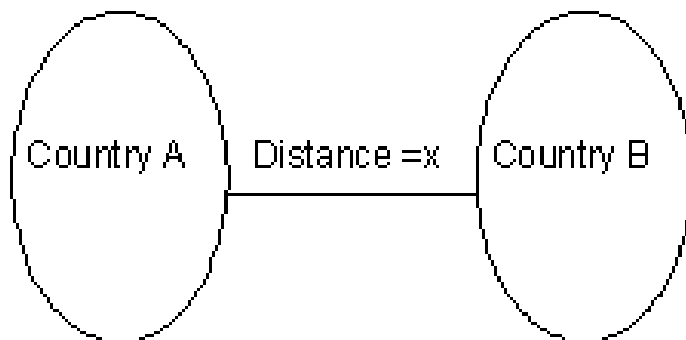

Figure 2: Spatial tax competition: a theoretical framework

In our model two countries A and B are located on a fixed distance x from each other as illustrated in Figure 2. We assume that there is only one firm, a multinational

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that does not compete with the domestic firms. This firm will have two location options. Either it locates in country A and produces for the domestic market, or it sets up in country B where it will produce for the market of both countries. In the latter case, the firm will need to pay a transportation cost to export the goods to country A. This transportation cost, c, is quadratic related to the distance x: cx^2 so that the transportation cost becomes more expensive for longer distances[6] (d'Aspremont et al. 1979). The reason why the multinational wants to sell to country A whatever location is chosen, is that the relevant market for its products is in country A. Consumers in country A have a higher demand for the products, for example welfare in country A is higher and the multinational sells luxury products. This assumption is translated in a larger market size for country A than for country B ($M >> m$). A final assumption is that set up costs and production costs are the same in both locations, therefore they will not affect the location decision of the firm and can be dropped from the analysis. The order of events is as follows.

- Stage 1: the government of country A will set its tax rate.

- Stage 2: the multinational makes its location decision.

- Stage 3: the multinational sells to maximize its profits.

We solve the model backwards, introducing additional formal notation as required[7]. To simplify things we assume that the corporate tax rate in country B is fixed. Moreover it is not essential for the aim of this model, namely the impact of distance between countries on the tax rate of country A. In stage 3, the multinational sells a certain output to maximize its profits. Using the demand functions of both countries A and B

$$P_A = (M - Q_A) \tag{1}$$
$$P_B = (m - Q_B),$$

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[6]We can relax this assumption and include a linear transportation cost cx. This will not change our outcome.

[7]The detailed computations are described in Appendix.

the after-tax profit of the multinational is:

$$\pi_A = (M - Q_A)Q_A(1 - t_A) \tag{2}$$

$$\pi_B = [(m - Q_B)Q_B + (M - Q_{AB})Q_{AB} - cx^2 Q_{AB}](1 - t_B)$$

where t_A (t_B) is the corporate tax rate of country A (B) and $0 < t_A(t_B) < 1$.

The equilibrium output and after-tax profits in A or B are respectively

$$A : Q_A^* = \frac{M}{2} \tag{3}$$

$$\pi_A^* = \frac{M^2}{4}(1 - t_A)$$

and

$$B : Q_B^* = \frac{m}{2} \ and \ Q_{AB}^* = \frac{M - cx^2}{2} \tag{4}$$

$$\pi_B^* = (1 - t_B)(\frac{m^2}{4} + M\frac{M - cx^2}{2} - \frac{(M - cx^2)^2}{4} - cx\frac{M - cx^2}{2})$$

The second stage deals with the firm's location decision. The multinational will be indifferent in its location preference when its after-tax profit in country A equals the after-tax profit it could earn in country B. This is when the tax rate of country A equals

$$\pi_A^* = \pi_B^* \tag{5}$$

$$\Rightarrow t_A^* = -(1 - t_B)(\frac{m^2 + (M - cx^2)^2}{M^2}) + 1$$

This equilibrium tax rate is among others a function of the tax rate of country B, market size, transport cost and distance x.

