Tax Competition in European Diesel Excises

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Abstract

This paper estimates Nash-type fiscal reaction functions for European governments competing for revenue from diesel excises. It appears that European governments strategically set their excise levels by responding to their neighbors' tax rates. This provides evidence for the presence of tax competition in diesel excises. In particular, a 10% higher rate in neighboring countries (in terms of the user price) induces a country to raise its own rate by between 2 and 3%.

JEL Codes: H23, H77, H87, R4

Key words: Diesel excise; Strategic tax setting; European Union.

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1. Introduction

European governments face an increasing international mobility of tax bases. For instance, differences in excise rates on beverages or cigarettes in Europe induce incentives for cross-border shopping (Cnossen, 2002). Similarly, corporate tax rate differentials are found to exert an impact on the location of foreign direct investment (De Mooij and Ederveen, 2003). As a response to this, European governments engage in a process of tax competition, i.e. they strategically set their tax rates in order to lure mobile factors of production or cross-border shoppers. Strategic tax setting means that, by reducing tax rates, governments aim to broaden their own tax base, thereby recovering or even raising fiscal revenue. The theory of tax competition reveals that strategic tax setting is typically inefficient from a European perspective.[1] Indeed, independent governments do not take into account the welfare implications of their own actions on neighbouring countries when deciding about their own tax rates. Thus, they end up in a prisoner's dilemma in which fiscal externalities cause inefficiently low levels of public goods supply.

Empirical studies on tax competition usually explore whether tax rates are decreasing over time in light of the increasing economic integration among countries. For instance, Devereux et al (2002a) show that the mean corporate tax rate in 16 OECD countries has gradually declined between 1982 and 2001. This holds both for statutory rates and average effective tax rates. It provides an indication that tax competition is indeed an important phenomenon in the OECD.

Recently, a number of studies have tried to empirically assess the importance of tax competition between countries in an alternative way. These studies estimate so-called fiscal reaction functions. They measure the responsiveness of a countries' tax rate to the rate of neighbouring countries, thereby controlling for other determinants of the tax rate. Most of these studies focus on corporate taxation (Besley et al., 2001; Devereux et al., 2002b; Altshuler and Goodspeed, 2002).[2] They typically show that countries in the OECD and Europe do indeed systematically respond to each other's corporate tax rates. For instance, Devereux et al. (2002b) find that strategic tax responses are strong and highly robust for both statutory tax rates and (marginal and average) effective tax rates in 16 OECD countries. For the European Union, Altshuler and Goodspeed (2002) find similar results for alternative specifications for the tax game, i.e. Nash and Stackelberg. Their results suggest that a 10%-point higher tax rate in neighboring countries implies an 8% higher rate in a particular European country. These findings provide evidence for the claim that governments aggressively compete with their corporate tax systems for foreign direct investment.[3] In a recent study, Devereux et al. (2004) estimate fiscal reaction functions for US States competing for revenue from excises on cigarettes and gasoline. They explore both vertical tax competition between States and the federal government, and horizontal tax competition among States. For excises on cigarettes, they find that horizontal tax competition is important: a one-cent increase in the neighbor state excise level induces a rise in the home tax rate of 0.5 cents. For gasoline, they report mixed findings: the strategic interactions are not always statistically significant.

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1) See Wilson (1999) or Zodrow (2003) for recent reviews of the literature on tax competition.
2) There is a substantial empirical literature that estimates fiscal reaction functions for local governments as well, see Bruckner (2002) for an overview.
3) A related literature explores how jurisdictions strategically determine their stringency of environmental regulations. In response to regulations in neighbouring jurisdictions, they may thus reduce this stringency in order to attract foreign direct investment, see Levinson (2003) for an overview.

