Corporate Taxation and Firm Productivity

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February 15, 2024

Preliminary - do not share

Abstract

This paper provides novel evidence on the relationship between corporate taxation and firm productivity measured by total factor productivity (TFP). Existing theoretical literature suggests several channels through which taxes can affect firm productivity. Nevertheless, empirical evidence is scarce. We investigate the relationship between corporate taxation and firm productivity - overall and across the distribution of firm productivity. We also analyze how different tax system characteristics affect the development of a firm's productivity over time. Our findings suggest that a higher tax burden may drive the least productive firms out of the market and may decrease the probability of a firm moving up the productivity distribution over time.

Keywords: Corporate Taxation, Total Factor Productivity

JEL Classification: D24, H25, O32

1 Introduction

In this study, we empirically investigate how corporate taxation relates to firm productivity. Previous literature has revealed that firms respond to taxes very differently depending on firm characteristics, such as company size (see, e.g., Baldwin and Okubo, 2009; Egger et al., 2014). We, therefore, not only investigate the overall relationship between the corporate tax burden and firm productivity, but also take firm heterogeneity into account and evaluate the whole distribution of firm productivity. Additionally, we investigate the role of corporate taxation in a firm's productivity evolution.

Reverse causality; high prod firms have low/high tax burdens

Are we picking up market power/other market issues when measuring tfp?

Firm productivity is an important indicator of economic growth. Several papers beginning with Solow (1957) have shown that up to 90% of the increase in real per capita output can be attributed to productivity gains. Therefore, previous literature has evaluated drivers for firm productivity. Syverson (2011) summarizes internal and external factors which drive firm productivity, including managerial practice, quality of capital and labour input, research and development (R&D), firm structure decisions, and competition. A further potential driver of firm productivity, which also relates to several already identified drivers, is tax policy. Being a central toolkit of governments, tax policy impacts the type of capital input as well as R&D and structure decisions. Especially in times of economic crises and a global political agenda towards more sustainability, it is crucial to understand the potential role of tax policy in increasing firm productivity and, hence, boosting the economy, ideally without exploiting natural resources.

To measure productivity at the firm level, we estimate total factor productivity (TFP), a comprehensive measure of productivity. TFP represents the part of firm output that observable firm inputs can not explain. To capture the corporate tax burden, we use tax data on country-industry-level effective average tax rates (EATRs) and effective marginal tax rates (EMTRs). We combine these data and apply three different methodological approaches to investigate the relationship between firm productivity and corporate taxation. First, we investigate the overall relationship between TFP and corporate tax burden by running fixed effect regressions over our whole sample. Second, we incorporate firm heterogeneity and investigate the relationship between corporate tax burden and productivity over the firm productivity distribution by applying recentered influence function regressions. This method allows us to investigate different quantiles of the firm productivity distribution. Third, we want to get a deeper understanding of the relationship between corporate taxation and productivity on an individual firm level. Therefore, we run logit regressions to examine whether corporate taxation relates to the probability of a firm climbing up the productivity distribution over time.

Higher tax rate drives out bottom firms but is worse for higher firms

In the first part of the paper, where we investigate the overall relationship between corporate tax burden and firm productivity, we find a negative association between EATR/EMTR and TFP. In the second part, where we evaluate whether this relationship changes across the distribution of firm productivity, our results suggest that a higher tax burden may drive the least productive firms out of the market. This pattern is particularly clear for purely domestic firms that cannot avoid taxes through international tax planning. In the third part of the paper, where we take a closer look at the individual firm over time and examine the relationship between corporate taxation and firm productivity mobility, our results show that a higher tax burden is associated with a lower probability of climbing up the productivity distribution over time. When we disentangle the corporate tax burden into tax rate and tax base regulations, we find a negative association between the corporate income tax rate (CITR) and the upward productivity mobility of both domestic and multinational firms. We also find evidence that a decreased tax base is associated with a higher probability of moving up the productivity distribution. This relationship is more pronounced for purely domestic companies, which heavily rely on domestic tax regulations such as depreciation allowances to reduce their tax burden.

There is primarily theoretical literature investigating the relationship between firm performance and corporate taxation. Empirical literature is scarce. One strand of empirical literature generally studies the relationship between different measures of firm performance and taxation. Johansson et al. (2010) empirically examine the effect of changes in tax structure, i.e., differences in the design of different tax instruments, on firm performance. They investigate OECD countries between 1970 and 2005 and find that shifting the focus from income taxation towards consumption and property taxes may increase firm performance and economic growth. Using data only for Romanian companies, Lazăr and Istrate (2018) evaluate the impact of an overall firm-specific tax-mix on the respective firm's performance. They find that an increase in the firm-specific tax rate decreases firm performance measured as return on assets. Finally, Chauvet and Ferry (2021) study developing countries. They show that higher taxes result in higher firm performance and growth, especially in lower-income countries. They explain this effect with the positive contribution of higher tax rates to higher tax revenue that is invested in the public infrastructure.

A second strand of literature explicitly investigates the relationship between taxes and TFP. Minniti and Venturini (2017) analyze the effect of corporate taxes on innovation and productivity growth. They use data for US manufacturing industries to show that a more generous tax treatment of research and development (R&D) positively impacts productivity growth. Gkikopoulos et al. (2021) take a different angle and show that a higher engagement in tax avoidance – and therefore a lower tax burden – results in higher productivity. Analyzing multinational corporations in the UK after the change towards a territorial tax system in 2009, Langenmayr and Liu (2022) also find evidence that an increase in profit shifting results in increased productivity of foreign affiliates of UK multinationals.

Investigating firm heterogeneity in this context more closely, Gemmell et al. (2018) examine whether higher corporate tax rates affect how fast small firms converge to the productivity frontier. They argue that higher corporate tax rates lower the after-tax returns of investments. Using data for eleven European countries, they find that a higher statutory tax rate decelerates the productivity catch-up for smaller firms. Romero-Jordán et al. (2020) use data for Spanish manufacturing companies to show that a higher corporate tax rate negatively impacts productivity growth for the most productive companies. They also find that this negative impact is, in relative terms, more significant for small firms. Schwellnus and Arnold (2008) analyze the effect of corporate taxes on productivity and investment using firm-level data across OECD countries. They find a negative effect of the corporate tax rate on firm productivity across firm size and age, except for small and young firms. Similarly, Galindo and Pombo (2011) investigate the effect of corporate taxes on investment and productivity for firms in 42 developing countries. They find a negative effect of the corporate tax rate on investment and productivity, while the effect is more pronounced for larger firms. Bournakis and Mallick (2018) investigate the effect of corporate tax liability on firm-level TFP and find that corporate tax rates negatively impact firm productivity. For R&D- and export-intensive firms, they find a decrease in TFP growth that is associated with higher tax liabilities.

The contribution of this study to the existing literature is twofold: First, to the best of our knowledge, we are the first to study the whole distribution of firm productivity in the context of corporate taxation for a large sample of countries. Previous literature has focused on firms at the productivity frontier or the most or least productive firms, often only for selected countries. Investigating the full amplitude of firm productivity allows us to consider the heterogeneity in firm responses to taxation. Second, we study the evolution of firm performance over time and identify corporate taxation as a potential driver for productivity mobility.

The following section discusses theoretical literature on the relationship between productivity and corporate taxation. Section 3 outlines the data and measures we use. Section 4 explains our three different methodological approaches, Section 5 presents the results. Section 6 concludes.