The outcome of the second stage leads to two options for country A's tax rate. Country A can set its tax rate below or above t_A^*. Both options result in a different welfare function for country A. We assume that the welfare function of country A consists of consumer surplus (CS), and tax income. Since a multinational is usually

foreign owned, after-tax profits will be shifted abroad and do not enter the welfare function of country A. Including the firm's after-tax profits into the welfare function would not change our basic result, on the contrary it would strengthen the outcome. But it makes the algebra simpler. The welfare function can be written as follows

$$W_A = CS + t_A \frac{\pi_A^*}{1 - t_A} \tag{6}$$

If country A chooses for option 1 and sets a tax rate lower than t_A^*, then the multinational will find country A more attractive and locates in A. Country A will receive tax incomes from taxing the firm's profit. On the other hand, if country A chooses to set its tax rate above t_A^* (option 2), then the firm will find country B a better location to produce and export to country A. As a consequence, country A looses its tax income and consumer surplus will be lower than in the first option due to transport costs.

This argument can be summarized as follows

$$t_A < t_A^* \quad \Rightarrow \quad W_A = CS_1 + t_A \frac{\pi_A *}{1 - t_A} \tag{7}$$
$$OR$$
$$t_A > t_A^* \quad \Rightarrow \quad W_A = CS_2$$

Since country A wants to maximize its welfare, the optimal tax rate of country A will be just below t_A^*.

This brings us to the main question in this paper, namely how will distance between two countries influence the tax rate of country A. Deriving the optimal tax rate for country A with respect to distance x leads us to the following equation

$$\frac{\partial t_A}{\partial x} = (1 - t_B)(\frac{4cxM - 4c^2x^3}{M^2}) \tag{8}$$

which will be positive as long as the market size of country A is larger than the transport cost $(M > cx^2)$. This indicates that countries closer to country B will set lower taxes as long as the domestic market is large enough. This aspect of the model seems to suggest that market size or the level of development plays a role as

well. Hence, in the empirical framework we will test for the level of development by using GDP per capita. Assuming that country A is a member of the EU15 countries and country B is an example of the EU10 countries, the outcome of the theoretical model can be summarized in the following proposition.

PROPOSITION: EU15 countries closer to the new EU10 member states experience more tax competition from the EU10.

5   Methodology and Data

To test this theoretical proposition empirically, a fiscal reaction function for the EU15 countries is estimated. As explained in section 3, a fiscal reaction function has a nonzero slope when countries strategically react to tax rates in other countries. We investigate the interaction between the EU15 and EU10 countries for the period 1993-2006.

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\begin{aligned}
TAX_{i_{EU15},t} &= \beta_0 + \beta_1 TAX_{i_{EU15},t-1} + \beta_2(\sum_{i \neq j} w_{ij} TAX_{j_{EU10}}) \qquad (9) \\
&\quad + \beta_3 X_{i,t} + \alpha_i + \delta_t + \varepsilon_{it}
\end{aligned}
$$

In the above expression (9), the dependent variable TAX is the statutory tax rate of country i in the EU15[8] at time t[9]. On the right hand side, the model includes the lagged dependent TAX variable, the weighted tax rate of the 10 new member states[10] ($w_{ij}TAX_{jEU10}$), a set of country control variables (X)[11] such as population

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[8]EU15= Belgium, Netherlands, Luxembourg, Germany, France, Spain, Portugal, UK, Ireland, Denmark, Sweden, Finland, Austria, Italy and Greece

[9]All data on corporate tax rates are collected for the period 1993-2006 from KPMG (2006)'s tax surveys and were available for 1993-2006.

[10]Poland, Slovakia, Czech Republic, Slovenia, Hungary, Lithuania, Latvia, Estonia, Malta and Cyprus

[11]The control variables, population density and GDP per capita are collected from the world de-

density, GDP per capita and the lagged personal income tax rate, country fixed effects (α_i) and time dummies (δ_t).

