Are your firm's taxes set in Warsaw?

Spatial tax competition in Europe

K. Crabbé (Lessius and KU Leuven) *

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Abstract

Tax competition within the EU is fiercer than in the rest of the OECD with EU tax rates falling rapidly. This paper analyzes whether countries in an enlarged EU respond differently to EU15 countries' corporate tax rates and to new members' corporate tax rates. The average corporate tax rate in the new member states has always been considerably lower than the average in the EU15 countries. The new members' entry into the EU eliminated capital barriers, allowing firms to locate in one of the new member states with full access to the European Market. We use a spatial regression framework to test the hypothesis that tax reactions among European countries are asymmetric. Our results only find significant tax interaction between EU15 countries and new member states. This suggests that EU15 countries respond to corporate tax changes of their neighboring new member states during the period 1990-2009.

keywords: Spatial tax competition, Corporate taxes, fiscal reaction function

JEL classification: H25, H77, H39

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1 Introduction

Corporate tax competition within the EU is fiercer than in the major OECD countries. The rapidly falling nominal tax rates in Figure 1 capture this finding. From the mid-nineties onwards, corporate statutory tax rates (STR) throughout the OECD countries started to decline. Where this process halted for non-EU countries - with average tax rates stabilizing after 2004 - tax rates in Europe however continued to fall. The entry of the new member states (NMS¹) with lower tax rates², seem to have intensified tax competition in Europe. The average tax rate in the EU15 dropped from 38.57% in 1993 to 27% in 2009. Empirical evidence by Davies & Voget (2008) indeed shows that EU-members compete stronger over taxes than non EU-members.

The purpose of this paper is to study tax competition not only within the older EU members (EU15) or within the new EU members (NMS), but especially between these two groups. We focus on corporate statutory tax rates, since previous studies already showed that countries strongly compete over these tax rates (a.o. Overesch & Rincke (2008), Devereux et al. (2002)). The literature on European tax competition is widespread. While some authors focus on capital mobility as a driver for decreasing tax rates, others estimate fiscal reaction functions to prove tax interdependence. This paper follows the fiscal reaction literature. Previous studies using this methodology found empirical evidence of tax competition in the EU15 up to 1996 (Altshuler & Goodspeed (2002), Redoano (2003)) and weaker empirical evidence for the EU15 in more recent years (Ruiz & Gerard 2008)). A first attempt including the new member states in a European fiscal reaction function is made by Cassette & Paty (2008). This paper contributes to the literature using a longer time series on corporate tax rates, including the five years after the integration of Eastern

¹NMS= Slovenia, Slovakia, Poland, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Cyprus, Malta, Bulgaria and Romania

²The average corporate tax rate of the 10 new members states in 2004 was 20.8% compared to 29% in the EU15³. The average corporate tax rate of Bulgaria and Romania at their EU entry in 2007 was 22.25%.

Figure 1: Evolution of corporate tax rates in OECD and EU, 1990-2009

Source: European Commission

Note: OECD7 (non-EU countries)= Australia, New Zealand, Canada, Japan, US, Korea, Mexico.

NMS= Czech Republic, Poland, Slovakia, Slovenia, Hungary, Estonia, Lithuania, Latvia, Malta,

Cyprus, Bulgaria and Romania. EU15= Belgium, the Netherlands, Luxembourg, France, Germany,

UK, Ireland, Spain, Portugal, Greece, Italy, Finland, Sweden, Denmark and Austria.

European countries in the European Union (EU). Secondly, we use a dynamic tax interaction model including time effects. Thirdly, we allow for asymmetric tax competition between different groups of countries in the EU as suggested by Cassette & Paty (2008).

The rest of the paper is organised as follows. In section 2 we discuss related literature and previous findings. Section 3 discusses the empirical methodology and the data, including descriptive statistics. Section 4 reports the estimation results, while the final section concludes.

2 Related Literature on Fiscal Reaction Functions

The theoretical foundation of fiscal reaction functions is to be found in the Basic Tax Competition Model of Zodrow & Mieskowski (1986). This model assumes perfect capital mobility so that post-tax rate of returns on capital are equalized between countries. As a result, a higher tax on capital in one country will push capital away to other countries. Or in other words, if one country lowers its tax rate, it will attract capital. This triggers the other countries to lower their tax rate as well until the new equilibrium is reached. The Basic Tax Competition Model predicts that the bottom tax rate is zero (race-to-the-bottom)⁴. This model has been extended (for example by introducing asymmetric countries, more than 1 tax instrument, labor mobility, Leviathan governments and agglomeration rents) so that it is not clear whether a race-to-the-bottom indeed is inevitable. As shown in the new economic geography literature, high agglomeration rents, caused by the concentration of capital in one location allow countries to charge a higher tax rate. In this model, even with full capital mobility, tax rates will not end up in a race-to-the-bottom (Baldwin & Krugman 2004, Krogstrup 2004)). On the other hand, the yardstick competition literature states that policy-makers mimic tax policies of their neighbors because voters will judge their performance by comparing domestic policies with policy-decisions in neighboring countries (Besley & Case 1995). Devereux et al. (2008)

⁴This theoretical literature has been surveyed by Wilson (1999)

develop a theoretical model where governments can choose the tax rate and tax base under the assumption that firms are mobile. They derive a concave fiscal reaction function and test empirically for tax or yardstick competition. Their results show that tax rather than yardstick competition is present in the OECD.

