# Corporate Tax Policy and International Firm Behavior

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# Contents

# Chapter 1

# Introduction

*”The market mechanism alone cannot perform all economic functions. Public policy is needed to guide, correct, and supplement it in certain respects.”*

*(Musgrave and Musgrave, 1989, p.5)*

Modern economies are characterized by the coexistence of and, more importantly, the interdependencies between the private and the public sector. On the one hand, firms’ activities contribute to a country’s economic growth and development, boost investment and trade, create jobs, and foster technological progress and innovation, which is essential for an economy’s sustainable competitiveness. On the other hand, firms benefit considerably from a wide range of public goods and services which are, to the greatest extent, provided by the public sector. These include, among others, (i) public infrastructure and a successful education system as well as (ii) institutional quality, reflected, for example, by a strong adherence to the rule of law. In his pioneering contribution dating back to 1959, Richard Musgrave provides a very fundamental rationalization of government intervention in the economy, distinguishing between three branches (or functions): the *allocation*, *distribution*, and *stabilization function* of government activity (Musgrave, 1959). While, nowadays, the *stabilization function* is commonly associated with the field of macroeconomics, the two other functions still represent the seminal normative principles to guide government activity from a public finance perspective. As to the *allocation function*, one can summarize that if the market mechanism fails to achieve allocative efficiency (as, for example, in the context of the provision of public goods and services), then there is scope for an intervention of public policy for efficiency reasons. In the context of allocative efficiency and the maximization of total surplus, however, no statement is made about whether the outcome implies a socially desirable distribution of income. To the extent that a society pursues the objective of a reasonably fair income distribution, the *distribution function* implies that fiscal policy should be concerned with redistribution through some form of a tax and transfer system.

Musgrave's famous three-branch taxonomy offers a normative framework to guide the design of public policy. From a descriptive point of view, we can state that government activities intended to meet both allocation and distribution objectives of public policy are necessarily associated with public expenditures. This, in turn, implies that governments face a budget constraint and need to generate public income to finance expenditures related to, broadly speaking, the provision of public goods and services as well as a social security system. The major source of public income is tax revenue: countries levy taxes on personal and corporate income, goods and services, and other sources. One important feature in this context is that most taxes are not lump-sum, but imply behavioral responses, distortions, and efficiency losses. This is probably most intuitive in the case of corporate income taxation, as taxes bring on behavioral responses of firms. In general terms, a corporate tax reduces the net return on an investment, inducing firms to invest less. This behavioral response brings along welfare costs (an excess burden) of taxation (Harberger, 1962). In addition to the setting in this very fundamental example, Nicodème (2008) argues that the corporate income tax distorts a wide range of further firm decisions, particularly in an international context. In this regard, recent decades have witnessed fundamental changes to corporate sectors around the world, owing to increased international integration through trade and investment openness in general, and the proliferation of multinational enterprises (MNEs) and foreign direct investment (FDI) in particular (see, e.g., Markusen, 2002; UNCTAD, 2018; Cadestin et al., 2019). Taxing increasingly mobile MNEs on a national level has become more and more difficult and constitutes a far-reaching concern for policymakers. To the extent that (i) MNEs' investment decisions are influenced by tax incentives (see, e.g., De Mooij and Ederveen, 2003) and (ii) MNEs are able to shift profits to affiliates in low-tax jurisdictions (see, e.g., Heckemeyer and Overesch, 2017), the capability of governments to raise tax revenue from corporate income generated by MNEs is severely restricted.

Turning the focus to the tax policy of governments, the latter have recognized these challenges and, broadly speaking, react in two different ways. On the one hand, we observe intensified competition for mobile tax bases, as a lot of countries have reduced their statutory tax rate on corporate income. Moreover, a variety of policies have been enacted by countries to concede preferential tax treatment for specific forms of corporate income (for example, income from intellectual property, see Griffith et al., 2014). On the other hand, more and more countries also strive to implement policy instruments to restrict the tax-avoidance activities of, in particular, MNEs. Anti-tax-avoidance-rules have been introduced to limit profit shifting and, eventually, an erosion of tax bases. Policy actions taken by jurisdictions in this context have been largely uncoordinated so far. However, the recent BEPS (Base Erosion and Profit Shifting) initiative of the OECD and G20 countries marks an important step towards more coordinated, multilateral efforts to tackle these concerns. The BEPS report includes specific policy recommendations and is, indeed, designed to be implemented in a coordinated manner, both domestically and through multilateral treaty provisions (OECD, 2016). It is, however, unclear to what extent still tax-sovereign states will comply with these suggestions and effectively implement and enforce the respective policy measures.

Taken together, these trends exemplify that corporate tax policy takes place in a highly dynamic and international environment. Current developments and their implications for firm behavior and strategic tax policies lie at the core of both academic research and controversial policy debates. The dynamics of ongoing changes to the global business environment and international tax policy responses to these changes, however, necessarily imply that there remain open questions. On a lot of different margins, we still know remarkably little about the interdependencies between international tax policy and firm behavior, and, on a broader scale, about the extent to which this impacts the economic development of countries at a global level.

This dissertation consists of four self-contained essays and contributes to a better understanding of the corporate tax policies of countries operating under very different conditions to generate tax revenue, taking into account the behavioral responses of firms to tax incentives in an international context. Moreover, it also provides novel evidence as to how MNEs' international investment decisions are made and how the latter are crucially affected by profit-shifting opportunities and facilitated access to financial capital.