2 Theory & Literature

This chapter provides an overview of the theoretical literature on the relationship between firm productivity and corporate taxation. Previous literature has revealed several channels through which taxes may affect firm productivity. A first channel is location choice. Davies and Eckel (2010) and Haufler and Stähler (2013) argue that high-productivity firms cluster in low-tax countries. This sorting occurs as production costs reduce the corporate tax base. This tax deduction is more valuable in countries with high tax rates and is more valuable for firms with high production costs, i.e., low productivity. Therefore, low-productivity firms locate in large, high-tax countries while highly productive firms self-select into small, low-tax countries. Baldwin and Okubo (2009) and Bauer et al. (2014) endogenize the corporate tax base in similar models. They show that firm heterogeneity can explain why governments have often broadened tax bases when they reduced tax rates (so-called 'tax-rate-cut-cum-base-broadening reforms').

A further channel relating productivity and corporate taxation is profit shifting, which leads to a mismeasurement of productivity (see Langenmayr and Liu, 2022). In particular, productivity is overstated in countries to which profits are being shifted and understated in countries from which profits are shifted away. Theory also suggests that the fundamental paradigm for pricing intra-group transactions, the arms-length principle, does not work well for highly productive firms (Bauer and Langenmayr, 2013), enabling these firms to shift profits to other countries legally. Looking at real effects, Guvenen et al. (2022) theoretically examine how international tax avoidance affects country-level aggregate productivity growth.

Taxes may also affect productivity via anti-profit shifting rules. Langenmayr (2015) develops a model where governments can implement specific anti-tax-avoidance rules, such as thin capitalization rules. However, these rules do not only affect the companies that actually engage in profit shifting but also impose additional costs on firms that do not actively engage in profit shifting. Therefore, anti-tax-avoidance rules can drive low-productivity firms out of the market.

A country's tax system may also affect a firm's scope, which is related to a firm's productivity. Flach et al. (2021) show that multi-product firms face tougher competition in export markets with lower corporate tax rates. This tough competition makes firms concentrate on their "best product". Exporting to countries with low tax rates thus makes firms more productive. However, a lower domestic corporate tax rate is positively related to the exported product range, leading to lower productivity as firms also produce things they are not as good at.

Another channel through which taxes may affect productivity is innovation and R&D. A small literature strand studying the underlying sources of firm heterogeneity and their role in firms' international activities has endogenized firm heterogeneity as a result of R&D activities (see, e.g., Bonfiglioli et al., 2020; Bustos, 2011; van Long et al., 2011). Tax incentives – targeted subsidies or lower tax rates for R&D outputs (i.e., patent boxes) – have been shown to encourage investment (see, e.g., Chen et al., 2021). The resulting investment may be productivity increasing.

Lastly, a higher tax burden could also decrease average productivity due to its effect on project selection in multinational firms' M&A activities (see Becker and Fuest, 2011).

3 Data & Measures

We derive a measure for firm productivity using the Orbis dataset from Bureau van Dijk. In addition, we combine our productivity measure with the International Tax Institutions (ITI) Database provided by the Research School of International Taxation (RSIT).

3.1 Corporate Taxation

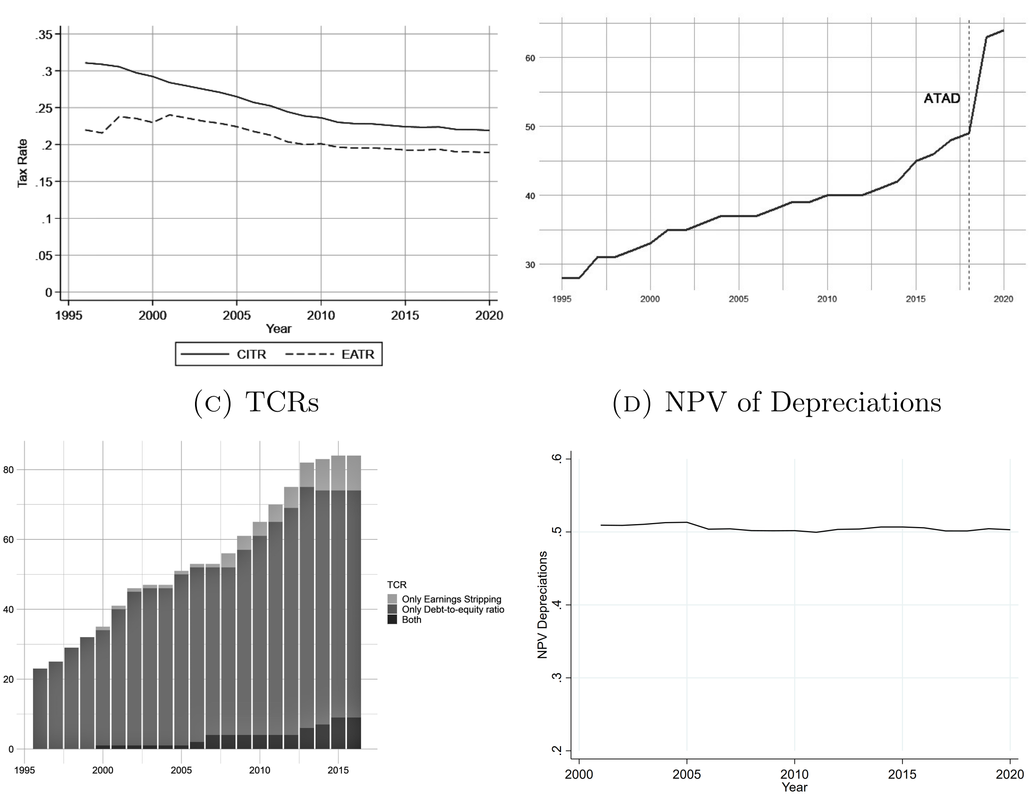
The ITI Database provides tax information for over 200 countries since 1996. Apart from the statutory corporate tax rate, the database also contains information on several tax base characteristics. Figure 1 depicts some essential developments in the area of international taxation in the last two decades. Figure 1a describes the variation in CITRs and EATRs over time. Worldwide, the average CITR has fallen from over 30% in 1996 to about 22% in 2020. During the same period, the EATR, reflecting the statutory corporate tax rate and tax base regulations, fell from 22% to 18%. This downward trend, which started in the late 1980s, likely reflects stronger competition for increasingly mobile capital (see Devereux et al., 2002).

At the same time, the sharp rise in multinational firms' profit-shifting activities led to a coordinated international effort led by the Organisation for Economic Co-operation and Development (OECD) to introduce anti-tax-avoidance regulations. Figure 1 shows the evolution of two types of rules: Controlled Foreign Company (CFC) rules (Figure 1b) and Thin Capitalization Rules (TCRs, Figure 1c). CFC rules allow parent-firm countries to tax income from low-taxed affiliates that would otherwise be tax-exempt. TCRs limit the use of tax-motivated debt financing by restricting the deduction of interest payments. The number of countries applying such rules has risen steadily since the mid-1990s and jumped after adopting the European Union's Anti-Tax Avoidance Directive (ATAD) in 2018. Both figures show that the number of these rules has also risen steadily over the last two decades.

Figure 1d depicts the net present value (NPV) of depreciation allowances at a country-industry level over time. While we observed strong changes in tax rates and the number of anti-tax-avoidance rules, the NPV of depreciation remained relatively constant over time at a level of around 50%.

