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## Corporation effective tax rates and company size: evidence from Germany

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### ABSTRACT

We investigate the relationship between the effective tax rate (E.T.R.) and company size in Germany to test tax planning–political power versus political cost theories. In contrast to most studies in this field, which use linear approximations, this paper uses a quantile regression approach. We use data from Compustat, corresponding to non-financial listed companies during 1992–2009. The results indicate a nonlinear relation, with a positive sign for the first quantiles and a negative one in the last part of the distribution. Additionally, leverage, inventory intensity and return on assets are found to be significant determinants of the E.T.R.

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## 1. Introduction

Corporate income tax (C.I.T.) is a key and highly-debated component of the tax systems of developed countries. Although the revenue from C.I.T. is not a large proportion of total tax revenue, this tax is very significant for a good number of companies – taking into account payments and compliance costs – and may therefore have a significant effect on certain corporate decisions. As governments are perfectly aware of this situation, over recent decades several reforms of different degrees have been applied to C.I.T. in most countries.<sup>1</sup>

These company tax reforms have been generally characterised by a reduction of the statutory tax rate (S.T.R.) and a simultaneous enlargement of the tax base, with the aim of simplifying the tax, maintaining revenues and reducing the gap between the S.T.R. and the effective tax rate (E.T.R.). In this context, the E.T.R. differs from S.T.R. in that the former attempts to measure taxes paid as a proportion of economic income, while the latter indicates the amount of tax liability (before any credits) relative to taxable income, which is defined by the tax law and reflects tax benefits and subsidies built into the law. A common measure of tax liability has been current tax

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expense with some variant of pre-tax income (United States Government Accountability Office (U.S. G.A.O.), 2013), as we discuss in Section 3 below.

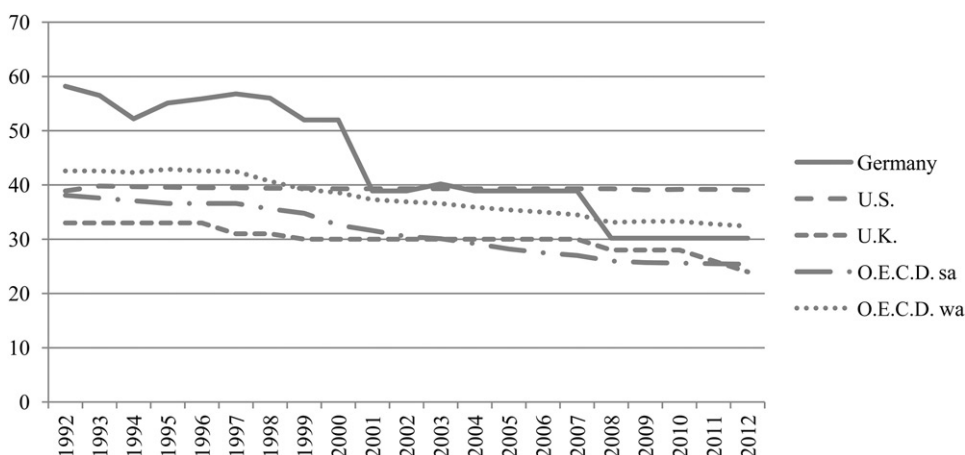
Nevertheless, despite this international trend in S.T.R.s, some countries maintain relatively high rates, such as the U.S. or some European Union (E.U.) Member States such as Belgium, Germany, France, Italy or Malta. In this paper we focus on Germany, a leading world economy only smaller than those of the U.S., China and Japan. In fact, within the E.U., Germany is the country with the largest absolute tax revenues in terms of both aggregate tax revenue as well as C.I.T.

The last two important reforms of C.I.T. in Germany were implemented in 2000 and 2008. One of the highlights of these reforms, aside from other measures that we will comment on below, was the reduction of the S.T.R.s. Concretely, in the 2000 reform the rate dropped from an average of 51 percent to 38.3 percent, while in 2008 this trend continued with a further reduction in the rate to 30.2 percent. Until 2008, however, Germany had the highest S.T.R. in the E.U., except for the years 2001 and 2002, when Belgium and Italy had the highest rates.

C.I.T. has been analysed from several viewpoints in the literature in recent decades (for a complete review on this topic, see the papers by Hanlon and Heitzman (2010) and Graham, Raedy and Shackelford (2012)), with two of the most prominent research areas being *tax competition* (Devereux & Loretz, 2012), which analyses the validity of the prediction of a 'race to the bottom' (Leibrecht & Hochgatterer, 2012) or the mechanisms of tax interactions; and *tax convergence*, which studies the possible convergence of corporate taxes (Slemrod, 2004). This paper, on the other hand, belongs to the literature devoted to the determinants of corporate E.T.R.s, detailed in Section 3. While there is a consensus or agreement in this literature regarding potential explanatory variables of corporate E.T.R.s as they are used in most studies, namely size, debt, asset composition and profitability, the results are not conclusive: a literature review can be found in Delgado, Fernández-Rodríguez and Martínez-Arias (2014). This study focuses on firm size, but other variables are included in the estimations. To conduct our study, we use a sample of German listed companies between 1992 and 2009 extracted from the Compustat database ([www.spglobal.com](http://www.spglobal.com)).

The contribution of this paper is two-fold. First, the econometric methodology, based on conditional quantile regression, has barely been used in this literature; see Hsieh (2012) for the case of China and Delgado et al. (2014) for the E.U. This methodology allows the evaluation of the relative importance of variables at different points of E.T.R. distribution, thereby relaxing the commonly-used assumption of linearity. Secondly, to the best of our knowledge there is only one previous paper on this topic devoted to the German case (Kraft, 2014), so additional empirical evidence for Germany as a leading European country is relevant. In contrast to Kraft (2014), who uses a linear approximation to study the Corporate Tax Reform 2008 and the period 2005–2011, we employ quantile regression for the period 1992–2009, including the two reforms (2000 and 2008).