The weighted EU10 tax rates is our main variable of interest. This variable is the weighted sum of the statutory corporate tax rates of the new EU10 member states:

$$(wSTR)_{it} = \sum_{j \neq i} w_{ij} STR_{jt}$$

$$\forall i : \sum_{j} w_{ij} = 1 \tag{10}$$

For the weight, different measures from the theory will be used. According to Besley & Case (1995), spatial models typically use geographical weights for 2 reasons. First, geographic neighbors are likely to experience similar shocks and therefore neighbors' tax rates are more informative than tax rates in far away districts. A second reason is that information about policy decisions in nearby countries spreads quicker. The main weighing scheme that we will use is the inverse distance between the EU15 and EU10 countries. In addition, four other weighing schemes will be used to gain insight in the EU15 tax competition game. The most widely used definition of neighbors is contiguity. In this definition the weight w_{ij} equals 1 if country i has a common land or water border with country j and 0 otherwise. A third spatial weight is based on the idea that also neighbors of second order can be affected by changes in the corporate tax rates of the EU10 countries. In this case, w_{ij} equals 1 if country i is a second neighbor of country j and 0 otherwise. Finally, two non-distance related weighing schemes will be used. The first is the lagged share of exports from country i to country j in the total exports of country i. The second non-distance weighing scheme is the inverse difference in gdp per capita between country i and j[12]. All weights are normalized so that their sum equals 1.

Due to possible correlation between country fixed effects and the lagged dependent

velopment indicators (WDI), while the personal income tax rate is available in the OECD database until 2004

[12]The distances are selected from the CEPII distance measures, export shares are calculated from Eurostat and GDP per capita is collected from World Development Indicators (WDI).

variable in the estimation of equation (9), we need to take first differences in order to get rid of this correlation[13]. Equation (9) can consequently be rewritten as:

$$\Delta TAX_{i_{EU15},t} = \beta_0 + \beta_1 TAX_{i_{EU15},t-1} + \beta_2 \Delta(\sum_{i \neq j} w_{ij} TAX_{j_{EU10}}) \quad (11)$$
$$+ \beta_3 \Delta X_{i,t} + \varepsilon_{it}$$

A second econometric issue is the possible endogeneity of the weighted tax rates of the EU10. To solve this problem, the instrumental variables method is frequently applied in the fiscal reaction literature since it is easier to implement than maximum likelihood (Brueckner (2003) and Allers & Elhorst (2005)). As an instrumental variable, the endogenous variable can be lagged by one or more periods. Another typical procedure under the IV approach in the spatial lag model is to regress each country i's neighbor tax rates $\sum_{i \neq j} w_{ij} TAX_{j_{EU10}i}$ on $\sum_{i \neq j} w_{ij} X_{i \neq j}$ and X_i[14]. The fitted values, $\sum_{i \neq j} \widehat{w_{ij} TAX}_{j_{EU10}i}$ are then used as instruments for the weighted EU10 tax rates in equation (11) (Brueckner (2003), Altshuler & Goodspeed (2002), Redoano (2003), Heyndels & Vuchelen (1998), Brett & Pinkse (2000), Carlsen et al. (2005), Solé-Ollé (2003), Figlio et al. (1999), Revelli (2002), Ladd (1992), Buettner (2003), Geys (2006), Baicker (2005), Werck et al. (2007) and Allers & Elhorst (2005)). We will use this approach in the estimations.

6 Results

Table 1 reports the estimation results of equation (11). Columns (1) to (3) use OLS, while in all other estimations the weighted EU10 tax rates are instrumented with the fitted value of the approach explained in section 5. First, Column (1) reports the reaction function for the whole EU25. The slope of the reaction function is positive

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[13]Time dummies are also not included anymore, since the variables are in first differences and the regressions already control for GDP fluctuations.

[14]X=population density, gdp per capita, lagged personal income tax rate

and significant indicating that spatial tax competition among EU25 countries is present and confirms results from previous papers on spatial tax competition in the EU15. The aim of this paper is to dig deeper than previous papers and study the interaction between the old EU15 and the new EU10. Column (2) shows the reaction function for the EU15 with respect to the EU10 tax rates and column (3) excludes Ireland as a special case (EU14). The spatial interaction is only significant in column (3) for the EU14 (Ireland excluded), suggesting that Ireland is indeed an outlier. This result suggests that EU15 countries closer to the EU10 low tax areas such as Denmark and Austria, react to the EU10 tax rates. In order to gain more insight in this interaction, columns (3) and (4) split up the EU14 into neighboring and non-neighboring countries of the EU10. The neighboring countries are those countries with a common land or water border such as Finland, Sweden, Denmark, Germany, Italy, Greece and Austria. The non-neighboring countries do not have a common border: Netherlands, Spain, Portugal, UK, Belgium, Luxembourg and France. A comparison of both results shows that the weighted EU10 tax rate is only significant in column (3). In other words, only neighbors of the EU10 for example Denmark, Austria, Germany react to changes in the tax rate of the new EU10[15]. More concrete, a 10% decrease in the tax rate of the EU10, decreases the tax rate of the neighbors of the EU10 by 21%. This could explain why Ruiz & Gerard (2007) find only weak tax competition among EU15 countries.