Most empirical papers concentrate on mimicking behavior within one country using local property or business tax rates (a.o. (Brueckner 2003, Bordignon et al. 2002, Heyndels & Vuchelen 1998, Brett & Pinkse 2000, Brueckner & Saavedra 2001, Carlsen et al. 2005)). The literature on fiscal reaction functions including different European countries is however growing⁵. The first to test tax competition on a national level are Devereux et al. (2008). They analyze strategic tax competition in 21 OECD countries for the period 1982-1999. They find that OECD countries strategically compete over the statutory tax rate and the effective tax rate⁶. Altshuler & Goodspeed (2002) are the first to study tax competition in EU15 countries for the period 1968-1996. Their findings suggest that EU15 countries react to the corporate tax⁷ of geographically close countries (having a common border), but do not react to the personal income tax of geographic neighbors. They also find that ever since the US tax reform of 1986, European countries compete to a lesser extent with the US on corporate tax rates. Redoano (2003) also studies tax reaction functions between EU countries (EU15, Norway and Switzerland). Using statutory tax rates for these countries during the period 1980-1995, she finds that tax competition mainly occurs between countries that are geographically close. In contrast, Ruiz & Gerard (2008) provide empirical evidence of weak tax reactions between neighboring EU15 countries for statutory and effective tax rates during the period 1989-2001. They argue that tax rates in the EU are converging rather than decreasing due to

⁵See Brueckner (2003) and Allers & Elhorst (2005) for an overview of the fiscal reaction literature.

⁶The effective tax rate is calculated using the method of Devereux et al. (2002) (forward looking tax rate).

⁷Altshuler & Goodspeed (2002) use corporate tax revenues as a percentage of GDP as corporate tax measure and personal income tax revenues as a percentage of GDP as personal income tax measure.

tax competition. More recently, Overesch & Rincke (2008) estimate a dynamic panel for 31 European countries and show that European countries strongly compete over statutory and effective tax rates during the period 1980-2007. Finally, Davies & Voget (2008) use a spatial lag model based on market potential (domestic consumption and exports) for countries all over the world. Their results indicate that tax competition is present all over the world and that EU-membership intensifies existing tax competition. A first attempt to capture tax competition between EU15 and NMS is by Overesch & Rincke (2009). They analyzed the impact of European integration on corporate tax rates (EU15, Norway, Switzerland and Iceland) during the period 1982-2005. Their results indicate that Western European countries that are direct neighbors - i.e. have a common border - of Eastern European countries have decreased their corporate tax rates more than other Western European countries. The authors also suggest that the decreasing tax rates are probably caused by wage differentials, rather than by tax competition itself. A second attempt to capture 'between' tax competition was undertaken by Cassette & Paty (2008) who allow for asymmetric tax competition in the EU27 between 1995 and 2005. They only find significant tax interactions between EU15 and NMS when using the weight matrix based on FDI leadership. The authors conclude that there is profit shifting rather than tax competition between EU15 and NMS. Overesch & Rincke (2011) point to the importance of the inclusion of time effects and a lagged dependent variable in interaction models to account for the sluggish adjustment of corporate tax rates over time.

Our paper contributes to the literature as follows. First, compared to most studies we consider a long and very recent time period, including the five years directly after the EU integration of NMS. Using a longer time series is crucial since after 2004 competition for FDI with low tax countries became even fiercer. Second, Davies & Voget (2008) show that EU-membership intensifies tax competition and also Figure 1 shows that tax rates in Europe decline faster than elsewhere. Therefore, this paper focuses on tax competition using only European countries compared to

for example Davies & Voget (2008). Third, Overesch & Rincke (2009) already point to the border effect on tax rates, but do not estimate an interaction model and hence cannot really draw any conclusion as far as tax competition between EU15 and NMS is considered. In contrast to their work, we will estimate a tax interaction model in the EU27. As far as we know, Cassette & Paty (2008) are the only authors that allow for asymmetric tax competition in the EU and are not able to find significant results. This paper digs deeper into the asymmetric tax competition between EU15 and NMS. Moreover, compared to Cassette & Paty (2008) we will use a longer time period (20 years compared to 10 years), include a lagged dependent variable and time effects as shown to be important in Overesch & Rincke (2011). Finally, we rely on a FE estimation and an IV approach instead of GMM as explained in the Methodology section.

3 Methodology and Data

In this section we will first of all discuss some descriptive statistics concerning the tax rate and our other main variables. Afterwards, we carefully explain the methodology used.

3.1 Descriptive statistics

We collected data on taxes and control variables for the EU15 countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Luxembourg, Netherlands, Portugal, Spain, Sweden and UK) and the EU new member states since 2004 (Cyprus, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia and Slovenia) and 2007 (Bulgaria and Romania). Tax rates in these 27 countries vary from 10% in Cyprus and Czech Republic to 59% in Germany in the period 1990-2009. Table 1 also reports a zero variance in tax rates in Malta. The average tax rate over the period is 7.16 percentage points lower in the NMS compared to the EU15. Within the NMS there is also a higher variance in tax rates

than in the EU15 countries. The statistics of the control variables are reported in Table D in Appendix.