This paper empirically explores whether tax competition in Europe is also important for a different tax, namely the excise on commercial diesel. In estimating Nash-type fiscal reaction functions, we exploit a panel of 17 European countries between 1978 and 2001. Differences in excise duties between European countries have a potentially important impact on the fuelling behaviour of transport companies. Indeed, most trucks can cover between 1500 and 3000 kilometers on a single tank. As excise duties account for between 10 to 12 percent of the running cost of road haulage companies, active fiscal planning of international transport routes can substantially save on production costs. As a response, European governments may strategically set their diesel excise rates so as to attract trucks to fuel in their country and thus maximize the fiscal revenue from their excise duties.

2. Empirical analysis

To empirically explore strategic tax responses, we estimate the following linear fiscal reaction function, where n countries compete in a Nash-setting for fiscal revenue from diesel excises:[4]

$$\tau_t^i = \sum \omega^i \tau_t^{-i} \beta + X_t^i \theta + d^i \varphi + d_t \eta + \varepsilon_t^i \qquad i = 1, \ldots n \qquad (1)$$

where index i stands for a home country, $-i$ denotes all foreign countries, and t is an index for time. The variable τ_t^i is our tax measure, ω^i is a weighting matrix discussed below, X_t^i is a vector of exogenous control variables, d^i are country fixed effects, d_t are time fixed effects, and ε_t^i is an error term which is assumed to be normally distributed. The parameters β, φ, η and the vector θ will be estimated. The key coefficient in (1) is the reaction of country i to the tax rates of other countries $-i$, which is reflected by β.

Equation (1) contains a so-called weighting matrix, in which row i is denoted by ω^i. It determines which foreign countrie's tax rates exert an impact on a particular country's tax. We explore alternative weighting matrices to check the robustness of the strategic tax responses. In particular, our benchmark is that country i only responds to the tax rate of countries that share a common border. Hence, row ω^i contains a zero if a particular country $-i$ does not share a common border with country i, and a positive weight if there is a common border.[5] The tax rates of neighbouring countries that feature a positive weight are equally weighted in ω^i, with the weights summing up to one. Subsequently, we analyze a weighting matrix in which all countries within a range of 1000 kilometer feature positive weights, and explore trade shares instead of uniform shares.

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4) Compare Devereux et al. (2002b) and Altshuler and Goodspeed (2002).

5) For the Netherlands–Luxembourg and Italy–Greece, we also impose a positive weight. In the former case, the two countries are small and close to each other while many transport flows from and to the Netherlands pass through Luxemburg. The latter case is a necessary assumption, because otherwise Greece would not have any neighboring country in our weighting matrix. Excluding Greece from our sample, however, would hardly influence our results.

Diesel excise measure

For the excise rate on diesel, we use data from a balanced panel of 15 countries of the European Union, plus Norway and Switzerland. The data are taken from the OECD/IEA Energy Prices and Taxes, which provide information about both diesel excise levels and prices for the period 1978-2001. As a measure for the excise rate, we take the ratio of the excise and the price inclusive of excises (but exclusive of VAT). The reason for taking this ratio is that it provides a comparable measure for the excise rate across countries. Moreover, it is not sensitive to exchange rate fluctuations that appeared in the pre-1999 period in the EU.[6]

Figures 3.1 and 3.2 show, respectively, the development of the mean value for the excise ratio between 1978 and 2001, and its coefficient of variation (standard variation across countries divided by the mean). Figure 3.1 reveals that the excise ratio in Europe gradually increased over time. In particular, where excises made up around one quarter of the after-tax diesel price during the late 1970s, this share was more than doubled in the late 1990s. This rise was especially significant between 1985 and 1995. This is exactly the period in which the EU adopted its harmonization policy regarding diesel excises. In particular, in 1987 the European Union implemented its first proposal aimed at harmonizing excise rates. Apparently, countries anticipated this, as we observe that the excise ratios started to rise already in 1985. The harmonized excise rate has been gradually increased between 1987 and 1992, when the harmonized rate was transformed into a minimum rate.[7] Since 1992, the minimum rate has remained unchanged at a level of € 0.245 per litre. Because the excise involves a specific tax, i.e. per unit of consumption, the real value of this minimum excise rate gradually fell since 1992. This has made the minimum excise less important for the development of the excise ratio in European countries. Indeed, as most countries index their excises rates to inflation or increase them on a discretionary basis, the gap between the actual excise levels and the minimum level has increased after 1992.[8] In 2000 and 2001, we observe a sharp reduction in the excise ratio in figure 3.1. This is due to an increase in the pre-tax diesel price, which pulls down both the excise ratio and the minimum rate. Overall, the results suggest that the minimum excise rate has significantly reduced the intensity of tax competition, as measured by the development in the level of the excise ratio.[9] In 2003, the minimum was only binding for Greece, while Luxemburg was only slightly above the minimum rate at € 0.253 per litre.[10]