Two country control variables in estimations in Table 1 are significant at conventional confidence levels. First, countries with higher incomes, as measured by GDP per capita, have higher corporate tax rates. This is consistent with the literature that a higher country income is related to higher demands for public services and thus higher corporate tax rates to finance these public services (Altshuler & Goodspeed 2002). Second, also consistent with the literature suggesting that tax competition will lead to a movement away from taxes on mobile factors toward taxes

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[15]Estonia, Latvia, Lithuania, Poland, Slovakia, Slovenia, Czech Republic, Malta, Cyprus and Hungary

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Table 1: Estimation Results

	(1)	(2)	(3)	(4)	(5)	(6)
	EU25	EU15	EU14	EU14 IV	EU7 IV	EU7 IV
						non-neighb
$STRlag_{i,t-1}$	0.56***	0.8***	0.58***	0.64***	0.58***	0.8***
	(0.085)	(0.06)	(0.07)	(0.08)	(0.09)	(0.15)
$\mathbf{W}_{ij}\mathbf{Tax}_{EU10j,t}$	**0.47*****	**0.01**	**0.14****	**0.14***	**0.21***	**0.13**
	(0.2)	(0.15)	(0.07)	(0.08)	(0.12)	(0.1)
$W_{ij}\mathrm{Tax}_{EU7j,t}$	-	-	-		-	-0.66
						(1.02)
GDP per capita$_{it}$	0.0	-0.0002	0.001*	0.001***	0.0*	0.0
	(0.0)	(0.0001)	(0.0003)	(0.001)	(0.0)	(0.001)
$inctax_{i,t-1}$	-0.48***	-0.12***	-0.44***	-0.29**	-0.61***	-0.14
	(0.14)	(0.05)	(0.13)	(0.14)	(0.24)	(0.16)
pop density$_{it}$	0.02	-0.03	0.01	-0.02	-0.68	0.04
	(0.08)	(0.09)	(0.07)	(0.10)	(0.55)	(0.08)
constant	-0.34***	-0.07	-0.44***	-0.96***	-0.49	-0.06
	(0.31)	(0.18)	(0.18)	(0.32)	(0.34)	(0.35)
Nobs	119	168	154	104	70	48
serial correlation 1order test	0.0	0.00	0.00	0.00	0.00	0.0
serial correlation 2order test	0.2	0.3	0.2	0.08	0.6	0.15
Sargan test				0.02	0.89	1

The estimations are in first differences and the EU10 tax rates are distance weighted. Column (1) uses the tax rates of the EU25 countries, column (2) uses the tax rates of the EU15, while column (3) excludes Ireland. From column (4) onwards the weighted tax rates are instrumented. In column (5) the tax rates of only the neighbors of the EU10 are used as dependent variable. Column (5) uses tax rates of the non-neighbors of the EU10 as a dependent variable. Standard errors are in parentheses. note:***,** and * denote significance level of estimates at respectively 10, 5 and 1 percent levels.

on immobile factors (Altshuler & Goodspeed (2002), Wilson (1999)), the coefficient on the lagged personal tax rate is negative and significant. This indicates that a lower personal income tax rate might be compensated by a higher corporate tax rate.

7   Robustness checks

Table 2 reports some robustness checks of the previous results. The first column tests the reaction function of the neighbors of the EU10 with respect to changes in the tax rates of the EU10 and the non-neighbors of the EU10. Column (2) estimates the reaction function of the non-neighbors of the EU10 with respect to changes in the tax rates of the EU10 and the neighbors of the EU10. The result indicates that neighboring countries of the EU10 such as Italy and Germany do not react to changes in the tax rates of other EU15 countries such as UK and Spain, but only to changes in the tax rates of the EU10.