Figure 2 shows that on average the statutory tax rates of the new member states are lower during the period 1995-2009 than the STR of the EU15. Some NMS countries however had a higher STR than the EU15 average at the start of the period as reported in Table A in the Appendix. The tax rates of the Eastern European countries decreased rapidly and as a consequence, the gap between the average STR of the EU15 and the new member states grew larger. The average STR in the EU15 in 2009 was 27 percent, while the average STR in the new member states in that year was 18.5 percent.

Figure 2: EU15 and new member states' corporate tax rates, 1990-2009

Source:KPMG corporate tax surveys, world tax database, OECD tax database

Table 1: Statutory tax rates in the EU27, 1990-2009

country	mean	variance	minimum	maximum
Austria	32.75	24.93	25	39
Belgium	38.15	9.37	33.99	41
Denmark	31.7	15.17	25	40
Finland	29.07	24.14	25	42
France	35.07	5.67	33.33	41.66
Germany	47.39	112.56	29.44	59.67
Greece	34.7	37.17	25	46
Ireland	26.13	153.5	12.5	43
Italy	43.75	61.71	31.4	53.2
Luxembourg	35.2	21.02	28.59	40.3
Netherlands	33.03	12.9	25	35
Portugal	34.21	33.52	25	40.2
Spain	34.48	2.71	30	35.3
Sweden	28.82	7.66	26.3	40
UK	31.1	3.1	28	34
Bulgaria	24.94	124.37	10	40
Cyprus	19.5	51.53	10	25
Czech Republic	31.94	57.18	20	45
Estonia	26.85	20.48	21	35
Latvia	26.55	136.68	15	45
Lithuania	23.15	43.08	15	29
Hungary	22.6	93.52	16	40
Malta	35	0	35	35
Poland	30.75	81.46	19	40
Romania	30.86	155.98	16	57.4
Slovenia	24.73	3.78	21	30
Slovakia	30.12	107.99	19	45
Total	31.30	85.65	10	59.67
EU15	34.36	81.58	12.5	59.67
NMS	27.20	88.82	10	57.4

3.2 Methodology

In the literature, a basic fiscal reaction function is defined as follows (Brueckner 2003):

$$TAX_{i,t} = \alpha_i + \beta_1 Tax_{i,t-1} + \beta_2 \left(\sum_{i \neq j} w_{ij} TAX_{j,t} \right) + \beta_3 X_{i,t} + \beta_4 \delta_{it} + \varepsilon_{i,t} \quad (1)$$

with i = country, j = country $\neq i$ and t = year

Key in a fiscal reaction function is the tax interaction variable: $\sum_{i \neq j} w_{ij} TAX_{j,t}$ which is the weighted average of other countries' tax rates. A significant positive coefficient of this variable indicates that tax competition or interaction exists between country i and the other countries. Cassette & Paty (2008) splitting up this interaction variable so they could analyze tax competition within and between two groups of countries. Their interaction variable can be summarized as:

$$\begin{aligned} \sum_{i \neq j} w_{ij} TAX_{j,t} = & \alpha_1 \sum w_{eu15} TAX_{eu15} + \alpha_2 \sum w_{NMS} TAX_{NMS} \\ & + \alpha_3 \sum w_{eu15 \& NMS} TAX_{eu15 \& NMS} \end{aligned} \quad (2)$$

In contrast to the general interaction variable, this methodology allows to analyze tax competition not only within a group of countries (EU15 or NMS) but also between these groups. The downside is that the result on tax competition between the two groups remains vague. In this paper, we split this last component of the interaction variable as in the 'further results' section of the paper by Cassette & Paty (2008).

$$\begin{aligned} \sum_{i \neq j} w_{ij} TAX_{j,t} = & \gamma_1 \sum w_{eu15} TAX_{eu15} + \gamma_2 \sum w_{NMS} TAX_{NMS} \\ & + \gamma_3 \sum w_{eu15-NMS} TAX_{eu15} + \gamma_4 \sum w_{eu15-NMS} TAX_{NMS} \end{aligned} \quad (3)$$

The interaction variables in equation (3) indicate whether tax competition exists among neighboring EU15 countries (γ_1) or NMS (γ_2) and whether EU15 countries react on tax changes of neighboring NMS (γ_3) or NMS react on tax changes of neighboring EU15 countries (γ_4). In other words, this methodology makes it possible

to analyze who is competing with whom and more importantly, by which group of countries triggers tax competition in Europe. The variable $\sum w_{eu15} TAX_{eu15}$ corresponds to the weighted average tax rate of EU15 countries if the considered country i is itself a EU 15 country, but equals zero if the considered country i is a new member state to estimate tax competition within the EU15. The variable $\sum w_{NMS} TAX_{NMS}$ is the weighted average tax rate of new member states if the considered country i is itself a new member state, but equals zero if the considered country i is a country of the EU15 to study tax competition among the new member states. The variable $\sum w_{eu15-NMS} TAX_{eu15}$ is the weighted average tax rate of the EU15 countries if the considered country i is a new member state, but equals zero if the considered country i is a country of the EU15 to estimate the reaction of new member states on a change in the corporate tax rate of the EU15 countries. Finally, the variable $\sum w_{EU15-NMS} TAX_{NMS}$ is the weighted average tax rate of new member states if the considered country i is a EU15 country, but equals zero if the considered country i is a new member state to estimate the reaction of EU15 countries on a change in the corporate tax rate of the new member states.