The rest of the paper is organised as follows. Section 2 provides a general overview of corporate tax in Germany. In Section 3 we lay out the hypotheses, review the empirical literature and describe the methodology. Section 4 presents the data and main results. Finally, Section 5 contains a summary of our main conclusions and some future lines of research.



**Figure 1.** Statutory corporate tax rates.

*Note:* corporate income tax rate: combined central and sub-central.

*Source:* O.E.C.D., Taxfoundation.org.

## 2. The German corporate income tax

The impact of corporate taxation on tax revenue, the attractiveness of the locations and economic performance have been under debate in Germany for decades, and several tax reforms have been implemented to address these impacts. In 2000 and 2008, nominal tax rates were reduced and the tax base was broadened in accordance with the ‘tax-cutting and base-broadening’ strategies that have been enforced in other countries since the 1980s. In [Figure 1](#) we represent the evolution of the S.T.R.s in different areas since the early 1990s using O.E.C.D. data (oecd.org).

Concretely, [Figure 1](#) reflects the S.T.R. in Germany, the U.S., the U.K. and the O.E.C.D. (both simple -sa- and weighted -wa- averages) over the period 1992–2012. The graph reveals a downward trend in all these territories, with Germany under the U.K. and the U.S., and the weighted O.E.C.D. average in the last years of the sample.

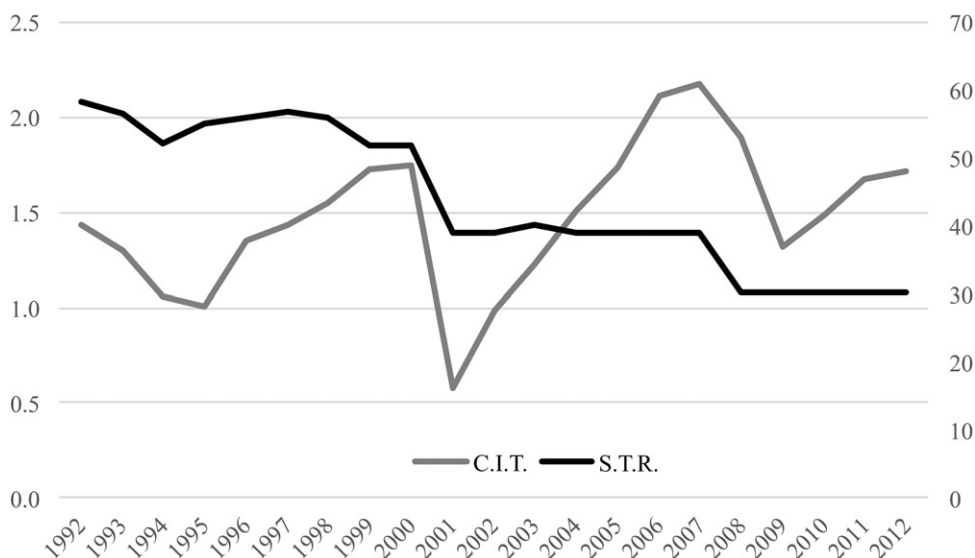
With data for the E.U. from Eurostat (ec.europa.eu/eurostat) ([Table 1](#)), it is possible to clearly distinguish a gap between the average rates of the E.U. and Germany. In Germany, the S.T.R. was 58.2 percent in 1992 and 51.6 percent in 2000, after which the nominal rate was established at 38.9 percent with the 2000 reform and further reduced to 30.2 percent since 2008. Two decades ago, there was a difference of 21.8 points between the German and the E.U. S.T.R.. But after the 2000 reform this gap decreased to less than 10 points, with the exception of 2005, due to a significant reduction of the European average as eight countries diminished their rates. In short, although it has been reduced in recent years, an important difference remains.

Despite these declines in the S.T.R.s, there was an increase in C.I.T. revenue in the E.U. countries during the years up to the beginning of the Great Recession, as a percentage of both G.D.P. and total tax revenue. This paradoxical phenomenon can be initially explained by the increase of the tax base. Some authors have, however, interpreted this result in other terms, such as an increase of the firms’ profitability, the rising weight of service sectors or the growth of the number of companies as opposed

**Table 1.** Adjusted top corporate statutory tax rates in the E.U.

	1995	2000	2001	2005	2008	2012
Germany	56.8	51.6	38.3	38.7	30.2	30.2
E.U.-28	35.0	32.0	30.4	25.3	23.8	22.9
E.U.-17	36.8	34.4	33.0	28.1	26.3	25.4

Source: Eurostat.

**Figure 2.** Corporate income tax (C.I.T.) collection and statutory tax rate (S.T.R.) in Germany.

Source: O.E.C.D. and authors' own work.

to individual entrepreneurs (Auerbach, 2006; Devereux, Griffith & Klemm, 2004; Mooij & Nicodème, 2008; Sørensen, 2007).

In addition, the evolution of the S.T.R. itself may be a motive for the rise in collection. This is due to the parabolic relationship between the tax rate and C.I.T. collection, as pointed out by Clausing (2007), where an S.T.R. of 33 percent maximised the tax revenues for the O.E.C.D. as a whole. This rate varies among countries depending on their size and degree of trade openness, and will be lower for smaller countries and more open economies. In this sense, Devereux (2007) concluded results similar to those of Clausing (2007) for 20 countries in the period 1965–2004, with a rate of 30 percent. It should be noted that the S.T.R.s in the E.U. are significantly lower than 33 percent, especially in the EU-28 context. Figure 2 represents the evolution of the C.I.T. collection (as a percentage of G.D.P.) and the S.T.R. in Germany (the coefficient of correlation between them is  $-0.228$ ), where we can clearly observe the effect of the two reforms on collection.