To learn about these topics, it is of great relevance to rely on a broad data basis. An integral part of this dissertation is a self-collected dataset on statutory and effective corporate tax measures around the world. This dataset is unique in its comprehensiveness, containing data on corporate tax regimes of 193 countries for the time period from 1996 to 2016. Complemented by further data sources, we use these data in all chapters of this dissertation, which we briefly demonstrate in the following, before presenting the main findings and contributions of each chapter in more detail. Chapter 2 provides an extensive survey on our self-collected dataset and presents two concise empirical applications for which the dataset can be used: one at the firm level, where we model a firm's fixed assets as a function of the tax measures in our data, and one at the country level, where we estimate whether tax-avoidance behavior implies an inverse-U-shaped Laffer-Curve relationship between statutory tax incentives and corporate tax revenue. The third chapter builds on the latter empirical application in the second chapter. It examines how countries generate corporate tax revenue in an international context and extends the Laffer-Curve framework by additionally taking into account the competitive pressure exerted by foreign countries' tax-setting behavior on (domestic) tax revenue. In Chapter 4, we first present a theoretical model to analyze how the threat of tax evasion affects a revenue-maximizing country's optimal tax-setting behavior. We evaluate our theoretical findings and their policy implications using our comprehensive dataset on corporate tax rates, complemented by data on tax revenues, the number of Double Taxation Treaties (DTTs) concluded by a country, and a wide range of additional country-level data. Finally, in the fifth chapter, where we use a rich micro dataset of German firms, we exploit our self-collected tax data to show that it is mainly due to reasons related to tax-planning opportunities and an improved access to financial capital that we observe a positive relationship between foreign and home investment of MNEs.

Chapter 2 of this dissertation is joint work with Georg U. Thunecke and Georg Wamser. First, it provides a survey on corporate income taxes around the world, including statutory and effective marginal and average tax rates as well as measures of the tax base. To the best of our knowledge, no study has calculated tax measures for such a large sample of countries as we do. We describe recent trends in tax policy and highlight salient features of the cross-country distributions of different tax measures, demonstrating that there is significant variation in these measures across countries and over time. Providing weights for financial structure and asset composition, we then augment the country-level information with firm- and industry-level data. This allows us to contrast statutory measures at the level of countries with measures accounting for firm- and industry-specific weights. Second, we use our self-collected data to demonstrate how the latter can be used for a number of research questions. In particular, we present two applications, one at the macroeconomic, country level, and one at the microeconomic, firm level. As to the former application, we estimate Laffer-Curves, i.e., the relationship between statutory tax rate and tax revenue, and show that this relationship is inverse-U-shaped. As to the latter application, we analyze how taxes affect firm-level investment in fixed assets and find very plausible tax and tax base elasticities, which are comparable to previous studies. While these two applications serve as examples for the usefulness of our new dataset, we indicate that future research may use our tax data to analyze numerous interesting research questions, particularly in an international context.

The third chapter draws on the first of the applications presented in Chapter 2. From a more general perspective, it contributes to a better understanding of how countries generate corporate tax revenue. First, we illustrate that the amount of tax revenue countries raise from different sources is substantial and varies considerably across countries. Taking into account that governments face a budget constraint, raising adequate tax revenue is essential, as public expenditures are mostly financed with tax revenue. Second, we analyze empirically how corporate tax revenue is related to international statutory tax incentives. To this end, we suggest a Laffer-Curve framework, which reflects that statutory tax rate and revenue in one country show an inverse-U-shaped relationship. We extend this framework and additionally link a country's corporate tax revenue to a weighted average of other countries' corporate tax rates. This captures the idea that countries compete for mobile tax bases over statutory tax rates, and corporate tax revenue in one country may be affected by other countries' tax-setting behavior. We find, however, that foreign countries' statutory tax rates have no significant effect on (domestic) corporate tax revenue and neither affect the revenue-maximizing tax rate nor the corresponding maximum tax revenue predicted by the Laffer-Curve. Moreover, the revenue-maximizing rate lies clearly above the global average, observed tax rate in our sample. While international tax competition is likely to be the driving force behind this finding, our predicted Laffer-Curves controlling for this competitive pressure show that tax revenue is not maximized at such a low tax rate. Our results imply that tax-avoidance activities give rise to a robust inverse-U-shaped Laffer-Curve relationship which is insensitive to the inclusion of foreign countries' tax rates. This suggests that the responsiveness of firms to foreign statutory tax rates is, on average, rather limited. We provide a number of stylized facts, descriptive statistics, and references to previous research to further explain our findings. From a policy perspective, our findings suggest that international statutory tax competition should not play a dominating role in a country's optimal tax-setting behavior. Instead, considerations about marginal statutory tax rate changes should be mainly related to the respective country's current rate-revenue combination and, hence, its location on the Laffer-Curve. Given that statutory corporate tax rates in most countries already are below the predicted revenue-maximizing rates, further tax cuts would most likely imply additional adverse revenue effects.