Finally, the fiscal reaction function for the EU14 (Ireland excluded) in column (3) includes a trend to control for shocks in the EU14. But this trend is not significant and does not change previous results.

In addition, Table 3 presents the results for the fiscal reaction function of the EU14 (Ireland excluded) using different weights of the EU10 tax rates. Column (1) uses the contingency weight, while the weight in column (2) equals 1 if the EU14 country is a second order neighbor of one of the EU10 countries. In column (3) the EU10 tax rates are weighted with the lagged export shares and in column (4) with gdp per capita. For all of these weights we fail to find significant reactions of the EU14 to changes in the EU10 tax rates. This suggests that distance is more important for tax competition in the EU14. Finally, column (5) estimates the fiscal reaction function of effective tax rates of the neighbors of the EU10, but does not show significant interaction. This is in contrast with Devereux. Lockwood & Redoano (2002) who find that 21 OECD countries compete over the STR and ETR during 1982-1999.

Table 2: Robustness Checks

	(1)	(2)	(3)
	EU7	EU7	EU14
$STRlag_{i,t-1}$	0.61***	0.57***	0.63***
	(0.12)	(0.12)	(0.08)
$\mathbf{W}_{eu10j}\mathbf{Tax}_{j,t}$	**0.24***	**0.36****	**0.15***
	(0.15)	(0.17)	(0.08)
$\mathbf{W}_{eu7non-neigh.j}\mathbf{Tax}_{j,t}$	-0.28	-	-
	(0.42)		
$\mathbf{W}_{eu15j}\mathbf{Tax}_{j,t}$	-	-0.74	-
		(0.46)	
GDP per capita$_{it}$	0.003***	0.002***	0.001***
	(0.001)	(0.001)	(0.001)
$inctax_{i,t-1}$	-0.10	-0.09	-0.28**
	(0.19)	(0.18)	(0.14)
pop density$_{it}$	-0.15	-0.34	-0.02
	(0.77)	(0.73)	(0.11)
trend	-	-	-0.007
			(0.05)
constant	-1.56**	-1.64***	-0.97***
	(0.19)	(0.71)	(0.32)
Nobs	56	56	104
serial correlation 1order test	0.00	0.0	0.00
serial correlation 2order test	0.31	0.33	0.08
Sargan test	1	1	0.02

The estimations are in first differences and all spatial variables are instrumented and distance weighted. Column (1) tests the reaction function of the neighbors of the EU10 with respect to changes in the tax rates of the EU10 and the non-neighbors of the EU10. Column (2) estimates the reaction function of the non-neighbors of the EU10 with respect to changes in the tax rates of the EU10 and the neighbors of the EU10. Column (3) includes a trend. Standard errors are in parentheses. note:***,** and * denote significance level of estimates at respectively 10, 5 and 1 percent levels.

Table 3: Robustness Checks

	(1)	(2)	(3)	(4)	(5)
	EU14	EU14	EU14	EU14	EU7 etr
$STRlag_{i,t-1}$	0.73***	0.19	0.66***	0.7***	0.4***
	(0.08)	(0.12)	(0.07)	(0.06)	(0.11)
$\mathbf{W}_{FONeu10j}\mathbf{Tax}_{j,t}$	**0.17**				
	(0.11)				
$\mathbf{W}_{SONeu10j}\mathbf{Tax}_{j,t}$		**0.15**			
		(0.18)			
$\mathbf{W}_{export_{t-1}eu10j}\mathbf{Tax}_{j,t}$			**2.44e-08**		
			(1.83e-06)		
$\mathbf{W}_{gdp\ per\ capitaeu10j}\mathbf{Tax}_{j,t}$				**0.014**	
				(0.02)	
$\mathbf{W}_{dist_{e}u10j}\mathbf{ETR}_{j,t}$					**0.00**
					(0.00)
GDP per capita$_{it}$	0.001	0.001	0.0004		-0.07
	(0.001)	(0.001)	(0.0003)		(0.1)
$inctax_{i,t-1}$	-0.36***	-0.6	-0.31***	-0.42***	0.002
	(0.15)	(0.39)	(0.12)	(0.17)	(0.004)
pop density$_{it}$	-0.03	0.17	0.07	0.07	-0.01
	(0.11)	(0.23)	(0.12)	(0.08)	(0.01)
constant	-0.51*	-1.46**	-0.54***	-0.36***	0.01
	(0.29)	(0.72)	(0.17)	(0.09)	(0.01)
Nobs	108	41	141	128	63
serial correlation 1order test	0.00	0.1	0.00	0.00	0.00
serial correlation 2order test	0.07	0.8	0.29	0.52	0.65
Sargan test	0.99	0.9	0.85	0.71	0.99