Returning to the German case, companies are charged with three taxes on profits:

- Corporate income taxes (*Körperschaftsteuer*);
- Trade tax (*Gewerbesteuer*);
- Solidarity surcharge (*Solidaritätszuschlag*).

In 2000, the C.I.T. rates were reduced from 45 percent on non-distributed profits and 30 percent on distributed profits to a common rate of 15 percent, with

accompanying measures to expand the tax base. In 2008, the so-called ‘interest barrier rule’ introduced a profit-based limit on the deduction of interest expenses if net interest expenditure exceeded €3,000,000; and a modified tax base rule added parts of the interest expenditure, rents, leasing and license fees to the tax base.

The Municipal Trade Tax on business profits includes rates between 14 percent and 17 percent, and is based on taxable income in C.I.T. with several adjustments. Since 2008, the Trade Tax is no longer deductible.

Finally, a Solidarity Surcharge has been levied on corporate tax liability since the German reunification, with a rate of 3.75 percent in 1991–1992, 7.5 percent in 1995–1997 and 5.5 percent since 1998. Hence, with the 15 percent C.I.T. rate, the 5.5 percent solidarity surcharge and the trade tax, the overall rate is about 30–33 percent.

The German tax reform of 2000 has been studied by Keen (2002), Sørensen (2002) and Weber (2009), and the 2008 reform by Homburg (2007), Radulescu and Stimmelmayer (2010) and Finke, Heckemeyer, Reister and Spengel (2013). The main changes in both reforms are summarised below based on Sørensen (2002, p. 359) and Radulescu and Stimmelmayer (2010, p. 462).

- Business Taxation Reform Act 2000:
  - The tax rate on retained corporate income and the tax rate on distributed income are reduced from 51.8 percent and 43.0 percent, respectively, to 38.6 percent;
  - The top marginal personal tax rate on capital income is lowered from 53.8 percent to 44.3 percent, and the basic marginal rate from 24.2 percent to 15.8 percent; the rate of dividend withholding tax is also reduced from 25 percent to 20 percent;
  - Reduction of depreciation allowances for movable assets from 30 percent to 20 percent, and for business buildings from 4 percent to 3 percent; official depreciation rate tables are also to be based on more realistic useful life periods;
  - Reform of the method of corporate-personal tax integration;
  - Other reform measures (i.e., abolition of corporate income tax on capital gains on a parent company's shares in a subsidiary).
- Business Taxation Reform Act 2008:
  - Cutback of the corporate tax rate by 10 percentage points and a reduction of the uniform trade tax measure from 5 percent to 3.5 percent;
  - Counteract the tax shifting activities by multinational enterprises via intra-company loans;
  - Abolition of accelerated depreciation for fixed assets;
  - Limits the deduction of net-interest expenses for tax purposes to 30 percent of the earnings before interest and taxes (E.B.I.T.);
  - Other reform measures (i.e., any income from capital such as interest, dividends and capital gains is subject to a final withholding tax of 25 percent plus solidarity surcharge and church tax).

### **3. Hypothesis, empirical literature review and methodology**

With the aim of investigating the relationship between the effective corporate tax rates and firm size, we employ the following variables in an empirical study:

- ETR: the dependent variable, defined as the ratio between current tax payments and earnings before taxes;
- SIZE: size of the company, defined as the logarithm of the total assets;
- LEV: leverage, defined as the ratio between total debt and total assets;
- CAPINT: capital intensity, defined as the tangible assets as a proportion of total assets;
- INVINT: inventory intensity, defined as the investment in inventories as a proportion of total assets;
- ROA: return on assets, defined as the ratio between earnings before income taxes and total assets.

In the literature on E.T.R.s there exists a wide range of definitions, and reviews are provided by Nicodème (2001) or, more recently, Gravelle (2014). The E.T.R. is taxes paid divided by profits, and captures some of the tax benefits and subsidies that reduce the tax paid per Euro of profit. This measure can make a country with a high statutory tax rate but narrow base more comparable to a country with a low legal tax rate and wide base. It is probably more appropriate to assess the true relative burden on investment than the statutory tax rate. These tax rates may not, however, capture temporal effects (for example, accelerated depreciation) and generally depend on accounting rules that may vary across countries.

Nevertheless, in a time series framework such as ours, the temporal problem disappears. On the other hand, the marginal effective tax rate is the appropriate measure for determining the effects of tax rate differentials on investment. This is computed as the ratio of the difference between pre-tax and post-tax returns to pre-tax return. In some cases, however, marginal tax rates do not include all of the components of investment, frequently being restricted to investment in fixed assets or fixed assets and inventory. In addition, these tax rates depend on estimates of economic depreciation, expected inflation and rates of return. A drawback of this rate is the estimation procedure, which is not easy, and changes according to the fiscal context. As Bach (2013) noted, the results reported for different studies show remarkable differences in effective tax rates depending on the assumptions made about economic conditions and other factors that influence the tax burden.

Another approach is the effective average tax rate (E.A.T.R.) (Devereux & Griffith, 1998, 2003), although ‘the implications of this tax rate, which combines statutory and marginal effective rates, are not clear’ (Gravelle, 2014). This measure is highly relevant for the analysis of the impact of the business tax system on tax revenues, since it is closer to standard ‘backward looking’ measures of tax ratios, but these rates also require simulations, with the problems these entail. According to Bach (2013, p. 11),

in the long run forward-looking and backward-looking measures should not diverge so much as it seems to be the case in Germany. This questions the representativeness and suitability of the forward-looking-measures, which are widely used for the analysis of business taxation and its reform in Germany.

In addition, the choice of the definition depends on the aims of the research. Following Nicodème (2001), the methodology of the micro backward-looking approach has two advantages: (1) it uses real-life data and allows all the elements of

taxation to be taken into account; and (2) it makes it possible to study effective taxation at a sectoral level and for different sizes. Moreover, it makes it possible to identify the items of the balance sheet that have a significant influence on effective corporate taxation. The aim of this research is to analyse the relationship between the E.T.R.s and firm size, and we therefore believe that the most suitable rate is that calculated from the microdata of the annual accounts of our sample (Compustat).