While, in Chapters 2 and 3, we aim at providing a 'unified', global view on the tax-setting behavior of countries, we change the perspective in Chapter 4, which is joint work with Thomas Letsche and Georg Wamser. To be more precise, we explicitly account for the notion that governments and tax authorities around the world operate under very different conditions. These include a variety of aspects such as the quality of fiscal institutions and tax enforcement, the level of corruption, or location-specific rents. We first present a theoretical framework in which we model the tax-setting behavior of a government, whose objective it is to raise revenue from taxing firm profits. Firms, however, may attempt to bribe the tax agent in charge with the aim of avoiding the tax. The extent to which such behavior is detected and punished by the government depends on several country characteristics. We show that these characteristics and, as a consequence, the threat of tax evasion affect optimal tax policy, suggesting that a country belongs to one of three possible types and either (i) ignores, (ii) combats, or (iii) tolerates tax evasion. Our findings indicate that countries characterized by widespread corruption, weak fiscal institutions, and high location-specific rents (e.g., due to natural resource abundance) are likely to set comparatively high tax rates and to tolerate tax evasion. Moreover, these countries lack the incentive to increase the efficiency of tax collection, as small (but costly) improvements on tax enforcement usually do not translate into higher revenue. We provide evidence for an empirical pattern strongly reinforcing the predictions of our model and, in particular, their policy implications. We show that it is only through a *big push* – substantial and persistent improvements towards stricter tax enforcement – that a country, at last, benefits in terms of a considerable increase in tax revenue. We illustrate that most of the countries which have experienced such a *big push* in terms of tax enforcement are newly-industrialized countries. This is consistent with our theoretical finding that favorable economic development is often accompanied by improvements on tax enforcement and revenue collection. Hence, overcoming the problems related to poor tax enforcement and inefficient revenue collection proves to be an indispensable step on a country's way towards economic growth and development.

Finally, Chapter 5, which is joint work with Stefan Goldbach, Arne J. Nagengast, and Georg Wamser, presents new empirical results on the relationship between foreign and domestic investment of MNEs. Increased international integration and, in particular, the global expansion strategies of MNEs may raise the concern that the foreign activities of these firms imply losses for the home countries due to a shift of production and employment abroad. Previous contributions to the literature provide ambiguous evidence in this regard, implying that it is not clear whether domestic investment and FDI can be seen as substitutes or complements. Our empirical approach exploits variation at the extensive and intensive margin of foreign activity. It mainly relies on two comprehensive micro datasets provided by the German Central Bank (Deutsche Bundesbank), which allow us to observe the operations of German firms at home and abroad, including yearly balance-sheet information. Our basic results, which prove to be robust against a large number of sensitivity tests, suggest that FDI complements domestic investment at the firm level. In this regard, we can distinguish between an extensive and an intensive margin effect. As to the former, setting up a new foreign affiliate is associated with an immediate positive effect of about EUR 460,000 additional investment. As to the latter, the investment elasticity at the intensive margin is estimated to be approximately 0.13. Trying to explain these results, we investigate three specific channels through which foreign activity may affect domestic investment: technology upgrading and productivity gains, tax savings and profit-shifting opportunities, and internal capital markets. We do not find evidence that foreign activity enhances domestic total factor productivity (TFP), hence, the positive effect on investment at home does not seem to be caused by improved production processes and technology upgrading. In contrast, this positive effect seems to be mainly related to (i) additional opportunities for tax planning and (ii) an improved access to financial capital. We highlight that these two channels are closely linked, as internal debt is the common vehicle for both profit shifting and a more efficient allocation of financing capital.

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# Chapter 2

# Corporate Income Taxes Around the World: A Survey on Forward-looking Tax Measures and Two Applications[1]

ABSTRACT

This study provides a survey on corporate taxes around the world. Our analysis has three main objectives. First, we collect tax data and calculate (forward-looking) effective tax measures for a large sample of countries and recent years. We particularly describe how these measures vary over time and across countries. Second, we augment the country-level information with firm- and industry-level data (providing weights for financial structure and asset composition) to contrast statutory measures at the level of countries with measures accounting for firm- and industry-specific weights. Third, we utilize our new data to (i) estimate Laffer-Curves, i.e., the relationship between statutory tax rate and tax revenue, based on non-parametric as well as parametric specifications; (ii) examine how taxes affect investment in fixed assets at the level of firms. As for the latter, our preferred specification, in which we use a firm-specific effective marginal tax rate to capture tax incentives, suggests an elasticity of -0.33.

[1]This paper is joint work with Georg U. Thunecke and Georg Wamser. The corresponding paper is published in *International Tax and Public Finance*.

## 2.1 Introduction

Corporate tax issues have been at the center of public debate in recent years. Very often, this debate has been related to the specific policies of countries to grant preferential tax treatment and tax exemptions for some forms of corporate income (e.g., income from intellectual property). A number of countries feel pressured to respond to the far-reaching corporate tax reform recently implemented by the US government. Most notably, the "Tax Cuts and Jobs Act" involves a massive cut of the federal corporate tax rate from 35% to 21% and allows for immediate expensing of some capital investments for a limited period of time.[1] Apart from this ongoing discussion, the last decades have witnessed many governments pursuing so-called *tax-cut-cum-base-broadening* policies. Most governments have significantly reduced their statutory tax rates (STRs) on corporate income, while broadening the tax base through less attractive depreciation allowances and reducing tax exemptions (see Devereux et al., 2002, for an early survey).

An important objective of our research is to calculate and analyze forward-looking measures depicting the *effective tax burden* of a hypothetical investment project. Thereby, we distinguish between an *effective average tax rate* (EATR), which measures the average tax burden of an investment project, and an *effective marginal tax rate* (EMTR), which measures the tax burden of a marginal investment precisely earning the minimum required return on capital. Examining a time series of EATRs and EMTRs for a large set of countries not only yields valuable insights about countries' tax policies over recent years, it also helps us to better understand the associated incentive effects for firm behavior and the resulting consequences for corporate tax revenue. The analysis of effective tax rates (ETRs) has been a key point of interest in previous academic literature. King (1974) and King and Fullerton (1984) have provided a theoretical framework to investigate the effects of taxation on companies' investment decisions.[2] Devereux

[1]Additional changes in tax law affect the way how international business income is taxed. Moreover, some new legislation has been implemented to prevent profit-shifting activities of multinational enterprises.