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6) For the pre-1999 period, the excise rates are expressed in 1999 Euro conversion rates. Hence, exchange rate fluctuations in the pre-1999 period are not captured by the data for excise levels. As they can be important for the real value of the excise levels, we prefer to use the excise ratios rather than excise levels.

7) Note that, although Norway and Switzerland are not members of the EU, the minimum rate is not binding for them. For Norway, the introduction of the EU minimum was accompanied by a rise in the level of the excise so as to conform with the trend in the rest of Europe.

8) Note that changes in the net of tax diesel price do not affect the difference between the average and the minimum excise ratio.

9) In a recent proposal, the Finance ministers of the EU agreed upon a proposal for a new Directive on Taxation of Energy Products, originally put forward in COM(1997)30. The aim is to increase the minimum excise duty to € 0.33 per litre by 2012.

10) In Evers et al. (2004), we explore whether minimum rates have affected the intensity of competition in terms of the strategic tax responses.

Figure 3.1: Mean and minimum diesel excise ratio in Europe, 1978-2001

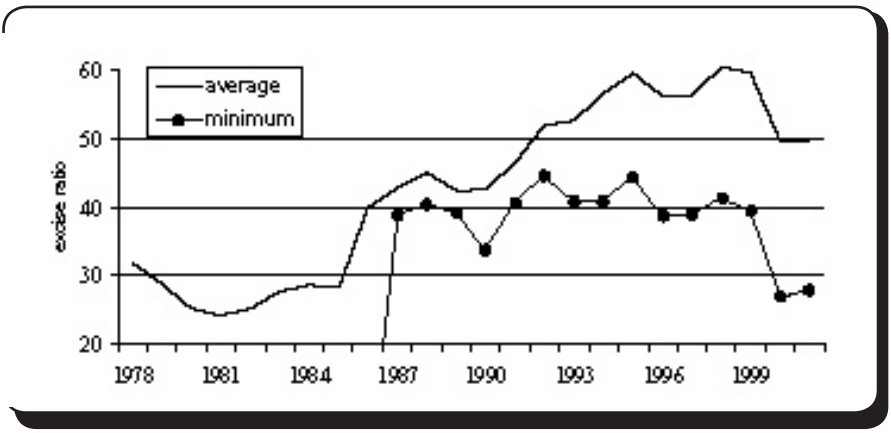
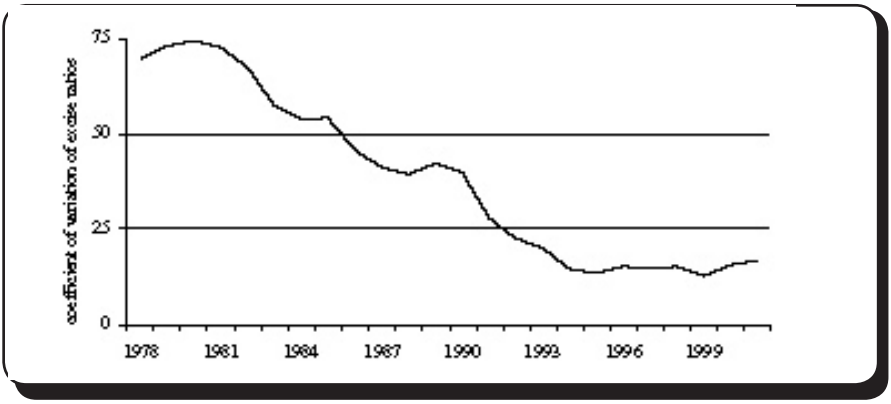