Regarding the expected signs for the explanatory variables, we summarise the theoretical arguments in the following hypothesis. Our underlying assumption is that most relationships, including the principle one between size and E.T.R., are nonlinear, so that there may be different patterns along the firms' distribution.

### 3.1 Main hypothesis

- *Hypothesis 1:* SIZE and ETR are non-linearly related.

Firm size is the most widely-used variable in previous research on the corporate tax burden for two contrasting reasons. First, the political cost hypothesis (Jensen & Meckling, 1976; Watts & Zimmerman, 1978) predicts a positive relationship between size and E.T.R. due to the largest firms having greater taxation because of greater government control. In addition, the largest firms tend to be more exposed and monitored by the markets, which would lead them to pay more taxes to give a good image. Secondly, in contrast, the political power hypothesis (Siegfried, 1972) predicts a negative relationship due to the largest companies having a greater influence on the regulators to reduce their tax rates. In addition, the largest firms will have greater scope for tax planning or the adoption of accounting practices that diminish their E.T.R.s.

Therefore, from a theoretical perspective, the relationship between size and E.T.R. is undetermined. Since Zimmerman (1983), who found a positive relationship between size and E.T.R., and Porcano (1986), who concluded a negative relation, the abundant empirical research carried out for different geographical areas and temporal intervals is not conclusive about the prevalence of one of these hypotheses. It is possible that the diversity of results achieved in the existing literature is a consequence because, throughout the distribution of the sample and for different size levels, the relationships are altered. For this reason, the present study contrasts the possible non-linear relationship between size and E.T.R. for German companies by quantile regression.

### 3.2 Other hypotheses

- *Hypothesis 2:* LEV and ETR are non-linearly related.

The relation may be positive for companies with high effective tax rates, while from the traditional perspective – deductibility of interest payments – it would be negative.

- *Hypothesis 3:* CAPINT and ETR are non-linearly related.

The relation may be positive because firms with low capital intensity and high effective tax rates can be induced to increase their noncurrent assets to diminish the tax rates through depreciation and investment tax credits. As companies with high



fixed assets should face a lower fiscal burden than those with low fixed assets due to the deductibility of depreciation and fiscal credits for noncurrent assets, however, the relation could also be negative.

- *Hypothesis 4:* INVINT and ETR are positively related.

An investment in inventories is considered to be an alternative employment of funds to noncurrent assets and consequently limits the possibilities of reducing the managerial E.T.R..

- *Hypothesis 5:* R.O.A. and ETR are non-linearly related.

A priori, profitable firms would be expected to have a higher tax burden, and hence the expected sign is positive. On the other hand, however, these firms may have more tax planning instruments and clear incentives to diminish the effective taxation.

Theoretically, therefore, SIZE, LEV, CAPINT and R.O.A. can be related both positively and negatively with E.T.R., whereas INVINT is expected to be positively related to the effective tax rates.

Additionally, we have included dummies by years and sectors. To define sectors we use the Standard Industrial Classification (S.I.C.), dropping the financial sector (Finance, Insurance, Real Estate) and disaggregating the manufacturing and services sectors according to the two-digit S.I.C. codes due to the large number of companies dedicated to these activities. More concretely, we have considered the following main sectors (sectors with a sufficient number of observations are considered): Manufacturing I; Manufacturing II; Transportation, Communication, Electric, Gas and Sanitary Services; Wholesale Trade; Retail Trade; Services I; Services II; Others (Agriculture, Forestry, Fishing; Mining; Construction; Nonclassifiable Establishments).

In line with the theoretical arguments described in Hypothesis 1, the empirical evidence on the relationship between size and E.T.R. is ambiguous. The results achieved in the empirical literature are not conclusive as pointed out by Belz, von Hagen and Steffens (2018) in their meta-analysis: they review 49 studies, with 20 in favour of the political cost theory, nine in line with the political power theory, nine with no significant results and 11 supporting both theories. For example, in agreement with the political costs hypothesis, Zimmerman (1983), Wang (1991), Omer, Molloy and Ziebart (1993), Plesko (2003), Calvé-Pérez, Labatut-Serer and Molina-Llopis (2005), Noor, Syazwani and Mastuki (2010) and Kraft (2014) find a positive relation between E.T.R. and size. On the other hand, Porcano (1986), Kim and Limpaphayom (1998), Derashid and Zhang (2003), Harris and Feeny (2003), Janssen (2005), Richardson and Lanis (2007) and Chen et al. (2010) find a negative relation between them. Finally, several studies find no significant relation between size and E.T.R., including Stickney and McGee (1982), Gupta and Newberry (1997), Wilkinson, Cahan and Jones (2001), Fernández-Rodríguez (2004), Feeny, Gillman and Harris (2006) and Liu and Cao (2007).

Recently, however, Fernández-Rodríguez and Martínez-Arias (2011), for the U.S. using fixed effects and random effects models; Fonseca-Díaz, Fernández-Rodríguez and Martínez-Arias (2011), for Spain through the generalised method of moments (GMM) estimator developed by Arellano and Bond (1991) for dynamic panel data; Hsieh (2012), for China using ordinary least squares (O.L.S.) and quantile regression; Delgado, Fernández-Rodríguez and Martínez-Arias (2012), for the U.S. through a fixed effects model; and Delgado et al. (2014) for the E.U. using quantile regression, found a nonlinear relationship between size and E.T.R.. Additionally, Wu et al. (2012) find both positive and negative relationships for China depending on the sub-sample used. These results highlight the need to handle this relationship using tools other than simple linear models. One of these tools is the quantile regression approach used in this research.