[2]Another early contribution to the literature on ETRs is Boadway et al. (1984). The approach of the latter paper differs from King and Fullerton (1984) in the sense that it relies on an open economy model. Recent extensions and applications based on this early contribution include, e.g., Bazel et al. (2018), and Mintz (2018).

et al. (2002) have calculated ETRs for 16 countries and 20 years (from 1982 to 2001). While they find that STRs have been cut by most countries, this policy has usually been accompanied by a broadening of the tax base. The broader tax base, however, does not fully compensate the reductions in the STRs, so that EATRs and EMTRs decrease over time as well. Beside the work of Devereux et al. (2002), our study is most closely related to the work of Loretz (2008). The latter paper basically confirms previous findings by providing evidence for 26 OECD countries and more recent years. Our paper also relates to the seminal contributions on EATRs by Devereux and Griffith (1998) and Devereux and Griffith (2003). The studies of Egger et al. (2009b) as well as Egger and Loretz (2010) draw on these earlier contributions but argue that the focus on country-specific tax law may lead to wrong conclusions as industry- and firm-specific components are neglected.

Another strand of the literature on ETRs shows how the forward-looking measures of the effective tax burden can be refined in order to incorporate specific details of the tax code: Evers et al. (2015) demonstrate how the formulas for the effective taxes can be adjusted for the case of income from intellectual property, concluding that IP box regimes can vastly reduce the effective average tax burden. Spengel et al. (2016c) study the impact of variations in interest rates and inflation on ETRs. In another paper, Spengel et al. (2016b) analyze how different tax-planning strategies affect the effective taxes on cross-border investment. Spengel et al. (2016a) assess the effect of interest deduction limitation rules on ETRs and use country-level effective tax data to evaluate fundamental tax reforms.

Apart from these contributions to the academic literature, several groups of researchers have provided comprehensive data collections in the context of forward-looking ETRs. Most prominently, researchers from the Centre for European Economic Research (ZEW) have collected detailed information on effective tax levels for 35 (mainly EU) countries as part of a long-term project for the EU commission (Spengel et al., 2017). Moreover, researchers from the Oxford University Center for Business Taxation have calculated effective tax data for 42 countries and used them for various policy reports, where the focus is on OECD countries (Bilicka and Devereux, 2012).

The first part of our study provides a survey on corporate income taxes. In particular, novel data on corporate income taxes and depreciation rules to calculate forward-looking ETRs for 142 countries and the most recent years (2004-2016) is presented. Formal ETRs are derived from a neoclassical investment model (Section 2.2), which allows us to distinguish between two effective tax measures: the EMTR and the EATR. Section 2.3 outlines the process of data collection, discusses some important data restrictions and necessary assumptions in order to compute the effective tax measures in the most coherent and comprehensive way.

Section 2.4 provides a descriptive analysis of the data, first focusing on tax measures at the country level (Section 2.4.1). Thereafter, we demonstrate how the country-level information on taxes can be combined with industry- and firm-level financial data taken from Bureau van Dijk's *Orbis* database (Section 2.4.2). In this regard, to begin with, we relax two fundamental assumptions made in the country-level analysis. First, we employ firm-specific debt and equity financing shares rather than relying on the assumption of symmetric financing behavior across firms. Second, we relax the assumption of a symmetric capital stock composition and use an industry-specific within-firm asset composition. In both parts of the descriptive analysis, we particularly focus on the distribution of STRs, EMTRs, and EATRs across countries. Moreover, we also show how the average values of these measures have changed over the last 13 years. The data depict a downward trend in taxes over the period 2004 to 2016. At the same time, about half of the countries have broadened their tax bases. To be precise, many of the countries have both decreased the statutory corporate income tax rate (79.2% of all countries considered), as well as depreciation allowances (49.3%). However, average EMTRs and EATRs go down, suggesting that cutting statutory taxes outweighs the on average somewhat broader tax base. Extreme values in the distribution of all four variables have significantly decreased over time. Since 2011, it seems that the downward trend has come to an end and average tax measures have not changed much since then.

The second part of our study (Section 2.5) presents two applications for which our new dataset can be utilized: one at the macroeconomic, country level, one at the microeconomic, firm level. The first subsection (2.5.1) examines whether tax-avoidance behavior leads to a Laffer-Curve relationship between statutory tax incentives and data on corporate tax revenue. Our analysis provides conclusive evidence on an inverse-U-shaped relationship between statutory taxes and tax revenue, suggesting revenue-maximizing taxes of 31% (STR), 27% (EATR), and 17% (EMTR). Our analysis makes sure that the Laffer-Curve shape is not imposed on the data by specifying tax revenue as a polynomial function of taxes: additional results show that higher-order polynomials are inferior to a polynomial of degree two; non-parametric specifications of the relationship produce very similar results. In equilibrium, average tax rates are significantly lower than the implied revenue-maximizing tax rates – possibly a result of strategic tax competition between countries.