Following the literature, different weights can be used and thus different relations between the country groups can be studied. The weights are exogenously determined and row normalized so that $\sum_{i \neq j} w = 1$. We apply the weighting scheme of inverse distance:

$$W_{ij}^{distance} = \frac{1}{distance_{ij}} / \sum_j \frac{1}{distance_{ij}}, \text{ with } j \neq i \quad (4)$$

where distance is the geographical distance between both countries. Geographical distance has proven in the literature to be important for FDI location (among others: Redoano (2003), Overesch & Rincke (2011), Cassette & Paty (2008), Ghemawat (2001)). Distance is a measure of transportation costs for produced goods and increases the information cost for investment decisions (Portes & Rey 2005). The literature finds convincing evidence of a negative effect of distance on FDI (for example Bellak & Leibrecht (2005)). We therefore assume that countries competing for FDI take tax policies of neighbors into account rather than tax policies of more

distant countries. The geographical distance can be measured in two ways. First, the distance in kilometers between the capital cities of the countries. Second, we can use a dummy variable to indicate whether country j is a neighbor of country i , that is do they share a common land or water border. However, these measures do not take into account the location of human and economic activities within the countries which do affect FDI. To allow for this, we use the effective bilateral distance collected from CEPII and developed by Head & Mayer (2002). This measure uses city-level data to determine the geographic distribution of population inside each country. Distance between two countries is calculated as the bilateral distance between the largest cities in the two countries weighted by the share of the city in the country's population.

The control variables X in equation (1) are based on the literature. Corporate taxes are a backstop for personal income tax levied on capital income. Individuals can escape income taxes by incorporating themselves (Devereux et al. 2008). As a result, countries with higher income tax rates are likely to set higher corporate tax rates. The first important control variable is thus the highest domestic capital tax as a percentage (CAPITALTAX). This variable is lagged since the capital tax can also influence the corporate tax rate. The log of total population is a measure for the size of the country (TOTPOP). The socio-demographic variables, the proportion of population aged over 65 (POP65) and the proportion of population younger than 14 years (POP14), are included since these variables reflect the expenditure needs. We expect a positive sign, although a negative sign is also possible if the supply of public goods benefits from economies of scale (Cassette & Paty 2008). Finally, we include the control variable 'openness' (OPENNESS), this variable is defined as the sum of import and export as a percentage of GDP lagged one period because of possible endogeneity issues. The expected outcome is that more open economies tend to have lower corporate tax rates (Slemrod 2004). The variables are collected mainly from Eurostat. An overview of the definition and data sources can be found in Appendix Table C.

In order to estimate a reaction function different approaches are possible (see Brueckner (2003) for an overview of the methodology). It seems that in the literature, the instrumental variable (IV) approach is preferred over the Maximum Likelihood estimation. Instruments are used to solve the endogeneity problem of the weighted tax variable $wTax_{it}$. Good instruments that correlate with neighbors' tax rates and do not correlate with the error term are the control variables X as well as the control variables multiplied by the same weights used for the tax rates (wX). The validity of the instruments can be tested by the Sargan-Hansen test of overidentifying restrictions⁸. Another econometric issue is that tax rates are persistent since changes in the tax rate depend on previous tax rate levels and may be costly (Devereux et al. 2002). A time-lagged dependent variable allows for this persistence in the tax rates. At the same time, unobserved factors influencing the corporate tax rate should be taken into account. The unobserved factors that are constant over time are captured in country specific fixed effects, while the unobserved factors varying over time are taken into account by including yearly time dummies⁹. The combination of a time-lagged dependent variable and fixed effects, however, automatically leads to correlation of the time lagged dependent variable and the error term and hence to inconsistent coefficient estimates. However, the bias diminishes as the time series grows (Nickell 1981), also for models with spatial effects (Korniotis 2010). Another problem is that too many instruments can overfit instrumented variables. This means that the coefficients are biased towards those from non-instrumenting estimators (Roodman 2009). Overesch & Rincke (2011) concluded that their tax interaction model performed best applying the FE estimator instead of the Arrelano & Bond (1991) and Anderson & Hsiao (1982) estimators. Korniotis (2010) deals with both a lagged dependent variable and a spatial effect, but this estimator can only be used for balanced panels which is not the case in this study. We found that after taking first differences in order to eliminate country-

⁸The null Hypothesis of the Sargan-Hansen test is that all instruments are valid. Thus this should not be rejected by the test (p-values $\geq$ 0.1).