With the purpose of studying heterogeneous behaviour at different levels of the dependent variable, E.T.R., this semiparametric approximation, proposed initially by Koenker and Basset (1978) (more details on quantile regression can be found in Buchinsky (1998) and Koenker & Hallock (2001)), minimises the deviations in absolute value with asymmetric weighting instead of minimising the squares of the errors as in O.L.S. In this manner, the quantile regression is described as

$$y_i = x_i' \beta_\theta + u_{\theta i}$$

$$\text{Quant}_\theta(y_i|x_i) = \inf\{y : F_i(y|x) \geq \theta\} = x_i' \beta_\theta$$

$$\text{Quant}_\theta(u_{\theta i}|x_i) = 0$$

where  $\text{Quant}_\theta(y_i|x_i)$  denotes the conditional quantile of  $y_i$  on the vector  $x_i$ . Hence the quantile  $\theta$  ( $0 < \theta < 1$ ) solves the expression

$$\min_{\beta} \frac{1}{n} \left\{ \sum_{i: y_i \geq x_i \beta} \theta |y_i - x_i \beta| + \sum_{i: y_i < x_i \beta} (1 - \theta) |y_i - x_i \beta| \right\}$$

In the quantile regression approach, with the 0.1, 0.25, 0.5, 0.75 and 0.9 quantiles considered in this paper, the estimated marginal effects from the estimates of  $\beta$  would indicate how the 10 percent, 25 percent, 50 percent, 75 percent and 90 percent conditional quantiles would be affected at all  $x$  values. Methodologically, the quantile regression estimator can be more efficient than O.L.S. if errors deviate from normality and the quantile estimators are less sensitive to outliers.

Finally, we perform a symmetry test for the quantiles. The null hypothesis is that the effect of the variable is the same at the symmetric percentiles (0.25 and 0.75, 0.10 and 0.90 and so on).

#### 4. Data and results

The data were obtained from the Compustat database and comprise non-financial listed companies in Germany during the period 1992–2009, with a total of 4356

**Table 2.** Descriptive statistics and correlations.

	Mean	Standard deviation	Minimum	Maximum
ETR	0.3573	0.183	0.000	1.000
SIZE	5.7117	2.204	-2.674	12.685
LEV	0.5749	0.194	0.009	1.000
CAPINT	0.2498	0.189	0.000	0.939
INVINT	0.1588	0.134	0.000	0.888
R.O.A.	0.0889	0.089	0.000	2.053

Source: Compustat and the authors' own work.

**Table 3.** Correlations matrix.

	ETR	SIZE	LEV	CAPINT	INVINT	R.O.A.
ETR	1.000					
SIZE	0.068	1.000				
LEV	0.116	0.345	1.000			
CAPINT	0.079	0.221	0.305	1.000		
INVINT	0.056	0.007	0.129	-0.047	1.000	
R.O.A.	-0.099	-0.213	-0.237	-0.164	-0.029	1.000

Source: Compustat and the authors' own work.

observations. The estimations have been obtained with Stata software ([www.stata.com](http://www.stata.com)), and they have been replicated with two dummy variables corresponding to the two reforms in 2000 and 2008. The results, practically the same, are available upon request. In addition, although the manuscript only contains the results for 0.10, 0.25, 0.50, 0.75 and 0.90, for the sake of brevity, the more detailed results for the deciles and vigintiles are also available upon request.

Table 2 contains the descriptive statistics and Table 3 contains the correlations matrix. The average E.T.R. for 1992–2009 was 35.73 percent, far below the statutory rates during this period, which had a mean of 46.04 percent. Regarding the correlations matrix, it should be noted that it only reflects linear correlations and does not take into account possible nonlinear relations, as we find in the quantile results.

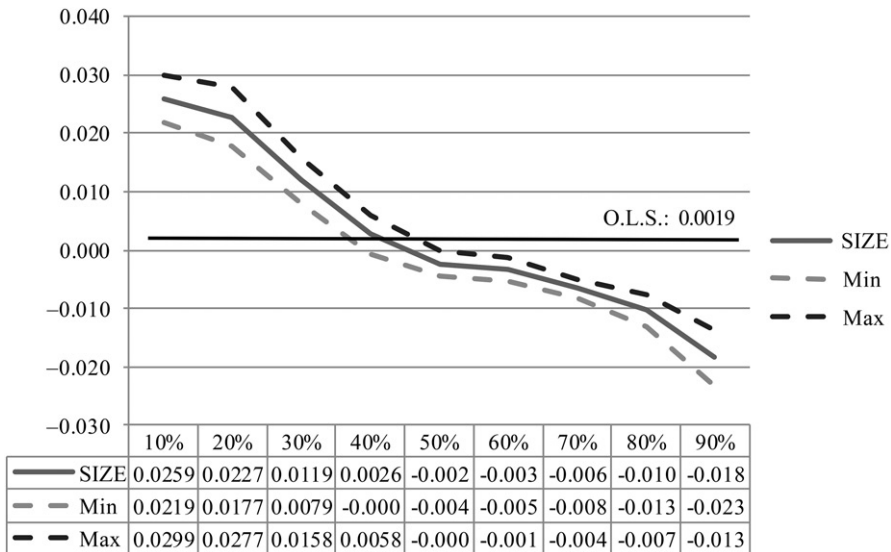
The main results are summarised in Table 4 and represented in Figures 3–7 and Tables 5–9 (O.L.S., quantile estimation and its confidence interval, minimum and maximum). As a general observation, the estimations are in line with the theoretical arguments described in the hypotheses above. There is no simple linear relation between some of the variables and the E.T.R.s, so the quantile regression is appropriate in order to correctly capture the nonlinearities in the data. Thus, O.L.S. does not provide a good fit for the observations due to the inappropriateness of the linearity assumption. In the benchmark case of the O.L.S. estimations, only the leverage and the return on assets are significant. The estimated coefficient on leverage is positive while that on return to assets is negative.