Figure 3.2 shows the development in the spread in excise ratios across European countries. It shows that the gradual increase in the excise ratios between 1978 and 2001 was accompanied by a steady reduction in the variation across countries. Indeed, the period until 1992 shows a process of rapid convergence (sigma convergence): the coefficient of variation dropped from over 60% in the early 1980s to around 16% in 1992. Again, the harmonization efforts of the EU have been responsible for this development. Indeed, the minimum excise has been binding for a number of low-tax countries. By raising their excises to conform to the minimum European rate, this triggered the process of convergence.[11] Yet, we do not observe full convergence: the variation has not entirely disappeared since 1992 and even tends to rise a bit lately.

Figure 3.2: Coefficient of variation of diesel excise ratio, 1978-2001



11) By testing for β-convergence, we obtain a coefficient of β = –5.42 (t-value –15.23). Hence, a country featuring an excise rate that deviates from the European mean gradually moves towards this mean. On average, the excise gap is reduced by 5.42% annually. Computing the speed of β-convergence in the corporate tax rates of 13 European countries used by Devereux et al. (2002ab), we get β = –1.83 for the statutory rates (t-value –2.93) and β = –2.56 for the average effective tax rates (t-value –5.89). Hence, diesel excises have converged faster in Europe than corporate tax rates which have not been subject to harmonization efforts of the EU.

Control variables

We control for a number of exogenous variables that affect a country's tax rate. The vector of controls contains a measure for the size of the transport sector in a country. Size here is not determined by ownership of transport companies, but rather by the number of kilometers that trucks drive through a country. As we do not have direct access to this measure, we include two other variables to capture this effect. These are taken from the World Road Statistics Database from the International Road Federation. First, we take the length of motorways (*ROAD*) as an indicator for country size. In addition to this, we include the number of trucks divided by the number of passenger cars in a country (*TRUCKSHARE*) to obtain an indicator for the (relative) size of the transport sector. Together, these two variables should provide a measure for the size of the transport sector of a country.

Diesel excise rates are probably influenced by lobbying behaviour of transport companies. To capture this potential impact of the diesel lobby, we use the ratio of diesel consumption to the number of inhabitants of a country (*DIESELCAP*).[12]

Diesel excises involve specific taxes. Many countries index these excises to prices or adjust them on a discretionary basis in order to avoid a gradual depreciation of its real value. This contrasts with ad-valorem taxes such as VAT or corporate taxes, which are not indexed. If all tax authorities would adjust excises to (local) inflation, the excises are likely to follow a trend. Without correction, this would wrongly be taken as evidence for tax competition (ceteris paribus the diesel price). Therefore, we control for the *PRICE* index in estimating (1). We also control for the *DIESELPRICE*, which directly affects the excise ratio. Also the minimum diesel excise rate set by the EU may result in a (spurious) pattern of strategic tax interactions if we do not control for it. Indeed, countries are likely to adapt their tax rates in similar directions in response to the harmonization efforts of the EU. Therefore, we also control for the minimum excise rate (*MIN*) in our regressions.

Finally, we include fixed effects, d^i, to control for unobserved heterogeneity between countries. In addition to this, we include time fixed effects to control for common shocks across countries.