Second, we combine the firm-specific tax rates analyzed above with further micro-level data and model the fixed assets of a firm as a function of our tax measures (2.5.2). The empirical results suggest that investment in fixed assets is negatively related to taxes. The estimated tax elasticities prove to lie in a range which is comparable to previous studies. To be specific, the semi-elasticity with respect to the EMTR is about -2.24. Including additional variation by alternatively using effective tax measures at the firm-industry-level appears to capture tax incentives even better.

Finally, Section 2.6 concludes, presents policy implications, and provides an outlook for further fields of application.

## 2.2 Forward-looking effective tax rates

### 2.2.1 Theoretical framework

The notion of a forward-looking measure of the effective tax burden on a hypothetical investment has been conceptualized by King and Fullerton (1984) and extensively used thereafter (OECD, 1991; Devereux and Griffith, 1998; Devereux et al., 2002; Loretz, 2008; Egger et al., 2009b; Egger and Loretz, 2010). Following Devereux and Griffith (2003) and Fabling et al. (2014), our forward-looking approach assumes that the firm's hypothetical, future investment project and consequently its financing structure and asset composition are organized in the same manner as previous investments.[3] We derive ETRs from a neoclassical investment model which is briefly outlined in the following.

Let us define the profit of a firm facing an investment decision as

$$\begin{aligned} \Pi = & - (1-\tau A)\cdot I \\ & + \frac{1}{1+\rho}\left[(1-\tau)(1+\pi)\cdot(p+\sigma)+(1-\tau A)(1+\pi)(1-\sigma)\right]\cdot I \end{aligned} \tag{2.2.1}$$

where $I$ is the firm's (real) investment and $A$ represents the net present value (NPV) of tax depreciation allowances per unit of investment, which may be interpreted as an upfront subsidy provided by the government.[4] The statutory tax rate on business profits is denoted by $\tau$,[5] $\rho$ is the discount rate,[6] $\pi$ represents the inflation rate, $\sigma$ the economic rate of depreciation, and $p$ depicts the pre-tax rate of return. Solving the associated first-order condition with respect to $I$ for $p$ yields

$$\hat{p} = \frac{(1-\tau A)\left[(1+\rho)-(1+\pi)(1-\sigma)\right]}{(1-\tau)(1+\pi)} - \sigma. \tag{2.2.2}$$

$\hat{p}$ can be interpreted as the minimum required pre-tax rate of return, for which the investment is marginal (Devereux et al., 2002). This means that $\hat{p}$ is equivalent to the (post-tax) rate of return on an alternative investment, also known as the *user cost of capital* (Auerbach, 1979).[7] For this paper, we abstract from inflation

[3]We are aware of the fact that this is a fairly strong assumption. To capture incentive effects, however, forward-looking measures are to be preferred to backward-looking measures, which are based on firms' operating profits and tax payments stated in the balance sheet. First, backward-looking rates do not comply with the forward-looking nature of investment decisions (Egger et al., 2009b). Second, the amount of taxes paid is strongly affected by tax-planning activities, making backward-looking measures prone to severe endogeneity issues (Fabling et al., 2014).

[4]For a detailed overview on how $A$ is calculated, consider the Appendix.

[5]We abstract from taxation at the shareholder level, and therefore ignore personal income taxes.

[6]The discount rate is defined as a weighted average of the rates applicable to equity- and debt-financed investment, respectively (see below).

[7]This result, derived from a neoclassical investment model, is equivalent to the results obtained by Devereux et al. (2002) and Egger et al. (2009b) in a cashflow- focused framework (see the Appendix).

(i.e., $\pi = 0$) and suggest the following user cost of capital

$$\hat{p} = \frac{(1-\tau A)\cdot(\rho+\sigma)}{(1-\tau)} - \sigma \tag{2.2.3}$$

It becomes evident that, in the absence of taxation, the user cost of capital is just equal to the nominal interest rate. This suggests a *tax wedge*, i.e., the difference between the required pre-tax rate of return and the interest rate, equal to $\hat{p} - \rho$. The EMTR is then defined as the ratio of this tax wedge and the user cost of capital:

$$EMTR = \frac{\hat{p}-\rho}{\hat{p}} = \frac{(1-A)\cdot\tau(\rho+\sigma)}{(1-\tau A)\cdot\rho + (1-A)\cdot\tau\sigma} \tag{2.2.4}$$

Note that in a cash flow tax model, which has partially been realized in the US tax reform by allowing for immediate deduction of all investment expenses for some investments, we would have $A = 1$. As a consequence, the user cost $\hat{p}$ would be equivalent to the discount rate $\rho$ and the EMTR would be zero.

While the EMTR is the relevant measure when considering *marginal* investment projects, an EATR is the essential criterion for an investment decision at the extensive margin. It serves as a measure of the effective tax burden of all infra-marginal (*average*) units of capital invested.[8] To be more precise, the EATR is calculated as the difference between the pre-tax NPV ($R^*$) and the post-tax NPV ($R$) of the investment for a given pre-tax rate of return $p$ (Devereux and Griffith, 1998):[9]

$$EATR = \frac{R^* - R}{p/(1+\rho)} = \frac{\tau\Big(p + \sigma(1+A) - \rho A\Big)}{p} \tag{2.2.5}$$

In the following, we abstract from economic depreciation and set $\sigma = 0$.[10] We are aware that the assumption of no economic depreciation across all countries is strong. However, being precise on this would require to account for the fact that

[8]Note that, for a marginal investment, the EATR is equal to the EMTR. The EATR can hence be interpreted in a way that it summarizes the distribution of tax rates for an investment as long as the latter is profitable, and the EMTR represents the special case of a marginal investment (Devereux and Griffith, 1998).