The results from the quantile regression permit a more detailed analysis of the determinants of S.T.R.s. Whereas in the O.L.S. estimations the size parameter is positive but not significant (and thus in line with the papers with no evidence of a concrete theory described previously), in the quantile regression the size is a significant variable and its sign varies from positive in the first part of the distribution to negative from the 0.5 quantile onwards, confirming the hypothesis of a non-linear relationship between the variables. In addition, the symmetry test confirms that the effects are not the same at the percentiles. Thus, the predictions from the

**Table 4.** Quantile regressions results.

Variable	O.L.S.	Quantiles				
		0.1	0.25	0.5	0.75	0.9
SIZE	0.00190 (0.0014)	0.02591*** (0.0020)	0.01738*** (0.0022)	-0.00234** (0.0011)	-0.00808*** (0.0011)	-0.01846*** (0.0025)
LEV	0.04783*** (0.0156)	-0.04759* (0.0254)	-0.07638*** (0.0245)	0.03550*** (0.0122)	0.09123*** (0.0123)	0.23411*** (0.0292)
CAPINT	-0.00455 (0.0161)	-0.01533 (0.0246)	-0.01294 (0.0247)	0.01376 (0.0126)	0.00312 (0.0124)	-0.02853 (0.0271)
INVINT	-0.00156 (0.0250)	0.14768*** (0.0436)	0.11476*** (0.0399)	-0.01080 (0.0195)	-0.04979*** (0.0189)	-0.18464*** (0.0421)
R.O.A.	-0.15394*** (0.0310)	0.04403 (0.0673)	0.13594** (0.0567)	-0.00368 (0.0243)	-0.20967*** (0.0275)	-0.39489*** (0.0961)
SECTOR1	0.02969 (0.0278)	-0.01528 (0.0387)	0.01522 (0.0401)	0.04445** (0.0215)	0.03225 (0.0221)	0.07181 (0.0484)
SECTOR2	0.02587 (0.0276)	-0.00674 (0.0384)	0.02130 (0.0396)	0.03828* (0.0213)	0.02413 (0.0220)	0.05884 (0.0480)
SECTOR3	0.03565 (0.0286)	-0.03562 (0.0396)	0.00673 (0.0412)	0.03976* (0.0221)	0.04507** (0.0226)	0.06806 (0.0492)
SECTOR4	0.05618 (0.0303)	0.01151 (0.0422)	0.04050 (0.0433)	0.05784** (0.0235)	0.04246* (0.0243)	0.08710* (0.0529)
SECTOR5	0.03986 (0.0305)	-0.02431 (0.0429)	0.03973 (0.0441)	0.05784** (0.0237)	0.04711* (0.0242)	0.09280* (0.0527)
SECTOR6	0.03305 (0.0280)	0.00516 (0.0393)	0.01443 (0.0403)	0.03690* (0.0217)	0.03650* (0.0221)	0.06464 (0.0482)
SECTOR7	-0.00466 (0.0298)	0.01122 (0.0420)	-0.00743 (0.0431)	-0.01005 (0.0231)	-0.00003 (0.0235)	0.03746 (0.0509)

Source: authors' own work. Standard errors in parentheses. \*\*\*, \*\*, \* denotes statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively.

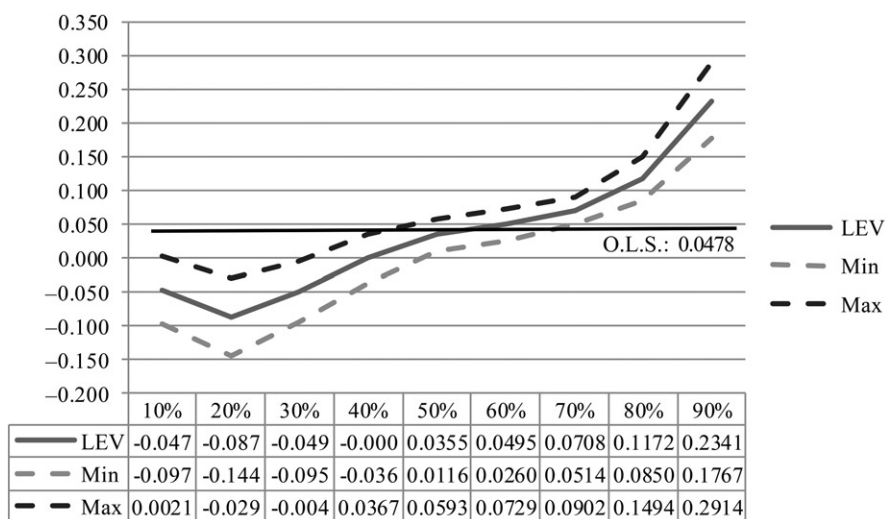


**Figure 3.** Quantile regressions results: size.

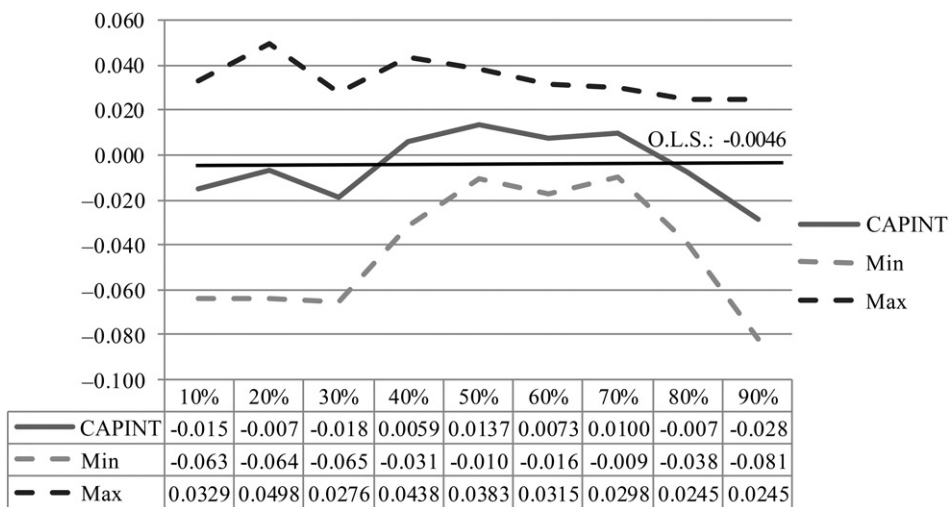
Source: authors' own work.

political cost theory prevail over the lower part of the distribution, but then the tax planning-political power theory is confirmed over the higher parts.