Econometric procedure

The tax ratios on the left-hand side of (1) are potentially endogenous. Indeed, if countries play a Nash game, they respond to each other's tax rates, which directly implies an endogeneity problem (Altshuler and Goodspeed, 2002; Brueckner, 2002). To control for this endogeneity, we estimate (1) using two-stage-least-squares. In particular, we estimate an equation with the endogenous regressors from (1) as the dependent variable, i.e. $\omega^i \tau_t^{-i}$. The exogenous regressors and some additional variables that are independent of τ_t^{-i} in equation (1), are then used as instrument variables. Thus, we first estimate:

$$\omega^i \tau_t^{-i} = \beta_1 \sum \omega^i X_t^{-i} + \beta_2 X_t^i \theta + \beta_3 d^i \varphi + \beta_4 d_t \eta + \varepsilon_t^i \qquad (2)$$

12) We also experimented with the share of diesel in total consumption of fuel (gasoline and diesel), without any effect on our main conclusions.

with $\sum \omega^i X_t^{-i}$ being the weighted exogenous variables, defined in the same way as the weighted tax rate. In a second step, the fitted values for the endogenous regressor $\omega^i \tau_t^{-i}$ for each of the countries are inserted into (1), which is then estimated using OLS.

We first estimate a fixed effects model by including a country specific constant d^i as in (1). These fixed effects d^i eliminate the possible problem of omission of unobserved country characteristics that are fixed over time. We also included time fixed effects, d_t, to control for common time shocks. Secondly, we estimate (1) in first-differences. The first-differences model captures the reaction of a country to changes in the other countries' tax rates. By removing stochastic trends using two period lags, the first-difference model estimates only short-term relations between the variables. Following Altshuler and Goodspeed (2002), we use two-year intervals to minimize the loss of data and to deal with the lag of political response to changes in the tax ratios of other countries.[13]

3. Regression results

Table 4.1 shows the regression results in a benchmark case. For the weighting matrix we assume that countries respond only to their neighbours, i.e. countries that share a common border, with uniform weights for these countries. The first two columns in table 4.1 show the coefficients for the fixed effects model, both without and with price variables. The last three columns show the same estimates in which we control for country fixed effect by the method of first differencing. Thereby, we use two-year lags for all variables. The final column excludes time fixed effects.

The table shows that the estimated coefficient for the tax interaction term is significantly positive in all specifications. The price variables exert a significant impact on the tax ratio. On the basis of the Wald-test statistic, we find that including price variables indeed gives the preferred specification compared to models excluding prices. This holds both for the fixed effects model and the first-difference model.[14] We take the first-difference model as our preferred specification. The reason is that the fixed effects model suffers from potential unit root problems. Indeed, the error terms in the fixed effects model show a time trend for some of the countries in our sample. This may create spurious correlation. The first difference model does not suffer from this problem.

In the first-difference model, we see that indexation of excises is important as the price variable exerts a significant impact on the tax ratio. Moreover, as can be expected from the definition of the excise ratio, the diesel price has a statistically significant negative impact on the ratio. The minimum excise level exerts a positive impact but is only significant at the 10% level.

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13) We also explored one and three year lags. This had little impact on the results. Results available on request.

14) The value of the Wald-test for including price variables is 70.26 for the fixed effects model and 17.53 for the model in first differences.

The strategic tax response in the first-difference model with price effects is 0.23 if we include time fixed effects. This suggests that a 10% increase in the excise ratio of neighbouring countries will systematically increase a countrie's own tax rate by 2.3%. This is consistent with the presence of tax competition in diesel excises. The strategic tax response is robust for alternative specifications. In the other columns of table 4.1, we find a significant strategic tax term, the magnitude of which moves between 0.17 (in the first-differences model without price variables) and 0.48 (the first-difference model without time fixed effects). Including time fixed effects appears to be important. Indeed, if we exclude time fixed effects from the regression, as in the final column of table 4.1, the strategic tax term increases from 0.23 to 0.48. The neighbour's tax may thus capture common shocks that are correlated with the tax term. Ignoring time fixed effects may thus bias the estimates.