In sum, we observe a decrease in corporate tax rates and a broadening tax base. Whether this leads to a higher or lower tax burden will depend mainly on firm characteristics.

Figure 1: Tax Developments



(a) CITR & EATR

(b) CFC Rules

(c) TCRs

(d) NPV of Depreciations

Graphs show development of corporate income tax rates (CITRs) and effective average tax rates (EATRs) (Panel A), controlled foreign company (CFC) rules (Panel B), and thin capitalization rules (TCRs) (Panel C), and the net present value (NPV) of decpreciations (Panel D). Tax data from 1996 until 2020 from the International Tax Institutions (ITI) Database provided by the Research School of International Taxation (RSIT).

3.2 Firm Productivity

To analyze the relationship between corporate taxation and firm productivity, we use Orbis to derive a comprehensive measure of productivity, total factor productivity (TFP), at an individual firm level. TFP, describes the variation in output or value added, which is not accounted for by the variation in the observed input factors labor and capital.[1]

However, when estimating TFP, there are two main challenges. First, a selection bias may occur. In general, firm entry and firm exit are accounted for by constructing a balanced panel. Therefore, all firms that enter the market later or exit the market before the end of the observation period are omitted. However, literature

[1] To estimate TFP, we use Orbis data on value added (output), the number of employees (labour input), tangible fixes assets (capital input), and material costs (proxy variable).

shows that a firm's decision on whether to enter or exit a market is driven by a firm's productivity, especially in relation to competitors' productivity (see ,e.g., Jovanovic, 1982). Therefore, using a balanced panel results in a selection bias based on unobserved productivity. Second, a simultaneity problem may occur. Firm productivity is not directly observable but determines several firm decisions, e.g., input demand decisions. Using Ordinary Least Squares (OLS) to estimate TFP requires that the input factors in the production function are exogenous so that a firm's input decisions are independent of the firm's productivity level. The firm, however, knows its productivity level when choosing the inputs resulting in a simultaneity bias.

To address both biases, the literature came up with several estimators. Olley and Pakes (1996) propose a semi-parametric estimator that uses investment as a proxy variable for unobserved TFP. Since this estimator is only valid for positive investments, Levinsohn and Petrin (2003) suggested another semi-parametric estimator that uses intermediate inputs as a proxy variable for unobserved TFP. The approach we are using to estimate TFP comes from Ackerberg et al. (2015). They propose an estimator that solves a problem in the first stage of both Olley and Pakes (1996) as well as Levinsohn and Petrin (2003).[2] To the best of our knowledge, we, therefore, use state-of-the-art methodology for estimating TFP.[3]

We can estimate TFP on a firm level for the years 2010 until 2018. We focus on corporations and drop firms from the following industries: "agriculture, forestry and fishing", "financial and insurance activities", "real estate activities", "public administration and defense", "arts, entertainment and recreation", "activities of households as employers", and "activities of extraterritorial organizations and bodies" since the business models of these industries differ substantially from the business models of all other industries.

To get a first impression of our estimates for firm productivity, Figure 2a depicts the distribution of TFP in our sample. Figure 2b shows TFP estimates over time, plotting the mean and the median as well as the 10th and 90th percent quantile. Tables A1 and A2 in the Appendix display the coverage of industries and countries. We observe a mean and median for TFP in our sample of slightly more than three,

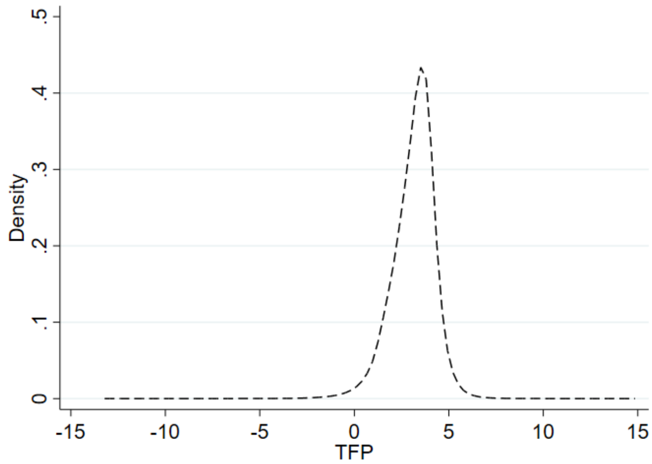
[2]Both approaches estimate the labor coefficient in the production function by regressing output on the labor input and its non-parametric function in a first stage. Due to collinearity between labor and the non-parametric terms, the moment condition underlying this first stage may not identify the labor coefficient. For a GMM approach that solves some econometric shortcomings of both Olley and Pakes (1996) and Levinsohn and Petrin (2003), see also Wooldridge (2009).

[3]We follow Gal (2013) regarding peculiarities estimating TFP with Orbis.

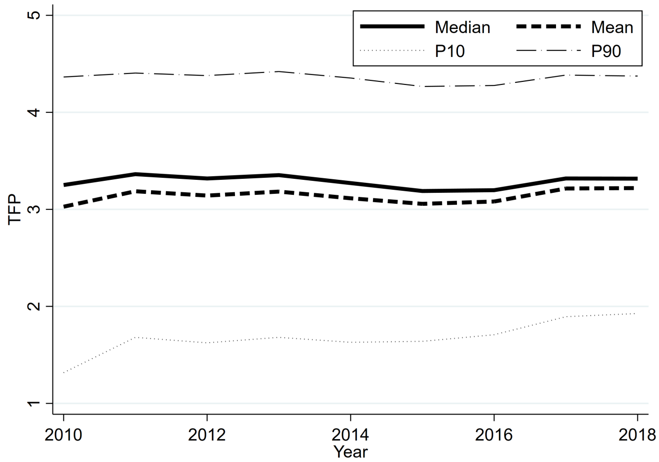
which is very stable over time.

Figure 2: Total Factor Productivity

(a) TFP Distribution



(b) TFP over Time



Graphs show the distribution of TFP (Panel A) and the development of TFP in our sample over time (Panel B). Data from Orbis for 2010 until 2018.

4 Empirical Strategy

We want to elaborate on the relationship between firm productivity and corporate taxation at different levels. We start by taking a big picture approach, continue by incorporating firm productivity heterogeneity and end with investigating a firm's productivity evolution over time.

4.1 Fixed Effects Model

First, we investigate the relationship between the corporate tax burden and firm productivity across our whole sample. Therefore, we apply fixed effects regression models and regress total factor productivity on the corporate tax burden, measured by EATR and EMTR. More formally, we estimate the following regression equation:

$$\mathrm{TFP}_{i,j,c,t} = \beta_0 + \beta_1 \mathrm{Tax}_{j,c,t} + \zeta_{\mathrm{i}} + \eta_{\mathrm{t}} + \lambda_j * t + \epsilon_{i,j,c,t} \tag{1}$$

The dependent variable is total factor productivity (TFP) of firm i in industry j in country c in year t. Our main explanatory variable is $Tax_{j,c,t}$, which is either a country-industry specific EATR or EMTR in year t. We include company fixed effects (ζ_{i}), year fixed effects (η_{t}) and a linear industry time trend ($\lambda_j * t$). $\epsilon_{i,j,c,t}$ is the error term. We cluster the standard errors at the country-industry and year level. If our results are in line with previous literature, we expect an overall negative relationship between TFP and the corporate tax burden, resulting in a negative coefficient estimate for β_1.