This result is in line with Bao and Romeo (2013), where they concluded that there was evidence of the political cost theory for the entire sample of firms, but of the

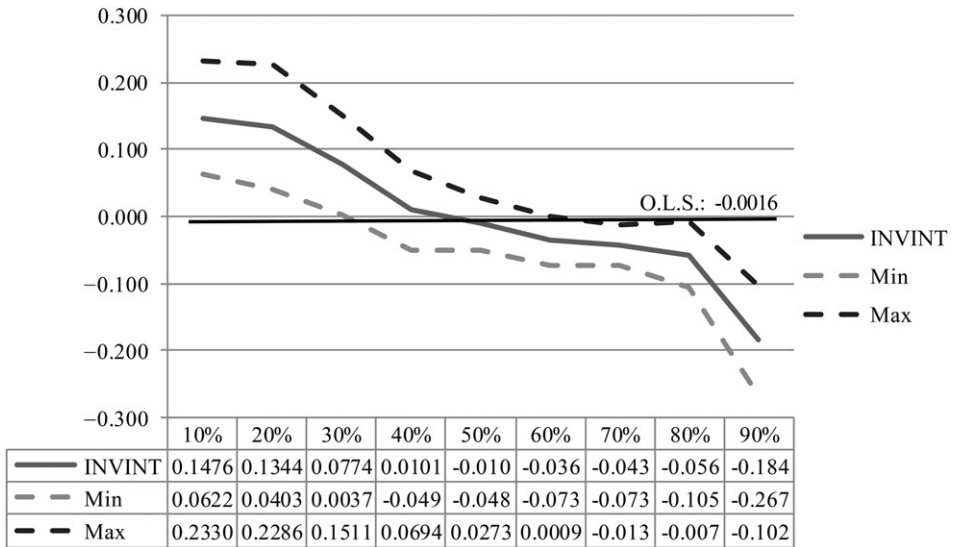


**Figure 4.** Quantile regressions results: leverage.  
 Source: authors' own work.



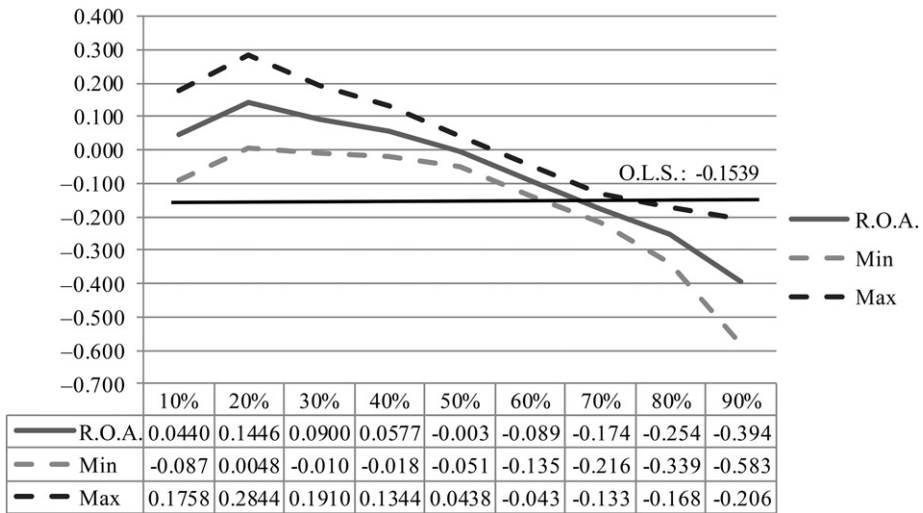
**Figure 5.** Quantile regressions results: capital intensity.  
 Source: authors' own work.

political power theory for the largest 5 percent of firms for the U.S. Our results are also in accordance with Fernández-Rodríguez and Martínez-Arias (2011) for the U.S. and EU-9; and Delgado et al. (2012) for the U.S.. Following the quantile regression approach, Hsieh (2012), for China, finds non-significant some deciles, concretely the first ones and the last one, showing that for most there was a negative sign. This author states that their empirical results for the quantile regression show that not all large firms may enjoy political power. On the other hand, and also using quantile regression, Delgado et al. (2014), for the E.U., find a positive relationship in all deciles, though in an unequal way along the sample. In particular, they find that the



**Figure 6.** Quantile regressions results: investment in inventories.

Source: authors' own work.



**Figure 7.** Quantile regressions results: R.O.A.

Source: authors' own work.

**Table 5.** Symmetric quantile test: size.

Quantiles	F	p-value
q60–q40	28.27	0.0000
q70–q30	82.78	0.0000
q75–q25	117.70	0.0000
q80–q20	214.88	0.0000
q90–q10	133.30	0.0000

Source: authors' own work.

**Table 6.** Symmetric quantile test: leverage.

Quantiles	<i>F</i>	<i>p</i> -value
q60–q40	14.75	0.0001
q70–q30	15.79	0.0001
q75–q25	42.84	0.0000
q80–q20	42.80	0.0000
q90–q10	37.62	0.0000

Source: authors' own work.