[9]For more details on $R$ and $R^*$, see the Appendix.

[10]ETR measures employing different values for economic depreciation are included in the Appendix.

true economic life varies across countries and time. For example, composition of assets and true economic depreciation rates in developing countries are certainly different from those in developed countries. We lack this information, and it would exceed the scope of our paper to calculate acceptable values that are specific to countries and time. Making assumptions about uniform rates introduces further restrictions and leads to bias which we believe may outweigh the bias associated with the assumption of zero economic depreciation.

### 2.2.2 Parameterization

In order to calculate an EMTR and an EATR for a large number of countries, we need to make several assumptions with respect to (i) financing options, (ii) the asset composition within firms, (iii) the discount rate $\rho$, and (iv) the pre-tax rate of return.[11] While these parameters are assumed to be common across firms in all countries in the first place, we relax some of these assumptions (financing options and asset composition) below when constructing *firm-industry-level* EMTR and EATR measures.

Table 2.2.1 depicts the parameter values we assume, most of them in line with previous work (OECD, 1991; Devereux and Griffith, 1998; McKenzie et al., 1998; Devereux et al., 2002; Devereux and Griffith, 2003; Yoo, 2003; Egger et al., 2009b; Fabling et al., 2014). With respect to the financing methods, we merely make the broad distinction between debt and retained earnings, rather than considering retained earnings and new equity as distinct modes of financing. This is, however, fully consistent because we ignore shareholder taxation. Egger et al. (2009b) argue that, in this case, financing via retained earnings is identical to financing via new equity. Moreover, note that debt financing implies a reduced discount rate, as to the fact that the cost of debt financing is tax-deductible. The composition of assets within a firm is crucial when it comes to computing the NPV of tax depreciation allowances as allowance rates and schedules vary widely, both across asset types and countries. We follow OECD (1991) in large parts, but adjust their

[11] We make the assumption of a common 'market interest rate' due to (broadly) two reasons. First, a meaningful measure in this regard is not available, also given the fact that many (multinational) firms finance investments partly via internal capital markets (Desai et al., 2004), and it is unclear which interest rates apply to such internal capital. Second, it is not our focus to analyze the effect of variations in interest rates across countries.

suggested asset composition to also include the asset types *Computers*, *Vehicles*, and *Office equipment*.

Table 2.2.1: *Parameter values*

| Parameter | | Value assigned |
|---|---|---|
| $\rho$ | Market interest rate | 0.05 (for equity) $0.05 \cdot (1 - \tau)$ (for debt) |
| $\pi$ | Inflation rate | 0 |
| $\sigma$ | Economic depreciation rate | 0 |
| p | Pre-tax rate of return | 0.2 |
| debt | Debt-financing share | 1/3 |
| equity | Equity-financing share | 2/3 |
| *Asset structure:* | | |
| $s_b$ | Share of investment in buildings | 0.38 |
| $s_{inv}$ | Share of investment in inventory | 0.26 |
| $s_m$ | Share of investment in machinery | 0.2 |
| $s_{ifas}$ | Share of investment in intangibles | 0.11 |
| $s_c$ | Share of investment in computer equipment | 0.02 |
| $s_v$ | Share of investment in vehicles | 0.02 |
| $s_o$ | Share of investment in office equipment | 0.01 |

*Notes:* More information on variable definitions and sources is provided in Table 2.A.3 in the Appendix.

## 2.3 Data collection

For our calculation of effective tax measures, we have compiled data on corporate tax regimes of 193 countries for the time period from 1996 to 2016. This section provides an overview on the data and their sources, obstacles and problems, as well as important assumptions made to warrant a comprehensive and reliable database.

The two key statutory variables for our analysis are the statutory corporate income tax rate and the depreciation allowance rate, including schemes for six asset categories (*Buildings*, *Machinery*, *Office equipment*, *Computers*, *Intangible fixed assets*, and *Vehicles*). The *EY Worldwide Corporate Tax Guides (WCTG)* serve as primary data source. These annual tax guides provide detailed information on the corporate tax regimes of 162 jurisdictions.[12] In spite of considering multiple sources, data coverage strongly varies across countries. The data on statutory corporate income taxes exhibit the best coverage with reliable and complete information for 178 countries and all years from 1996 to 2016. Since *WCTG* only provides country-level statutory corporate income tax rates, the reported rates for countries imposing federal- and state-level taxes may be inaccurate. In order to account for regional taxes, we retrieve data for the respective jurisdictions from the *OECD* and *World Bank* databases.[13]

In addition to the statutory tax rates, information on tax depreciation allowances constitutes the second main data compiled from *WCTG*. In this regard, reliable data covering many countries is only available starting from 2004, which is the reason why we calculate our effective tax measures for the years 2004 to 2016. Data coverage varies both across countries and with respect to depreciation regulations for the different asset types. More specifically, information in *WCTG* is most comprehensive for *Buildings*, *Machinery* and *Vehicles*, while the (initial) data coverage for *Computers*, *Office equipment* and *Intangible fixed assets* is somewhat fragmentary.[14]

In order to obtain a balanced panel for a broad and possibly comprehensive analysis of effective tax measures, we make several assumptions which are briefly outlined in the following. Two problems have been frequently encountered: First, no specific rates apply but a *'useful life'* should be assumed for the depreciation of assets. Second, depreciation rates may not be available for all asset types within a country. Concerning the *'useful life'* principle, we follow previous approaches (e.g., Spengel et al., 2017), and assume the useful life of *Machinery* to be 7 years and the useful life of *Intangible fixed assets* to be 10 years.[15] Moreover, for both asset types, a straight line depreciation method is assumed to apply. Concerning

[12] When the information from the *WCTG* is insufficient or counterintuitive, additional sources are considered, including the *OECD*, *IBFD* and *World Bank* databases as well as tax guides provided by *PwC* and *KPMG*.