The estimations are in first differences. Standard errors are in parentheses. The weighted EU10 tax rate in column (1) uses a weight equal to 1 if the EU14 country i shares a common land or water border with EU10 country j and 0 otherwise. In column (2) the weight w_{ij} equals 1 if EU14 country i is a second order neighbor of EU10 country j, 0 otherwise. In column (3) EU10 tax rates are weighted with export from EU14 to EU10 country as a lagged share of total export. Column (4) uses a gdp per capita weight. Column (5) estimates the reaction function for the ETRs of the neighbors of the EU10. note:***,** and * denote significance level of estimates at respectively 10, 5 and 1 percent levels.

8   Conclusion

During the past decade the 'old EU15 decreased its average corporate tax level by 10%. Besides Ireland, Germany and Italy experienced the largest decrease in their tax rates. Not surprisingly, both countries are neighbors of the 'new' EU10. The aim of this paper is to analyze the impact of distance to the low tax EU10-countries on corporate tax rates in the EU15 during the period 1993-2006. To our knowledge, this is the first paper studying the impact of the new EU member states on the tax rates of the old EU member states.

First, a spatial competition model is developed to predict the role of distance in tax competition. In this model a multinational makes its location decision between two countries taking into account the corporate tax rates, market size and transport cost. The outcome of the model suggests that tax competition is more intense between countries at a close distance. Second, this result is empirically tested for the EU15 during the period 1993-2006 using a fiscal reaction function. The results show that the low tax rates of the EU10-countries are the main driver of tax competition in the EU25. But only neighbors of the EU10 seem to react to low taxes of the EU10 in setting their own corporate tax rate. Moreover, we verified that these neighbors of the EU10 react far less to changes in the tax rate of other EU15 countries. To put it differently, the corporate tax rate of a country like Germany or Denmark seems to respond to changes in the tax rate of the EU10 like Czech Republic, but will respond much less to the tax rate of for example Belgium. When using other definitions of neighbors we failed to find spatial tax competition.

The resulting spatial dimension of tax competition in this paper will also have implications for transfer pricing. Since we find that neighbors of Eastern Europe are subject to more intense tax competition, tax differences between these countries will become smaller. As a consequence smaller tax differences are likely to induce less profit shifting towards Eastern Europe. In addition, smaller tax differentials will also stimulate decentralization choices of multinationals as pointed out by Nielsen

et al. (2007).

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9 Appendix A

The computations of the model in section 4 in more detail:

Stage 3

Using the demand functions in (1), the after-tax profits in country A and B are respectively

$$
\pi_A = (M - Q_A)Q_A(1 - t_A) \tag{12}
$$

$$
\pi_B = [(m - Q_B)Q_B + (M - Q_{AB})Q_{AB} - cx^2 Q_{AB}](1 - t_B)
$$

Maximizing these expressions leads to the equilibrium output and after-tax profits in (4) and (3). The maximization is as follows

$$
\frac{\partial \pi_A}{\partial Q_A} = (1 - t_A)(M - Q_A - Q_A) = 0 \Rightarrow Q_A^* = \frac{M}{2} \tag{13}
$$

$$
and
$$

$$
\frac{\partial \pi_B}{\partial Q_B} = (1 - t_B)(M - Q_B - Q_B) = 0 \Rightarrow Q_B^* = \frac{M}{2}
$$

$$
\frac{\partial \pi_B}{\partial Q_{AB}} = (1 - t_B)(M - Q_A - Q_A - cx^2) = 0 \Rightarrow Q_{AB} = \frac{M - cx^2}{2}
$$