⁹Results are similar when we include a time trend.

specific effects, the best performing instruments are the spatial weighted POP14 and POP65 and Tax_{t-2} for Tax_{t-1} .

4 Results

The results of the basic fiscal reaction model (1) are reported in Table 2. All estimations are using an unbalanced panel dataset and include a full set of country and year effects which are however not reported here for the sake of clarity. Column (1) is a baseline estimation to test our control variables. The lagged own tax rate is added in column (2) showing that corporate tax rates strongly depend on past levels. In column (3) we return to a smaller set of countries, the EU15 and run a fiscal reaction model as in prior studies. We find a positive and significant coefficient for the neighbors' weighted tax rates. This confirms that tax competition in the EU15 is present. Column (4) does not find significant tax competition among the new member states (NMS), while the coefficient is negative and significant for the EU27 as a whole (column (5)). An unexpected negative coefficient could indicate that tax competition is not straightforward in the EU27. The aim of this paper is exactly to determine the geographical pattern of European tax competition.

Table 2: estimation results

dep var.=Tax _{i,t}	(1)	(2)	(3) EU15	(4) NMS	(5) EU27
Tax _{i,t-1}		0.79*** (0.04)	0.91*** (0.02)	0.79*** (0.04)	0.77*** (0.04)
wTax _{j,t-1}			0.02*** (0.01)	-0.04 (0.1)	-1.12** (0.56)
capital tax _{i,t-1}	1.98 (1.51)	0.56 (0.91)	1.01 (0.69)	0.53 (0.91)	0.07 (0.96)
Openness _{i,t-1}	-0.04*** (0.02)	0.002 (0.01)	0.004 (0.004)	0.001 (0.01)	0.0003 (0.01)
log(TOTPOP) _{i,t}	31.45*** (7.51)	-0.18 (0.04)	0.1 (0.14)	0.94 (5.64)	5.62 (5.94)
POP14 _{i,t}	1.84*** (0.2)	0.28*** (0.15)	0.002 (0.1)	0.35 (0.23)	0.44*** (0.18)
POP65 _{i,t}	0.59 (0.41)	-0.12 (0.27)	0.05 (0.11)	-0.1 (0.27)	-0.06 (0.28)
Observations	457	426	255	171	426
R overall	0.82	0.94	0.93	0.94	0.93
Sargan test (p-value)		0.00	0.18	0.54	0.15

Note: EU15=Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Netherlands, Luxembourg, Portugal, Spain, Sweden and UK. EU13= EU15-Luxembourg-Ireland. NMS= Bulgaria, Cyprus, Czech Republic, Estonia, Latvia, Lithuania, Malta, Hungary, Poland, Romania, Slovakia and Slovenia. EU27 =EU15+NMS. All estimations include year dummies. The neighbors' tax rates, wTax, are weighted with the inverse distance between the two countries. ***,** and * denote significance level of estimates at respectively 1, 5 and 10 percent levels. Standard errors are between brackets.

Our main results using the split interaction variables as in equation (3) are illustrated in Table 3. Column (1) shows the estimation without a lagged dependent variable and column (2) reports the estimation with a lagged dependent variable. The results show that after adding the lagged dependent variable, only the spatial variable for NMS neighbors of the EU15 is significant¹⁰. This suggests that tax competition in Europe is driven by EU15 countries reacting to changes in the tax rates of the NMS. In particular, a decrease of 1 percentage point in the corporate tax rate of countries nearby, will lead to a 1 percentage point decrease in the corporate tax rate of country i . This result is tested in column (3) using a different set of instrument variables, namely the weighed proportion of population older than 65 years (pop65) and the weighed openness. The result is similar. In column (4), we explore the idea of Overesch & Rincke (2009) that the decrease in the tax rates of the EU15 might be a reaction on the low wages in the NMS. We collected the hourly labor costs in manufacturing from Eurostat. The minimum wage in this sample is 11.9 dollar for EU15 countries and 0.93 euro in the NMS. The large wage differential between Western and Eastern European countries can pressure policy makers to lower their corporate tax rate (Overesch & Rincke 2009). In order to let the tax rates of the EU15 react to the wages in the (neighboring) NMS, the wages of the NMS are weighted using the inverse distance. This variable is instrumented like the other spatial variables, but even without the IV approach the result remained the same. The result in Column (4) show that this variable does not significantly influence the STR in Europe, moreover the tax competition effect between Western and Eastern Europe disappeared. Note that the number of observations decreased to 312 because the labor cost data are only available from 1995 onwards. In column (5) the yardstick effect is tested. We follow the approach of Devereux et al. (2008) who interact the weighted neighbors' tax rates with a measure for the barriers of mobile capital. If the strategic interaction is indeed due to yardstick competition

¹⁰Using a Wald test, we can reject the null hypothesis that the sum of the coefficients of the time-lag and the spatial-lags equals 1 at the 5 percent level of significance.