[13] Most notably, these countries include Germany, Switzerland, Japan, USA, and Canada.

[14] Concerning the allowances for buildings, we always choose the available rate for industrial buildings. Furthermore, we have treated *Furniture* to be representative for *Office equipment* if not specified differently.

[15] As data coverage for *Intangible fixed assets* is particularly poor, we assume a straight line depreciation scheme for a period of 10 years whenever no information is specified for this asset type, yet data on all other types is available.

the problem of missing rates for some asset types, we resort to the assumption that depreciation patterns are equal to the ones of similar asset categories, for which information is available. For instance, if no rates for *Office equipment* are specified, we assume the depreciation rates of *Office equipment* to equal the ones of *Machinery*. Similarly, *Computers* is assumed to be part of *Office equipment* whenever rates are not specified. When no rates for *Vehicles* are provided, we also assume *Vehicles* to depreciate like *Machinery*.

Nonetheless, we have to disregard 15 countries, for which information is insufficient. In many cases, this is related to political reasons: some countries have dissolved during the considered time period, e.g., the Netherlands Antilles or Yugoslavia, other countries face violent interior or exterior conflicts, such as Syria or Afghanistan.

## 2.4 Taxes around the world

The purpose of this section is to survey the three types of forward-looking tax measures we have collected, first at the country level (Section 2.4.1), then at the firm-industry level (Section 2.4.2).[16] The first tax measure we will present is the statutory tax rate (STR) on corporate profits. We have collected data on STRs for 178 countries and over the time period from 1996 to 2016. The second measure includes information on countries' depreciation rules to account for tax base effects. In particular, we calculate the NPV of depreciation allowances and measure an effective marginal tax rate (EMTR). The EMTR captures the tax burden on a *marginal* investment project that just breaks even. We further present measures on an effective average tax rate (EATR), which captures the *average* tax burden of a hypothetical investment project. The average tax burden considers that the total project may earn above-normal returns and is therefore the relevant incentive variable for discrete decisions of firms, such as location choices. EMTRs as well as EATRs are presented for a sample of 142 countries and over the time period 2004 to 2016. Both EMTRs and EATRs are calculated following the theoretical approach discussed in Section 2.2.

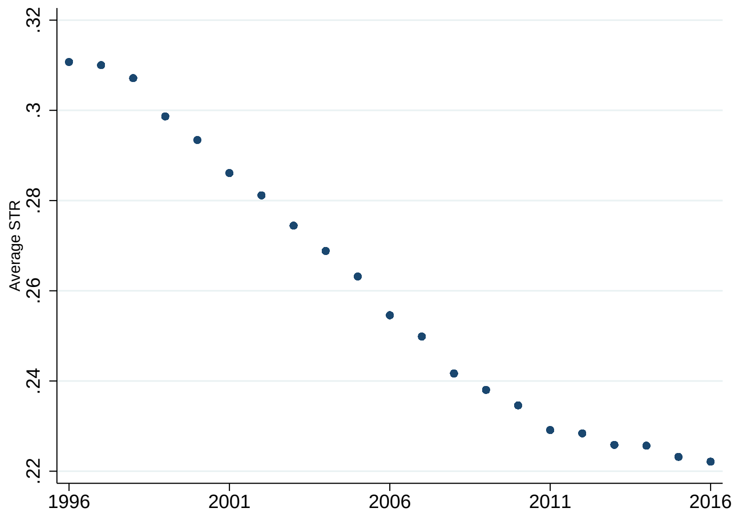
[16]A precise definition of what we mean with *firm-industry level* is given below.

### 2.4.1 Country-level tax measures

#### 2.4.1.1 Statutory tax rates

Devereux et al. (2002) demonstrate that there is a clear downward trend when depicting the yearly average of the statutory tax rate (STR) throughout the 1980s and 1990s. For our sample of 178 countries and 21 years, Figure 2.4.1 confirms this long-run pattern for the STR.

Figure 2.4.1: *Statutory tax rates*



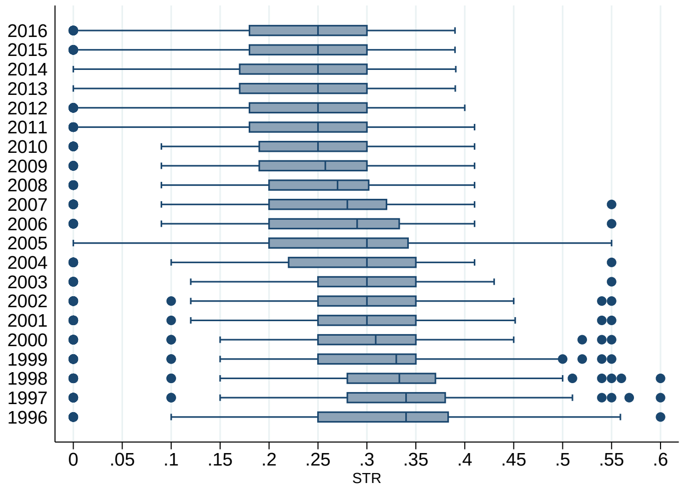

While it appears that this process has slowed down and the average STR converges to a lower level of roughly 22%, between the years 1996 and 2016, 141 countries have cut their STRs, only 22 have increased it, and 15 countries have kept it constant. The reduction in the average STR between 1998 and 2011 is particularly evident (7.8 percentage points), compared to the 0.7 percentage points from 2011 to 2016.[17] In any case, after the massive US corporate tax cut in 2018, we expect the general downward trend in the STR to continue.