Table 4.1 Fiscal reaction function estimates[a]

	Fixed effects		First differences		
Neighbours' tax ratio	0.38***	0.32***	0.17**	0.23***	0.48***
	(3.12)	(3.97)	(2.04)	(2.76)	(7.09)
ROAD	-0.04*	-0.09***	-0.02	-0.03	-0.02
	(-1.92)	(-6.18)	(-0.88)	(-1.41)	(-1.09)
TRUCKSHARE	0.02	0.02***	0.01*	0.01*	0.01
	(1.59)	(2.69)	(1.92)	(1.76)	(1.43)
DIESELCAP	0.04	0.12***	-0.07	-0.06	-0.07
	(0.72)	(3.17)	(-1.02)	(-0.90)	(-0.94)
MIN	0.28	-0.50**	0.35***	0.20*	0.03
	(0.67)	(-2.08)	(3.78)	(1.90)	(0.98)
PRICE		0.46***		0.33***	0.42***
		(7.02)		(3.02)	(4.11)
DIESELPRICE		0.10		-0.42***	-0.50***
		(0.64)		(-3.62)	(-6.80)
R2	0.51	0.78	0.42	0.45	0.41
Country fixed effects	Yes	Yes	No	No	No
Time fixed effects	Yes	Yes	Yes	Yes	No
Number of observations	374	374	340	340	340
Number of countries	17	17	17	17	17

a *** denotes statistical significance at 1% level;** at 5% level; * at 10% level. T-values in brackets

As a robustness check we experimented with alternative weighting matrices for the model in first-differences. In particular, our benchmark (first column of table 4.2) adopts the assumption that only neighbouring countries exert an impact on a country's tax and that all these neighbours feature a common impact. Table 4.2 shows the results of two alternative weights. In the second column of table 4.2, we present an estimate for the reaction function where the weights are determined by trade shares. In particular, we use the share of imports + export of a particular country in the total of imports + exports in all European countries as weights. Still, we assume here that only neighbours' taxes are relevant. In the third column, we not only include neighbouring countries in the weighting matrix, but also other European countries that are located within a range of 1000 kilometers from a particular country, using the distances between capitals of countries as an indicator for location. Table 4.2 reveals that our results are not sensitive to these alternative specifications of the weighting matrix.[15]

15) We also explored whether strategic tax responses are affected by country size. In particular, we included a cross-term in the regression between the neighbor's tax and GDP. It appeared that the coefficient for the cross-term is not significant (see Evers et al., 2004).

Table 4.2 Fiscal reaction functions with alternative weighting matrices[a]

	Neighbours with uniform shares	Neighbours with trade shares	Countries within 1000 km circle
Neighbours' tax ratio	0.23***	0.25***	0.23***
	(2.76)	(2.96)	(2.83)
ROAD	-0.03	-0.03	-0.03
	(-1.41)	(-1.47)	(-1.35)
TRUCKSHARE	0.01*	0.01*	0.01*
	(1.76)	(1.69)	(1.72)
DIESELCAP	-0.06	-0.06	-0.06
	(-0.90)	(-0.87)	(-0.88)
MIN	0.20*	0.18*	0.19*
	(1.90)	(1.72)	(1.80)
PRICE	0.33***	0.33***	0.32***
	(3.02)	(3.02)	(2.95)
DIESELPRICE	-0.42***	-0.42***	-0.43***
	(-3.62)	(-3.61)	(-3.67)
R^2	0.45	0.45	0.45

a *** denotes statistical significance at the 1% level;** at the 5% level; * at the 10% level. T-values are in brackets. The regressions refer to the model in first differences, including time fixed effects.

5. Conclusion

Following recent papers that empirically assess strategic interactions among countries with respect to corporate taxes, this paper estimates fiscal reaction functions for diesel excises in Europe. The estimates reveal that a 10% higher tax rate in neighboring countries (in terms of the user price) induces a country to raise its own rate by around 2 to 3%. This impact is robust for alternative specifications. This provides evidence for the presence of tax competition in diesel excises in Europe.

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