4.2 Recentered Influence Funcion (RIF) Regressions

Next, we want to incorporate heterogeneity in terms of productivity in investigating the relationship between firm productivity and the corporate tax burden. Therefore, we take an unconditional quantile regression approach using recentered influence function (RIF) regressions as proposed by Firpo et al. (2009). This approach allows us to investigate the whole TFP distribution. A RIF can be any distributional statistic of a variable of interest. Since we are interested in observing the relationship between corporate taxation and firm productivity over the whole productivity distribution, our RIFs will be quantiles of TFP. We regress these functions of TFP on the measures for corporate tax burden (EATR and EMTR). We also include company fixed effects, country-year fixed effects and cluster the standard errors at the country-industry level. As shown by Firpo et al. (2009), the estimated coefficients correspond to the marginal effect of a small location shift in the distribution of the covariates on the unconditional quantile of the dependent variable. Therefore, we can interpret the coefficient estimates for the EATR/EMTR as the effect of a small increase in the EATR/EMTR on the specific quantile of TFP.

4.3 Logit Regressions

Lastly, we want to zoom in at the individual firm level and explore whether companies move the productivity distribution upward over time and whether taxes can explain this productivity mobility.

We apply a logit regression approach to investigate how productivity mobility relates to corporate taxation. We build two mobility variables depicting the upward movement of firms along the productivity distribution. First, we define $Climb20$ as equal to one if a firm belongs to the 20% worst-performing firms in the first period and to the 20% best-performing firms in the last period. The mean of $Climb20$ in our sample is 0.01. Thus, only 1% of the firms in our sample accomplish this climb from the bottom to the top of the productivity distribution. Second, we define $Mobility3$ as equal to one if a firm's productivity increases by at least three quantiles over time. The mean of $Mobility3$ is 0.09. Therefore, 9% of the firms in our sample increase their productivity by three quantiles or more over time.

$$\text{UpwardProd}_{i,j,c,t} = \frac{1}{1 + e^{-(\beta_0 + \beta_1 Tax + \gamma X_{i,j,c,t} + \epsilon_{i,j,c,t})}} \tag{2}$$

We regress these two productivity mobility measures on the different tax measures. We investigate the average EATR ($AverageEATR$) and EMTR ($AverageEMTR$) faced by the respective firm. We also separate the corporate tax burden into tax rate and tax base regulations by investigating the average statutory corporate tax rate ($AverageCITR$) and the average net present value of depreciation allowances ($AverageNPVDepr$). We control for the average natural logarithm of profit the firm made ($AverageLn(Profit)$), a dummy indicating whether a company is a multinational firm (MNE), the year of incorporation of a firm to control for age (Age), the natural logarithm of fixed assets ($Ln(FixedAssets)$) in the first year we observe the firm, the debt-to-equity ratio ($Debt/Equity$) in the first year we observe the firm, a variable that depicts how many years we observe the firm in our sample ($YearsInSample$), and an error term. Table A4 in the Appendix displays summary statistics for these regressions. The methodological approach is inspired by the seminal studies by, e.g., Chetty and Hendren (2018), who study the mobility of individuals within the income distribution over time.

As a firm's performance and profitability may drive a firm's effective tax rate, we additionally apply an instrumental variable (IV) approach and instrument the effective tax rate (EATR & EMTR) by the statutory corporate income tax rate. For this instrument to be reliable, there has to be a correlation between the statutory tax rate and the effective tax rate. Besides, we assume that the statutory tax rate does not directly affect firm productivity other than through the effective tax rate.

5 Results

5.1 Fixed Effects Model

Table 1 presents the regression results from the fixed effects models described in Section 4.1. We want to investigate the overall relationship between firm productivity and the corporate tax burden and regress TFP on two different measures for the corporate tax burden, the EATR and the EMTR. In the demanding baseline specification, we include a linear industry time trend as well as company and time fixed effects and apply two-way clustering on country-industry as well as year level. Column (1) shows the results for $EATR$ being our main variable of interest. We find a negative and statistically significant coefficient estimate suggesting a negative association between the corporate tax burden and firm productivity, which is in line with prior research. The coefficient estimates suggests that a one percentage point increase in the EATR relates to a decrease in TFP of 0.04. As the mean value for TFP in our sample is 3.16, this reflects a decrease of 1.3%. We also find a negative association between the EMTR and TFP, which is, however, not statistically significant. As firm productivity is more closely related to long-term planning than to making incremental decisions, we believe that the EATR is the more relevant measure of corporate tax burden in the context of firm productivity.

5.2 Recentered Influence Funcion (RIF) Regressions

Having observed an overall negative relationship between firm productivity and the corporate tax burden, we use RIF regressions to investigate whether this relationship differs across the productivity distribution. Table 2 presents the results from the RIF regressions for the 5th, 50th, and 90th quantile of TFP both when EATR and when EMTR are the tax variables of interest. All regressions include company and year fixed effects. Table A3 in the Appendix depicts summary statistics for these

Table 1: Fixed Effects Model

Dependent Var: TFP	(1)	(2)
EATR	-4.09**	
	(-2.50)	
EMTR		-1.03
		(-1.83)
Industry Time Trend	Yes	Yes
Company FE	Yes	Yes
Year FE	Yes	Yes
Observations	11,027,729	11,027,729
Adj. R^2	0.77	0.77

The observational units are firms. The dependent variable is TFP. $EATR$ ($EMTR$) is the effective average (marginal) tax rate of the country-industry where a specific firm is active. All specifications include company and time fixed effects as well as a linear industry time trend. Data from 2010 until 2018. Standard errors are heteroskedasticity-robust and clustered at the country-industry and year level. * Indicates significance at the 5% level, ** indicates significance at the 1% level, *** indicates significance at the 0.1% level. Productivity data on firm-level from Orbis; tax data from Research School of International Taxation (RSIT).

regressions.

Table 2: RIF Regression Coefficients

	TFP					
Quantiles:	5	50	90	5	50	90
EATR	3.61**	-0.10	-0.48***			
	(2.28)	(-0.49)	(-2.80)			
EMTR				4.47**	-0.16	-0.56***
				(2.27)	(-0.60)	(-2.64)
Quantile	1.17	3.28	4.36	1.17	3.28	4.36
Company FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,027,813	11,027,813	11,027,813	11,027,813	11,027,813	11,027,813
Adj. R^2	0.39	0.68	0.59	0.39	0.68	0.59

The observational units are firms. The dependent variable is the recentered influence function for the 5th, 50th, and 90th quantile of TFP. $EATR$ is the effective average tax rate of the country-industry where a specific firm is operating. All specifications include company and year fixed effects. Data from 2010 until 2018. Standard errors are heteroskedasticity-robust and clustered at the country-industry level. t-statistics in paratheses. * Indicates significance at the 5% level, ** indicates significance at the 1% level, *** indicates significance at the 0.1% level. Productivity data on firm-level from Orbis; tax data from Research School of International Taxation (RSIT).