Stage 2

Proof of the optimal tax rate t_A^* in (5):

$$
\pi_A^* = \pi_B^* \tag{14}
$$

$$
\frac{M^2}{4}(1 - t_A) = (1 - t_B)(\frac{M^2}{4} + 2\frac{M - cx^2}{M} - \frac{(M - cx^2)^2}{M^2})
$$

$$
-2cx^2 \frac{M - cx^2}{M^2}
$$

$$
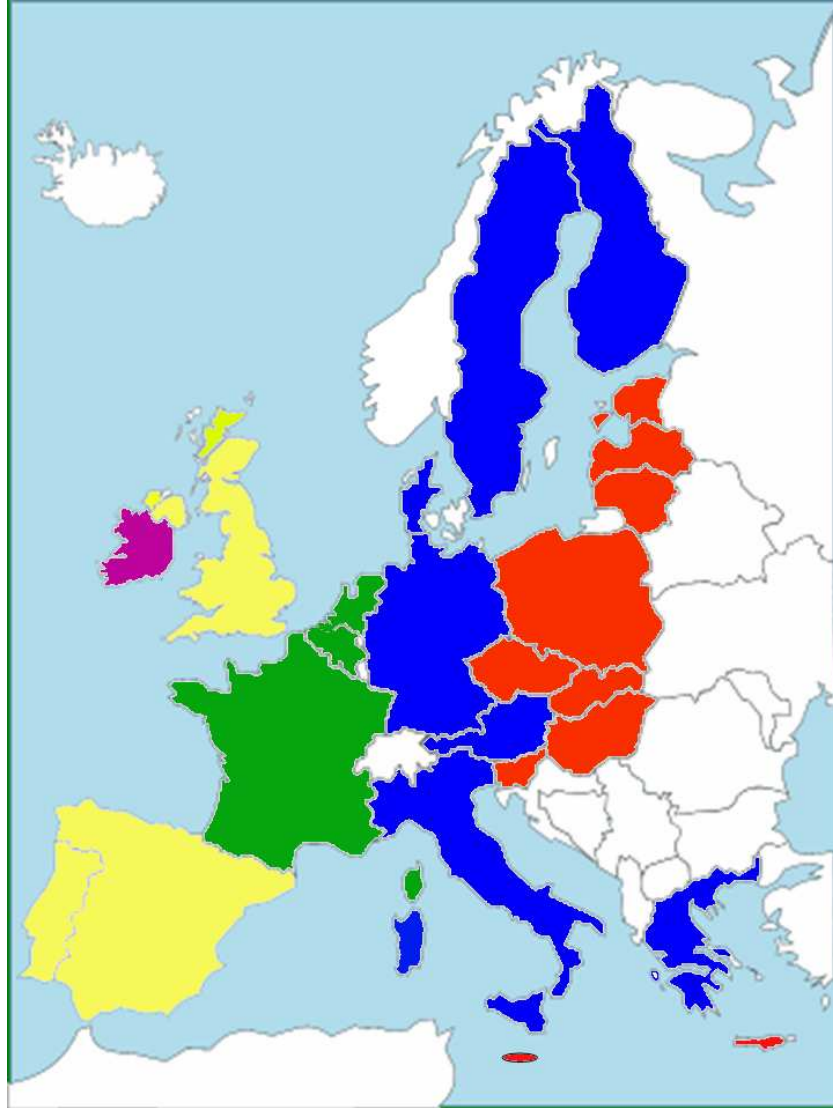t_A = -(1 - t_B)(\frac{m^2 + (M - cx^2)^2}{M^2} + 1
$$

Figure 3: Map of EU25

EU10 (red)= Estonia, Latvia, Lithuania, Poland, Hungary, Czech Republic, Slovakia and Slovenia

first order neighbors (blue)= Sweden, Denmark, Germany, Austria, Italy and Greece

second order neighbors (green)= Sweden, Denmark, Germany, Austria, Italy, Greece, Finland, Netherlands, Belgium and France

third order neighbors (yellow)=UK, Spain, Portugal

Fourth order neighbor (purple)=Ireland