**Table 7.** Symmetric quantile test: capital intensity.

Quantiles	<i>F</i>	<i>p</i> -value
q60–q40	0.00	0.9475
q70–q30	0.48	0.4871
q75–q25	0.24	0.6237
q80–q20	0.00	0.9973
q90–q10	0.11	0.7352

Source: authors' own work.

**Table 8.** Symmetric quantile test: investments in inventories.

Quantiles	<i>F</i>	<i>p</i> -value
q60–q40	4.15	0.0416
q70–q30	10.80	0.0010
q75–q25	11.99	0.0005
q80–q20	14.45	0.0001
q90–q10	25.43	0.0000

Source: authors' own work.

**Table 9.** Symmetric quantile test: R.O.A.

Quantiles	<i>F</i>	<i>p</i> -value
q60–q40	19.30	0.0000
q70–q30	36.86	0.0000
q75–q25	25.56	0.0000
q80–q20	48.93	0.0000
q90–q10	19.45	0.0000

Source: authors' own work.

coefficient falls as they move along the E.T.R., taking higher values for the first quantiles of the distribution and then remaining practically constant for the latter deciles.

The leverage of the companies is significant in all quantiles and the pattern is contrary in the case of size, changing from negative to positive after the 0.5 quantile. The symmetry test concludes that there are significant differences between the percentiles. Fernández-Rodríguez and Martínez-Arias (2011), for the U.S. and the E.U.; and Delgado et al. (2012), for the U.S., found also a non-linear relationship between leverage and E.T.R., although with contrary signs, while Hsieh (2012), for China, obtained a positive sign for the first half of the deciles and non-significant for the rest. In a previous study, Dwenger and Steiner (2014) estimated the impact of profit taxation on the financial leverage of German corporations in 1998–2001 using the marginal tax rate, finding a large positive effect on firm leverage (0.7 percent).

Capital intensity, on the other hand, is not significant in our quantile estimations, as occurred with O.L.S.. Accordingly, the symmetry test does not conclude that there

are differences in the estimates. Fernández-Rodríguez and Martínez-Arias (2011), for the U.S., and Delgado et al. (2014), for the E.U., found a positive relation between capital intensity and E.T.R. for some deciles and non-significant results for the others. In addition, Fernández-Rodríguez and Martínez-Arias (2011), for the E.U., and Delgado et al. (2012), for the U.S. found a non-linear relationship, positive until a certain size and then negative. By contrast, Hsieh (2012), for China, obtained a negative sign in all deciles, with more sensitivity of E.T.R. to capital intensity across the major quantiles of the distribution.

Investment in inventories was not significant in the O.L.S. estimations. The quantile regression results shed some light on the reason for this, however, as it is significant and positive for the first quantiles, non-significant for the intermediate ones, and negative and significant for the last quantiles. The effects of the investment in inventories are different at the percentiles according to the symmetry test. No previous study finds a sign change in the relationship between inventories' intensity and E.T.R., although Hsieh (2012), for China, and Delgado et al. (2014), for the E.U., point out a positive relation for some deciles of the distribution, revealing the estimations for different effects of inventories intensity on the E.T.R. depending of the decile.

Finally, the hypothesis of a non-linear relation between R.O.A. and E.T.R. was supported by the results. Concretely, the estimated parameter is positive and significant for the 0.25 quantile but it becomes negative and significant for the 0.75 and 0.9 quantiles. The symmetry test confirms the existence of significant differences between the effects at the percentiles. It should be noted that this is the first study that finds a sign change in the relationship between profitability and E.T.R.. Only Hsieh (2012), for China, and Delgado et al. (2014), for the E.U., obtained differences by deciles, but in all cases the estimations were positive. Additionally, most of the previous literature evidences positive relationships between R.O.A. and E.T.R.. Huang, Chen and Gao (2013) found a negative relation for Chinese companies, however, and the same was achieved for Malaysia by Derashid and Zhang (2003), Noor, Mastuki and Bardai (2008) and Noor, Syazwani and Mastuki (2010). The reason behind this result is almost certainly due to tax planning to reduce the tax burden.

## 5. Conclusions

German corporate tax has been reformed several times in recent decades, with the last two reforms taking place in 2000 and 2008. The observed overall trend consisted of a decline of the S.T.R. and an enlargement of the tax base, ensuring the maintenance of, or even an increase in, tax revenues in most years despite the financial crisis.

In this paper we have studied the determinants of the effective corporate tax rates in Germany over the last two decades, focusing on company size. As both the theoretical arguments as well as the existing empirical evidence for other countries are ambiguous regarding the signs of company size and some other determinants of effective tax rates, and in order to capture possible nonlinearities in the data, we use a quantile regression approach.

Regarding the effect of company size on effective corporate tax rates, our results show that, while the linear model does not reflect any significant relationship, the



quantile regression reveals interesting results. In particular, size is now a significant variable, and the predictions from the political cost theory (positive relation between size and effective tax rates) prevail first; but then the tax planning and political power theories (negative relation) become relevant from the 0.5 quantile onwards. With regard to the other potential determinants of the E.T.R.s, leverage is significant in all quantiles with the sign of the relationship also changing, going from negative to positive. Inventory also has a nonlinear relationship with E.T.R.s. The R.O.A. is significant and negative for the last quantiles, indicating greater tax planning.

This is the first study of this type devoted to the German case, and overall our results corroborate the main assumption of the paper, which is that the nonlinearities frequently observed in the data call for the use of techniques other than O.L.S.. As extensions of this research, at least two directions should be highlighted: first, it would be interesting to perform the analysis with microdata from tax statistics, though governments are generally unwilling to provide this detailed information for a long time series; secondly, different nonlinear approaches could be applied such as, for example, artificial neural networks.

## Notes

1. See Dyreng et al. (2017) for a recent complete review of the evolution of the C.I.T. in recent decades.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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