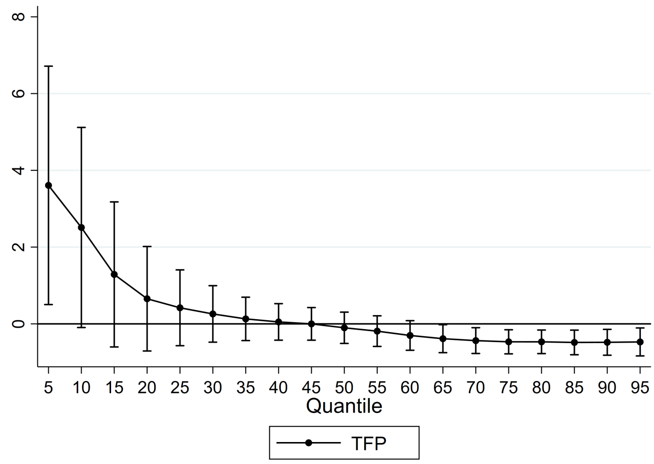
The coefficients for the EATR (EMTR) depict how the specific TFP quantile changes with a small change in the distribution of the EATR (EMTR). The first three columns depict the results for $EATR$ being the proxy variable for the corporate tax burden. The coefficient estimate for the 5th quantile is 3.61. Therefore, a small increase in the EATR is associated with an increase of the 5th quantile of TFP of 3.61. As a result, the TFP distribution is shifted to the right and firms in the 5th quantile are more productive. The coefficient estimate of the 50th quantile is negative and not statistically significant. The coefficient estimate for the 90th quantile is negative and statistically significant. Therefore, a small increase in the EATR is associated with firms becoming less productive at the upper end of the distribution. The same pattern can be observed with $EMTR$ being the explanatory tax burden variable.

Figure 3 depicts the EATR and EMTR RIF regression coefficients for the 5th to the 95th quantile of TFP. Panel A plots the coefficient estimates for $EATR$ being the proxy variable for the corporate tax burden. Panel B plots coefficient estimates for $EMTR$. For both, $EATR$ and $EMTR$, we observe a positive and statistically significant coefficient estimate on for the least productive firms in the 5th quantile. For the 10th to the 60th quantile, estimates are decreasing, but non-distinguishable from zero. For the 65th to the 95th TFP quantile, coefficient estimates are negative and statistically significant. The interpretation of the positive relationship between corporate taxation and TFP for the least productive firms could be in line with the theoretical consideration proposed by Langenmayr (2015): an increase in the tax burden affects all firms in the market and drives the least productive firms out of the market making the remaining firms relatively more productive.

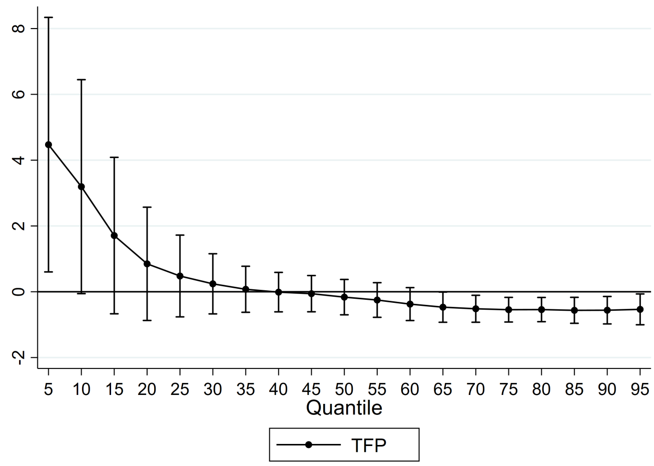
In the upper part of the distribution, we see a negative relationship between the EATR and TFP as well as EMTR and TFP. Three arguments could explain this relationship: First, governments in countries with unproductive firms may tend to levy higher taxes. Since unproductive companies generate few sales and, therefore, low tax bases, levying higher tax rates helps to increase tax revenue. Second, less productive firms with relatively high production costs tend to cluster in high-tax countries. This argument is in line with the theoretical considerations by Davies and Eckel (2010) and Haufler and Stähler (2013). The production costs reduce the tax base and this tax base reduction is especially valuable in a country with a higher tax rate. Third, companies that are resident in countries with a high tax burden engage in profit shifting reducing the observable productivity in this country. This consideration is in line with the argument proposed by Langenmayr and Liu (2022). Summing up, the RIF regression coefficients for the EATR and EMTR on TFP

Figure 3: RIF Regression Coefficient Graphs for EATR & EMTR

(a) EATR



(b) EMTR



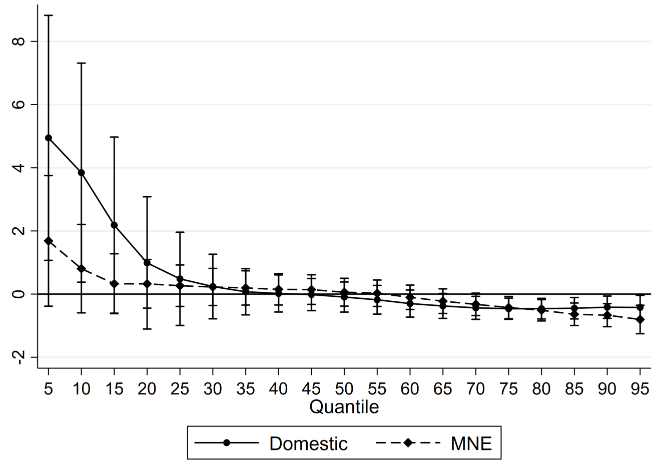
Graphs show the RIF regression coefficient estimates for $EATR$ (Panel A) and $EMTR$ (Panel B). The dependent variables are quantiles of TFP. All specifications include company and year fixed effects. Standard errors are heteroskedasticity-robust and clustered at the country-industry level. The bars depict 95% confidence intervals. Productivity data on firm-level from Orbis; tax data from Research School of International Taxation (RSIT). Data from 2010 until 2018.

suggest a selection effect of the least productive firms with an increasing tax burden. Besides, we observe a prevailing negative relationship between corporate taxation and firm productivity.

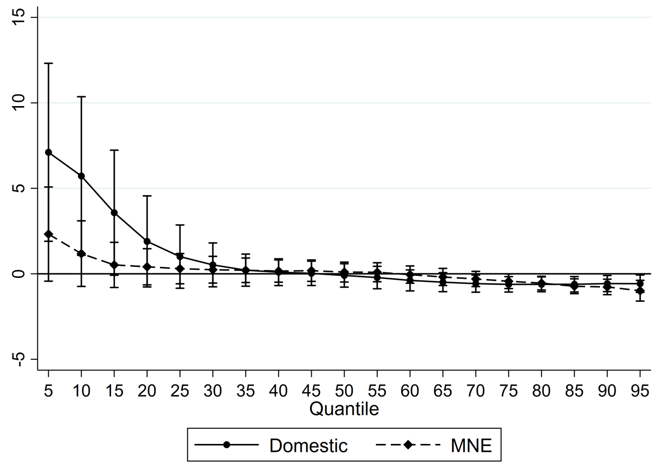
To gain additional insights into the relationship between corporate taxation and productivity, we incorporate a further dimension of firm heterogeneity and conduct a sample split where we investigate purely domestic vs. multinational companies separately.[4] While purely domestic corporations have limited possibilities to avoid taxes, there are various channels multinational firms can use to legally reduce their tax burden. Separating these two groups may provide additional insights. We again apply the RIF regression approach and regress quantiles of TFP on the EATR and several control variables. Figure 4 depicts the respective EATR regression coefficients for the 5th to the 95th productivity quantile.