or a common trend, this should be unrelated to barriers of capital mobility. On the other hand, if strategic competition is due to tax competition for mobile firms or capital, this effect should be stronger when barriers of capital mobility decrease. Since in our model only one weighted tax rate is significant, we interact this tax rate with a measure for barriers of mobile capital. This measure is collected from the Heritage foundation and is an index of investment freedom. The index evaluates a variety of restrictions typically imposed on investment and each country receives a score between 0 and 100. The higher the investment freedom index, the less restrictions there are on foreign and domestic capital¹¹. The regression is as follows:

$$\begin{aligned}
TAX_{i,t} = & \beta_1 \sum w_{eu15} TAX_{eu15,t} + \beta_2 \sum w_{NMS} TAX_{NMS,t} \\
& + \beta_3 \sum w_{NMS-eu15} TAX_{eu15,t} + \beta_4 \sum w_{eu15-NMS} TAX_{NMS,t} \\
& + \beta_4 \sum w_{eu15-NMS*investment\ freedom} TAX_{NMS,t} + \beta_5 control\ variables_{i,t} + \xi_{i,t}
\end{aligned} \tag{5}$$

The results from this estimation are shown in column (4). The tax interaction effect is still positive significant, but combined with investment freedom it is not significant. Hence tax interaction between EU15 and NMS is present, but when investment freedom increases, tax interaction is not significantly strong. This indicates that the tax interaction between EU15 and NMS might be a matter of EU15 countries following the trend of lowering taxes of NMS instead of tax competition for firms.

¹¹To know more on the investment freedom index or the other indices see <http://www.heritage.org/index/investment-freedom>.

Table 3: estimation results

dep var.=Tax _{i,t}	(1)	(2)	(3)	(4)	(5)
Tax _{i,t-1}		0.94*** (0.03)	0.99*** (0.04)	0.98*** (0.05)	0.91*** (0.04)
wTax _{EU15,t}	5.25*** (2.03)	0.06 (0.31)	-0.44 (0.49)	-0.13 (0.47)	0.31 (0.24)
wTax _{NMS,t}	1.74*** (0.88)	0.66 (0.45)	0.63 (0.49)	0.75 (0.62)	-0.02 (0.61)
wTax _{NMSfEU15,t}	5.31*** (2.14)	0.37 (0.28)	-0.12 (0.45)	-0.24 (0.41)	0.44* (0.24)
wTax _{EU15fNMS,t}	2.01*** (0.82)	1.07* (0.62)	1.05* (0.67)	0.67 (0.78)	0.44* (0.27)
w _{dist-inv.freed.} Tax _{EU15fNMS,t}					-0.26 (0.68)
capital tax _{i,t-1}	3.2 (2.58)	0.69 (0.84)	-0.1 (0.19)	0.58 (1.04)	0.94 (0.76)
Openness _{i,t-1}	-0.01 (0.02)	0.003 (0.005)	0.62 (0.85)	-0.004 (0.01)	0.003 (0.004)
log(TOTPOP) _{i,t}	2.43*** (1.04)	0.05 (0.17)	0.002 (0.005)	-0.26 (0.22)	0.07 (0.15)
POP14 _{i,t}	1.27*** (0.52)	0.2 (0.14)	0.18 (0.15)	0.05 (0.2)	0.11 (0.13)
POP65 _{i,t}	-0.17 (0.76)	0.17 (0.15)	0.13 (0.16)	0.04 (0.18)	0.15 (0.13)
wwage _{NMS,t}				-0.38 (0.38)	
Observations	457	426	426	312	426
R-squared	0.18	0.89	0.9	0.93	0.92
Sargan test (p-val)	0.32	0.24	0.81	0.6	0.10

Note: All estimations include year dummies. ***,** and * denote significance level of estimates at respectively 1, 5 and 10 percent levels. Standard errors are between brackets.

5 Conclusion

This paper contributes to the literature on tax interdependence among countries. Using a fiscal reaction function methodology for 27 European countries, we allow for asymmetric tax responses during the period 1990-2009. In particular, we allow for tax interdependence among old EU members (EU15), among new EU members (NMS) and between these two groups. Thereby we especially analyze whether it are rather the EU15 countries following tax changes in the new member states (NMS) or vice versa. First of all, our results confirm that tax competition in the enlarged EU is present during the period 1990-2009. Secondly, we find evidence of asymmetric tax reactions within the EU. Our estimations show that EU tax competition is mainly present between the West and the East. Especially EU15 countries located geographically close to the new member states such as for example Germany, take into account changes in the corporate tax rate of the new member states in setting their own corporate taxes rates. The fiscal reaction showed that if the new member states decrease their tax rate by 1 percentage point, leads the EU15 countries to decrease their own tax rate by also 1 percentage point. To conclude, our paper contributes in the field of tax competition and points to the important observation that tax competition in Europe is not necessarily symmetric among all countries.