Figure 4: RIF Regression Coefficient Graphs for the EATR - MNEs vs. Domestics

(a) EATR



(b) EMTR



Graphs show the RIF regression coefficient estimates for $EATR$ (Panel A) and $EMTR$ (Panel B) for a sample split into domestic and multinational firms. The dependent variables are quantiles of TFP. All specifications include company and year fixed effects. Standard errors are heteroskedasticity-robust and clustered at the country-industry level. The bars depict 95% confidence intervals. Productivity data on firm-level from Orbis; tax data from Research School of International Taxation (RSIT). Data from 2010 until 2018.

[4] For summary statistics for both groups, see Table A3 in the Appendix.

The results show that the domestic firms mainly drive the pattern we observed for the full sample in Figure 3. For the domestic firms, we see a positive and statistically significant relationship between TFP and both EATR and EMTR for the least productive firms. While we also observe a positive relationship for the least productive multinational firms, this relationship is not statistically significant and smaller than for domestic firms. This result suggests that the least productive domestic firms may be driven out of the market due to tax burden increases as they have limited options to avoid these taxes. In contrast, multinational firms may be able to avoid at least part of the additional tax burden and can prevent a market exit.

5.3 Logit Regressions

In a last step, we want to zoom in at the individual firm level and explore whether companies move the productivity distribution upward over time and whether taxes can explain this positive productivity mobility.

First, we descriptively evaluate the mobility of firm productivity over time in our data.

Table 3: TFP Mobility Trends

	decile last period									
decile first period	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	*43.20*	23.18	12.22	7.22	4.56	3.09	2.20	1.65	1.33	1.35
2	26.06	*28.40*	17.49	10.11	6.15	4.06	2.74	2.02	1.55	1.40
3	11.97	21.85	*23.62*	15.57	9.69	6.22	4.13	3.01	2.17	1.78
4	6.23	10.93	19.79	*21.79*	15.25	9.76	6.38	4.34	3.19	2.33
5	3.82	5.78	10.81	18.69	*21.04*	15.57	10.12	6.65	4.55	2.98
6	2.49	3.35	6.00	11.08	18.25	*21.14*	16.52	10.85	6.43	3.89
7	1.87	2.28	3.72	6.15	11.14	18.20	*22.20*	17.66	11.24	5.55
8	1.55	1.61	2.65	4.18	6.60	11.35	18.88	*24.86*	19.53	8.79
9	1.43	1.39	2.01	2.98	4.46	6.76	11.30	19.81	*30.37*	19.49
10	1.39	1.24	1.67	2.24	2.84	3.85	5.54	9.14	19.64	*52.46*

Productivity mobility over time. We always compare a firm's productivity in the first year we observe it with the productivity in the last year we observe the firm. We focus on firms we can follow for at least five years. The rows depict the productivity deciles in the first period, the columns the productivity deciles in the last period. Therefore, 43.20 in row (1) and column (1) means that 43.20% of the firms that were in the first productivity quantile in the first year we observe them are also in the first productivity quantile in the last year we observe them. Data from Orbis for 2010 until 2018.

Table 3 shows that a substantial share of firms seems to stick to their productivity level over time: 21% to 52% remain in the same productivity quantile. We find exceptionally high productivity stability among the best-performing firms, i.e., firms in the highest quantile. However, we also observe a considerable share of firms that move the productivity distribution upward over time. We find this upward mobility to be less likely for the worst-performing firms: Only 1.4% of the firms in the first productivity quantile in the first year manage to become one of the best-performing firms. Especially for firms ranging in the low and medium quantiles in the first year, however, we observe that up to 23% increase their productivity by at least one decile over time.

Tables 4 and 5 show the results of our logit regressions where we investigate how productivity mobility relates to corporate taxation. We regress our two variables of upward productivity mobility ($Climb20$, which is equal to one for a firm which belongs to the 20% worst-performing firms in the first period and to the 20% best-performing firms in the last period and $Mobility3$, which is equal to one if a firm's productivity increases by at least three quantiles over time) on measures for the corporate tax burden. In the first two columns, we investigate the full sample. In columns three to six, we differentiate between multinational firms (Columns (3) and (4)) and purely domestic firms (Columns (5) and (6)).

Table 4 depicts results where we use EATR as the corporate tax burden measure. We see a uniform pattern for both productivity mobility measures and across all groups: an increase in the EATR is associated with a decrease in the probability of climbing up the productivity distribution over time. The regression coefficients of $EATR$ are negative and statistically significant in all six specifications. One argument for this observation could be that a higher tax burden and, therefore, higher costs impede productivity growth for firms. For our full sample, a one percentage point increase in the EATR is associated with a decrease in the probability of upward mobility over time by 3-5%. Differentiating between multinational firms and domestic firms suggest that this relationship is more pronounced for multinational firms, which have limited options to avoid an increased tax burden.

Table 5 shows results for the EMTR being the corporate tax burden measure. Consistent with our findings for the EATR, we find negative and statistically significant coefficient estimates for $EMTR$ suggesting that the corporate tax burden is negatively associated with a positive productivity mobility over time. A one percentage point increase in the EMTR is associated with a decrease in upward productivity mobility of 4-9% in the full sample.

Table 4: Logit Regression Results - Productivity Mobility - EATR

	Full Sample		**MNEs**		**Domestics**	
	Climb20	Mobility3	Climb20	Mobility3	Climb20	Mobility3
AverageEATR	-5.43***	-2.63***	-3.74***	-2.89***	-7.92***	-2.71***
	(-6.99)	(-5.08)	(-4.51)	(-5.66)	(-8.86)	(-4.05)
AverageLn(Profit)	0.25***	0.15***	0.20***	0.12***	0.29***	0.17***
	(8.85)	(5.71)	(8.20)	(5.41)	(7.30)	(5.11)
MNE	0.04	0.10**				
	(0.55)	(2.15)				
Age	0.05***	0.03***	0.06***	0.04***	0.04***	0.03***
	(12.84)	(11.87)	(10.05)	(11.53)	(9.41)	(10.35)
Ln(FixedAssets)	-0.12***	-0.09***	-0.10***	-0.08***	-0.12***	-0.10***
	(-9.31)	(-8.12)	(-6.34)	(-6.43)	(-7.05)	(-7.43)
Debt/Equity	-0.35	0.57**	-0.34	0.20	-0.05	0.69***
	(-1.12)	(2.40)	(-0.83)	(0.72)	(-0.17)	(3.00)
YearsInSample	-0.03	-0.01	-0.04*	-0.01	-0.02	-0.00
	(-1.35)	(-0.68)	(-1.77)	(-0.86)	(-0.95)	(-0.38)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	761,133	761,133	261,488	261,488	499,645	499,645
Pseudo R^2	0.05	0.03	0.05	0.04	0.06	0.03

The observational units are firms. The dependent variables are $Climb20$ and $Mobility3$. $Climb20$ is a dummy variable that equals one if a firm was climbing from the 20% worst-performing to the 20% best-performing firms over time. $Mobility3$ is a dummy variable that equals one if a firm's productivity grew for three deciles or more over the observation period. The dependent variables are $AverageEATR$, $AverageLn(Profit)$, MNE, Age, $Ln(FixedAssets)$, $Debt/Equity$, and $YearsInSample$. Data from 2010 until 2018. Standard errors clustered at the country-industry level. t-statistics in paratheses. * Indicates significance at the 5% level, ** indicates significance at the 1% level, *** indicates significance at the 0.1% level. Productivity data on firm-level from Orbis; tax data from Research School of International Taxation (RSIT).

To rule out potential endogeneity bias, we also conduct an IV approach and use the corporate statutory tax rate as an instrument for the effective tax rate (EATR & EMTR). Table 6 reports the respective results. Columns (1) and (4) confirm the relationship between the CITR and EATR/EMTR in the first stage. Columns (2)-(3) and (5)-(6) suggest that an increase in the corporate tax burden results in a decrease in the probability of a positive productivity mobility over time.

5.3.1 Specific Tax System Characteristics

So far, we have used the EATR and EMTR as our tax variables of interest, which combines the statutory tax rate and tax base regulations. To further differentiate between tax rate and tax base regulations, we conduct a more detailed analysis: instead of using the EATR or EMTR as an explanatory variable, we use the CITR as

Table 5: Logit Regression Results - Productivity Mobility - EMTR

	Full Sample		**MNEs**		**Domestics**	
	Climb20	Mobility3	Climb20	Mobility3	Climb20	Mobility3
AverageEMTR	-8.75***	-4.38***	-6.66***	-4.91***	-11.65***	-4.27***
	(-7.48)	(-5.62)	(-5.05)	(-5.68)	(-7.69)	(-4.33)
AverageLn(Profit)	0.25***	0.15***	0.20***	0.12***	0.28***	0.17***
	(8.51)	(5.50)	(8.36)	(5.36)	(6.79)	(4.91)
MNE	0.04 0.10**					
	(0.55)	(2.20)				
Age	0.04***	0.03***	0.06***	0.03***	0.04***	0.03***
	(12.61)	(12.40)	(9.63)	(11.98)	(9.41)	(10.52)
Ln(FixedAssets)	-0.12***	-0.09***	-0.10***	-0.07***	-0.12***	-0.10***
	(-9.05)	(-7.81)	(-6.11)	(-6.30)	(-7.25)	(-7.18)
Debt/Equity	-0.48	0.53**	-0.50	0.13	-0.32	0.64***
	(-1.62)	(2.34)	(-1.31)	(0.45)	(-1.11)	(2.94)
YearsInSample	-0.02	-0.01	-0.04*	-0.01	-0.01	-0.00
	(-1.16)	(-0.44)	(-1.69)	(-0.71)	(-0.61)	(-0.09)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	761,133	761,133	261,488	261,488	499,645	499,645
Pseudo R^2	0.05	0.03	0.05	0.04	0.06	0.03

The observational units are firms. The dependent variables are $Climb20$ and $Mobility3$. $Climb20$ is a dummy variable that equals one if a firm was climbing from the 20% worst-performing to the 20% best-performing firms over time. $Mobility3$ is a dummy variable that equals one if a firm's productivity grew for three deciles or more over the observation period. The dependent variables are $AverageEMTR$, $AverageLn(Profit)$, MNE, Age, $Ln(FixedAssets)$, $Debt/Equity$, and $YearsInSample$. Data from 2010 until 2018. Standard errors clustered at the country-industry level. t-statistics in paratheses. * Indicates significance at the 5% level, ** indicates significance at the 1% level, *** indicates significance at the 0.1% level. Productivity data on firm-level from Orbis; tax data from Research School of International Taxation (RSIT).

well as the net present value of depreciation allowances. We regress our productivity-mobility variables ($Climb20$, $Mobility3$) on the average CITR over the respective period ($AverageCITR$) and the average net present value of depreciation allowances ($AverageNPVDepr$). The remaining control variables are in line with the baseline specification in Equation 2. Tabel 7 shows the respective regression results.

For the full sample as well as for multinational and domestic firms separately, we find negative and statistically significant coefficient estimates for $AverageCITR$. This pattern suggests that a higher statutory corporate tax rate is associated with a decreased probability for positive productivity mobility over time. In contrast, we find a positive relationship between the net present value of depreciation allowances and productivity mobility: all coefficient estimates are positive and statistically significant. The net present value of depreciation allowances is a discounted measure

Table 6: Logit Regression Results - IV

	Stage 1	**Stage 2**		**Stage 1**	**Stage 2**	
	EATR	Climb20	Mobility3	EMTR	Climb20	Mobility3
CITR	0.85***			0.55***		
	(2.65)			(18.78)		
EATR		-1.88***	-1.20***		-3.06***	-1.92***
		(-6.49)	(-4.21)		(-6.93)	(-4.47)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Company Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	761,133	761,133	761,133	761,133	761,133	761,133

The observational units are firms. The dependent variables are $Climb20$ and $Mobility3$. $Climb20$ is a dummy variable that equals one if a firm was climbing from the 20% worst-performing to the 20% best-performing firms over time. $Mobility3$ is a dummy variable that equals one if a firm's productivity grew for three deciles or more over the observation period. The dependent variables are $AverageEMTR$, $AverageLn(Profit)$, MNE, Age, $Ln(FixedAssets)$, $Debt/Equity$, and $YearsInSample$. Data from 2010 until 2018. Standard errors clustered at the country-industry level. t-statistics in paratheses. * Indicates significance at the 5% level, ** indicates significance at the 1% level, *** indicates significance at the 0.1% level. Productivity data on firm-level from Orbis; tax data from Research School of International Taxation (RSIT).

Table 7: Logit Regression Results - Productivity Mobility - CITR & Depreciation Allowances

	Full Sample		**MNEs**		**Domestics**	
	Climb20	Mobility3	Climb20	Mobility3	Climb20	Mobility3
AverageCITR	-7.84***	-3.52***	-7.02***	-4.48***	-8.73***	-3.11***
	(-10.86)	(-6.11)	(-9.03)	(-6.32)	(-9.88)	(-4.92)
AverageNPVDepr	2.84***	1.39***	2.71***	1.50***	2.84***	1.54***
	(7.32)	(3.82)	(6.73)	(4.17)	(4.58)	(2.94)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	761,133	761,133	261,488	261,488	499,645	499,645
Pseudo R^2	0.06	0.03	0.05	0.04	0.06	0.03

The observational units are firms. The dependent variables are $Climb20$ and $Mobility3$. $Climb20$ is a dummy variable that equals one if a firm was climbing from the 20% worst-performing to the 20% best-performing firms over time. $Mobility3$ is a dummy variable that equals one if a firm's productivity grew for three deciles or more over the observation period. The dependent variables are $AverageCITR$, $AverageNPVDepr$ $AverageLn(Profit)$, MNE, Age, $Ln(FixedAssets)$, $Debt/Equity$, and $YearsInSample$. Data from 2010 until 2018. Standard errors clustered at the country-industry level. t-statistics in paratheses. * Indicates significance at the 5% level, ** indicates significance at the 1% level, *** indicates significance at the 0.1% level. Productivity data on firm-level from Orbis; tax data from Research School of International Taxation (RSIT).

of depreciation which reduce a firm's tax base. A higher value represents higher deductible depreciation and, therefore, a lower tax base. Higher depreciation allowances and consequently a lower tax burden are positively associated with a positive productivity mobility over time.