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Appendix

Table A: Data corporate ax rates 1990-1999

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Austria	39	39	39	39	34	34	34	34	34	34
Belgium	41	40.17	40.17	40.17	40.17	40.17	40.17	40.17	40.17	40.17
Bulgaria				40	40	40	40	36	30	27
Cyprus	25	25	25	25	25	25	25	25	25	25
Czech Republic				45	42	41	39	39	35	35
Denmark	40	38	34	34	34	34	34	34	34	32
Estonia			35	35	26	26	26	26	26	26
Finland	42	40.2	37.2	25	25	25	28	28	28	28
France	37	34	33.33	33.33	33.33	33.33	36.67	36.67	41.66	40
Germany	57.7	59.3	59.4	59.67	55.64	54.9	56	56	56.66	52.31
Greece	46	46	46	35	35	35	35	35	35	35
Hungary	40	40	40	38	36	18	18	18	18	18
Ireland	43	40	40	40	40	38	38	36	32	28
Italy	52.2	52.2	52.2	52.2	52.2	53.2	53.2	53.2	41.25	41.25
Latvia	45	45	45	45	45	25	25	25	25	25
Lithuania	29	29	29	29	29	29	29	29	29	29
Luxembourg	40.3	39.4	39.4	39.4	39.4	39.4	39.4	39.4	37.45	37.45
Malta	35	35	35	35	35	35	35	35	35	35
Poland	40	40	40	40	40	40	40	38	36	34
Portugal	40.2	40.2	39.6	39.6	39.6	38.8	38.8	38.8	37.4	37.4
Romania			57.4	45	45	38	38	38	38	38
Slovakia				45	45	40	40	40	40	40
Slovenia						30	25	25	25	25
Spain	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35	35	35
Sweden	40	30	30	30	28	28	28	28	28	28
Netherlands	35	35	35	35	35	35	35	35	35	35
UK	34	33	33	33	33	33	33	31	31	31

Source: KPMG tax surveys, world tax database, OECD tax database, Weichenreider (2010), Note: We found no tax data information on some Eastern European countries in the early 1990s, mostly due to their independence.

Table B: Data corporate ax rates 1990-2009

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Austria	34	34	34	34	34	25	25	25	25	25
Belgium	40.17	40.17	40.17	33.99	33.99	33.99	33.99	33.99	33.99	33.99
Bulgaria	25	23.5	23.5	19.5	19.5	15	15	10	10	10
Cyprus	24	23	23	10	10	10	10	10	10	10
Czech Republic	31	31	31	31	28	26	24	24	21	20
Denmark	32	30	30	30	30	28	28	28	25	25
Estonia	26	26	26	26	26	24	23	22	21	21
Finland	29	29	29	29	29	26	26	26	26	26
France	36.66	35.33	34.33	34.33	34.33	33.83	33.33	33.33	33.33	33.33
Germany	51.63	38.36	38.36	39.58	38.29	38.31	38.34	38.36	29.51	29.44
Greece	35	35	35	35	35	32	29	25	25	25
Hungary	18	18	18	18	16	16	16	16	16	16
Ireland	24	20	16	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Italy	41.25	40.25	40.25	38.25	37.25	37.25	37.25	37.25	31.4	31.4
Latvia	25	25	22	19	15	15	15	15	15	15
Lithuania	24	24	15	15	15	15	15	15	15	20
Luxembourg	37.45	37.45	30.38	30.38	30.38	30.38	29.63	29.63	29.63	28.59
Malta	35	35	35	35	35	35	35	35	35	35
Poland	30	28	28	27	19	19	19	19	19	19
Portugal	35.2	35.2	33	33	27.5	27.5	27.5	25	25	25
Romania	38	25	25	25	25	16	16	16	16	16
Slovakia	29	29	25	25	19	19	19	19	19	19
Slovenia	25	25	25	25	25	25	25	23	22	21
Spain	35	35	35	35	35	35	35	32.5	30	30
Sweden	28	28	28	28	28	28	28	28	28	26.3
Netherlands	35	35	34.5	34.5	34.5	31.5	29.6	25	25.5	25.5
UK	30	30	30	30	30	30	30	30	28	28

Source: KPMG tax surveys, world tax database, OECD tax database, Weichenreider (2010), Note: We found no tax data information on some Eastern European countries in the early 1990s, mostly due to their independence.

Table C: Data-Appendix

Variable	source	description
Corporate tax rates	KPMG tax surveys	corporate tax in percentages
	world tax database	
	OECD tax database	
	(Weichenreider 2010)	
distance	CEPII database	effective bilateral distance
openness (t-1)	Eurostat	share of exports and imports as a % of GDP
pop14	Eurostat	proportion of population younger than 14 years in the total population
pop65	Eurostat	proportion of population over 65 years in the total population
capital tax	Eurostat	capital taxes as a % of GDP

Table D: Descriptives control variables

stats	str	opennesslag	population $\leq$ 14years	population $\geq$ 65	log(total population)	capital taxlag
mean	31.30	101.57	18.19	14.47	8.96	0.17
variance	85.65	2444.66	7.46	4.59	2.08	0.04
number of observations	524	513	540	513	540	494