6 Conclusion

This study analyzes the relationship between corporate taxation and firm productivity, measured by total factor productivity (TFP). We start by broadly investigating this relationship with a fixed effects model. To take into account heterogeneity in terms of firm productivity, we apply an unconditional quantile regressions approach and run recentered-influence-function regressions to evaluate the whole firm productivity distribution. Lastly, we focus on the individual firm level and use a logit regression approach to examine how corporate taxation relates to the mobility of a firm's productivity over time. This paper aims to gain a better understanding of the drivers of productivity in the context of taxation. Our results may be relevant for policymakers, especially during crises and economic downturns.

Our findings confirm the overall negative relationship between corporate tax burden and TFP from previous literature. For the worst performing firms, we find, however, a negative relationship between EATR/EMTR and firm productivity. An increase in the corporate tax burden may drive the least productive firms out of the market, making the remaining firms relatively more productive. Examining the relation between corporate taxation and individual productivity mobility over time, we observe a uniform pattern: an increase in the corporate tax burden is associated with a decrease in the probability of climbing up the productivity distribution over time. When we disentangle the EATR into the CITR and the net present value for depreciation allowances, we observe that this negative relationship seems driven by the CITR. For a decreasing tax base, we accordingly find a positive relationship towards upward productivity mobility. Some of our results suggest that multinational firms are less affected by an increase in the corporate tax burden than purely domestic firms which can be explained by tax avoidance possibilities.

Our results identify a significant relationship between firm productivity and corporate taxation. Therefore, the paper stresses the importance of understanding how tax policy may affect firm productivity, which is an important driver of long-term economic growth. We also can attribute the negative relationship between tax burden and positive firm productivity development mainly to the statutory tax rate. This finding may provide a rationale behind the so-called 'tax-rate-cut-cum-base-broadening reforms'. These reforms describe policies where governments lower the statutory tax rate (tax cut) and simultaneously broaden the tax base (base-broadening), leaving the effective tax burden unchanged. Lowering the tax rate and broadening the tax base may increase the productivity of firms without a loss in tax revenue.

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A Appendices

Table A1: Industries

Industry	TFP
B - "Mining and quarrying"	0.33
C - "Manufacturing"	18.61
D - "Electricity, gas, steam and air conditioning supply"	0.48
E - "Water supply etc"	0.83
F - "Construction"	13.13
G - "Wholesale and retail trade"	28.76
H - "Transportation and storage"	6.13
I - "Accommodation and food service activities"	6.20
J - "Information and communication"	4.51
M - "Professional, scientific and technical activities"	10.23
N - "Administrative and support service activities"	4.77
P - "Education"	1.06
Q - "Human health and social work activities"	3.26
S - "Other service activities"	1.71
Total	100.00
Observations	11,493,868

Share of industries in our data. Data from Orbis for 2010 until 2018.

Table A2: Industries

Country	TFP
Australia	0.14
Austria	0.22
Belgium	6.21
Bosnia & Herz.	0.42
Brazil	0.00
Bulgaria	0.21
Columbia	0.00
Croatia	2.05
Czechia	3.46
Denmark	1.01
Estonia	1.38
Finland	2.04
France	5.73
Germany	2.21
Greece	0.00
Hungary	2.23
Iceland	0.12
India	0.01
Ireland	0.20
Italy	19.08
Japan	0.00
Korea	2.96
Latvia	0.08
Lithuania	0.00
Luxembourg	0.04
Malta	0.00
Montenegro	0.07
Netherlands	0.25
New Zealand	0.00
Norway	1.83
Pakistan	0.01
Poland	0.84
Portugal	7.92
Rep. of N. Madeconia	1.13
Romania	10.42
Russian Federation	0.00
Serbia	2.14
Slovakia	2.87
Slovenia	1.60
Spain	15.04
Sweden	3.01
Taiwan	0.07
Ukraine	0.89
United Kingdom	2.09
Total	100.00

Share of industries in our data. Data from Orbis for 2010 until 2018.

Table A3: Summary Statistics RIF Regressions

	Full Sample (N=11,027,813)			Multinationals (N=3,186,342)			Domestics (N=7,841,471)		
	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
TFP	3.16	1.10	3.30	3.21	1.10	3.26	3.14	1.10	3.32
EATR	0.22	0.06	0.23	0.21	0.07	0.21	0.22	0.06	0.24
EMTR	0.15	0.06	0.14	0.14	0.06	0.13	0.15	0.06	0.15

Summary statistics for the full sample, as well as for the sample split into domestic and multinational firms. The observational units are firms. TFP is the total factor productivity estimated according to Ackerberg et al. (2015). $EATR$ ($EMTR$) is the effective average (marginal) tax rate of the country-industry where a specific firm is operating. Data from 2010 until 2018. Productivity data on firm-level from Orbis; tax data from Research School of International Taxation (RSIT).

Table A4: Summary Statistics Logit Regressions

	Full Sample (N=761,133)			Multinationals (N=261,488)			Domestics (N=499,645)		
	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
Climb20	0.01	0.09	0.00	0.01	0.10	0.00	0.01	0.09	0.00
Mobility3	0.10	0.29	0.00	0.11	0.31	0.00	0.09	0.29	0.00
AverageEATR	0.20	0.07	0.20	0.20	0.07	0.20	0.20	0.06	0.20
AverageEMTR	0.13	0.06	0.12	0.13	0.06	0.12	0.13	0.05	0.12
AverageCITR	0.23	0.08	0.23	0.23	0.08	0.23	0.23	0.07	0.23
AverageNPVDepr	0.49	0.17	0.50	0.48	0.18	0.51	0.49	0.15	0.50
AverageLn(Profit)	10.76	2.15	10.65	11.04	2.36	10.86	10.62	2.01	10.56
MNE	0.34	0.47	0.00						
Log(FixedAssets)	11.66	2.52	11.60	11.81	2.66	11.61	11.59	2.44	11.60
Age	1998.38	12.25	2001.00	1998.63	12.95	2002.00	1998.24	11.86	2000.00
Debt/Equity	0.85	0.15	0.80	0.84	0.17	0.83	0.85	0.15	0.80
YearsInSample	7.87	1.44	9.00	7.82	1.45	9.00	7.90	1.43	9.00

The observational units are firms. TFP is the total factor productivity estimated according to Ackerberg et al. (2015). $Climb20$ is a dummy variable that equals one if a firm was climbing from the 20% worst-performing to the 20% best-performing firms over time. $Mobility3$ is a dummy variable that equals one if a firm's productivity grew for three deciles or more over the observation period. $AverageEATR$ is the average effective average tax rate of the country-industry where a specific firm is operating. $AverageEMTR$ is the average effective marginal tax rate of the country-industry where a specific firm is operating. $AverageCITR$ is the average corporate income tax rate of the country where a firm is operating. $NPVDepr$ is the net present value of depreciation allowances of the country-industry the specific firm is operating. $AverageLn(Profit)$ is the natural logarithm of the average profit of a specific firm over time. MNE is an indicator that equals one if the respective firm is a multinational firm and zero if the firm is a purely domestic firm. $Log(FixedAssets)$ is the logarithmized value of fixed assets of the firm in the first period we observe the firm in our data. Age is the year of incorporation of the respective firm. $Debt/Equity$ is the debt-equity-ratio of the firm in the first period we observe the firm in our data. $YearsInSample$ is the number of years a firm appears in our data. Data from 2010 until 2018. Productivity data on firm-level from Orbis; tax data from Research School of International Taxation (RSIT).