Table E: First-stage regressions based on columns (3)-(4)-(5) of Table 2

	EU15		NMS		eu27	
	Tax _{<i>i,t-1</i>}	wTax _{EU15,<i>t</i>}	Tax _{<i>i,t-1</i>}	wTax _{NMS,<i>t</i>}	Tax _{<i>i,t-1</i>}	wTax _{EU27,<i>t</i>}
logtotpop	0.34 (0.28)	0.45*** (0.1)	-0.06 (0.28)	0.04 (0.13)	0.1 (0.14)	0.27*** (0.1)
capital tax _{<i>i,t-1</i>}	0.19 (0.69)	0.07 (0.24)	0.59 (2.27)	-0.05 (1.06)	1.3** (0.68)	1.35*** (0.3)
openness _{<i>i,t-1</i>}	0.004 (0.01)	0.01*** (0.002)	0.01* (0.01)	-0.01 (0.01)	0.003 (0.004)	0.003 (0.002)
pop14 _{<i>i,t</i>}	-0.17 (0.13)	0.08* (0.05)	-0.26 (0.3)	-0.02 (0.14)	0.13 (0.1)	0.15*** (0.04)
pop65 _{<i>i,t</i>}	-0.004 (0.14)	0.1* (0.1)	-0.28 (0.29)	-0.14 (0.14)	0.23*** (0.11)	0.06 (0.05)
Tax _{<i>i,t-2</i>}	0.9*** (0.03)	-0.04*** (0.01)	0.86*** (0.04)	-0.09*** (0.02)	0.9*** (0.02)	-0.02*** (0.01)
wtotpop _{EU15,<i>t</i>}	0.95 (1.00)	2.59*** (0.35)				
wPOP14 _{EU15,<i>t</i>}	1.12 (0.81)	-0.7*** (0.29)				
wtotpop _{NMS,<i>t</i>}			-4.24 (3.24)	3.13** (1.51)		
wpop14 _{NMS,<i>t</i>}			-1.24 (1.45)	1.62*** (0.68)		
wtotpop _{EU27,<i>t</i>}					1.4** (0.69)	4.69*** (0.3)
wpop14 _{EU27,<i>t</i>}					-0.2 (0.43)	0.6*** (0.19)
observations	255	255	171	171	426	426
R	0.93	0.96	0.91	0.95	0.92	0.94
AP F statistic	515.15	36.2928	32.46	2.49	1182.37	117.29

All first stage estimations include year dummies. Standard errors are between brackets.

***, ** and * denote significance level of estimates at respectively 1, 5 and 10 percent levels.

Table F: First-stage regressions based on column (2) of Table 3

dep var	Tax _{<i>i,t-1</i>}	wTax _{EU15,<i>t</i>}	wTax _{NMS,<i>t</i>}	wT _{NMS-EU15,<i>t</i>}	wT _{EU15-NMS,<i>t</i>}
logtotpop	-0.1 (0.18)	0.09* (0.05)	0.02 (0.11)	0.05 (0.05)	-0.11 (0.12)
capital tax _{<i>i,t-1</i>}	0.55 (0.74)	0.27 (0.19)	0.02 (0.47)	-0.18 (0.19)	0.14 (0.51)
openness _{<i>i,t-1</i>}	-0.002 (0.005)	0.002 (0.001)	-0.003 (0.003)	-0.001 (0.001)	0.0003 (0.003)
pop14 _{<i>i,t</i>}	-0.24* (0.13)	0.06* (0.03)	0.03 (0.08)	-0.06* (0.03)	-0.21*** (0.1)
pop65 _{<i>i,t</i>}	-0.003 (0.14)	-0.02 (0.04)	0.05 (0.09)	-0.02 (0.03)	-0.13 (0.1)
Tax _{<i>i,t-2</i>}	0.86*** (0.02)	-0.02*** (0.01)	-0.03** (0.02)	-0.02*** (0.01)	-0.02 (0.02)
wtotpop _{NMS-EU15,<i>t</i>}	4.34*** (1.56)	1.38*** (0.41)	-1.06 (0.99)	3.8*** (0.41)	1.6 (1.08)
wtotpop _{EU15-NMS,<i>t</i>}	1.75** (0.84)	1.5*** (0.22)	0.8 (0.53)	0.4* (0.22)	0.75 (0.58)
wtotpop _{NMS,<i>t</i>}	-2.24 (1.92)	0.83* (0.5)	1.46 (1.22)	-0.97* (0.5)	-1.58 (1.32)
wtotpop _{EU15,<i>t</i>}	0.08 (1.06)	1.91*** (0.28)	0.77 (0.67)	0.6** (0.28)	-1.35* (0.73)
wpop14 _{NMS-EU15,<i>t</i>}	-0.27 (0.77)	0.45** (0.2)	-0.54 (0.49)	-1.52*** (0.2)	-0.09 (0.53)
wpop14 _{EU15-NMS,<i>t</i>}	-2.51*** (0.85)	1.87*** (0.22)	-1.36*** (0.54)	-2.19*** (0.22)	0.92 (0.59)
wpop14 _{NMS,<i>t</i>}	-1.85*** (0.81)	0.21 (0.21)	1.08** (0.52)	-0.16 (0.21)	-0.92* (0.56)
wpop14 _{EU15,<i>t</i>}	0.84 (0.83)	0.1 (0.22)	-0.14 (0.52)	-0.28 (0.22)	-0.02 (0.57)
observations	426	426	426	426	426
partial R	0.6642	0.2794	0.0569	0.3626	0.0322
AP F-stat(5, 386)	436	17.20	8.10	58.73	5.25

All first stage estimations include year dummies. Standard errors are between brackets.