Figure 2.4.2 suggests that the distribution of the STRs has shifted to the left. Very high values of the STR have disappeared over time. An interesting

[17]Note that we have collected data on STRs from 1996 to 2016. Although the focus of this survey is on effective tax measures, which have been collected for the time period 2004 to 2016 – for reasons of data availability –, we present the STRs for the extended period of time to additionally show a more long-run development which can be compared to previous studies (Devereux et al., 2002; Loretz, 2008).

observation is that, from 2009 on, the median value is virtually unchanged. Very few countries have imposed STRs of more than 40%. Many larger economies have implemented STRs above the global time-average value of 26.09%, for example, France, Germany, Japan, and Canada in the late 1990s.[18] In 2011, only Japan and Puerto Rico sustained rates above 40%; in 2016, only the United States, Puerto Rico, and the U.S. Virgin Islands imposed rates around 40%.

Figure 2.4.2: *Statutory tax rates*

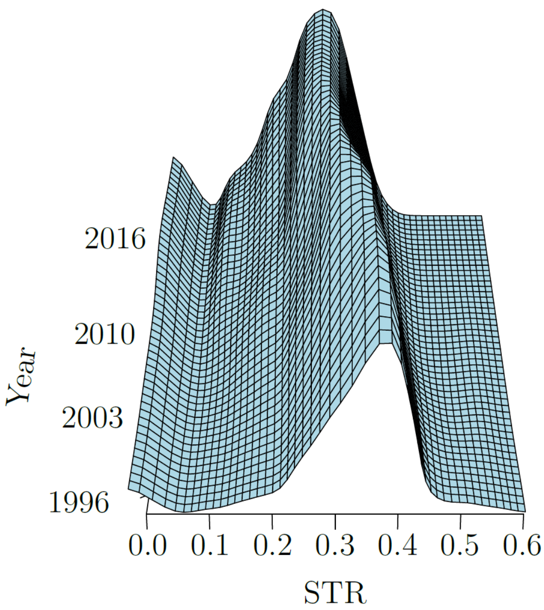



*Notes:* The box portrays the interquartile range (IQR) of the STR distribution. The vertical line in the box represents the median. The whisker's range includes the most extreme values within the 1.5 × IQR. The dots indicate extreme values outside of the 1.5 × IQR.

In Figure 2.4.3, we provide an alternative way of illustrating the distribution of the STRs over time, depicting a non-parametric conditional density. In line with the observation that the distribution has shifted, the most frequent STR values have decreased from around 35% in 1996 to about 25% in 2016. Moreover, it becomes evident that, in recent years, there is a larger probability density at the left side of the distribution. Most importantly, this implies that an increasing number of countries exhibit relatively low STRs. The figure also shows that a non-negligible share of countries do not tax corporate income at all, i.e., the STR is equal to 0.

[18]Note that the German STR accounts for the (average) local (municipality) business tax.

Figure 2.4.3: *Statutory tax rates (non-parametric conditional density)*

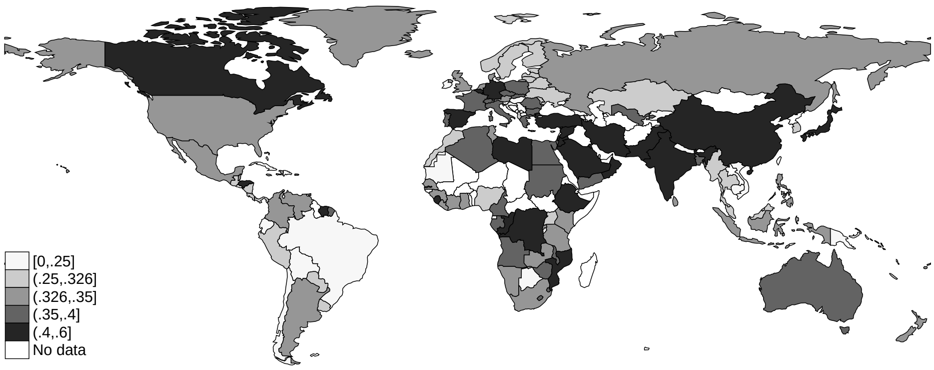



*Notes:* We choose a kernel bandwidth according to Silverman's rule of thumb, the underlying density being Gaussian (Silverman, 1986).

In addition to the development and distribution of the tax over time, it is worthwhile to shed light on the STR variation across countries. Our data shows that there is substantial variation across countries, indicating that the tax-setting behavior of countries vastly differs.[19] An interesting insight is revealed when we compare the tax rate distribution across countries at the beginning of the sample period (1996) with the one at the end of the sample period (2016). In this regard, Figure 2.4.4 and Figure 2.4.5 indicate that the vast majority of countries have reduced their STR, whilst the US and several South American countries have maintained a comparatively high STR.

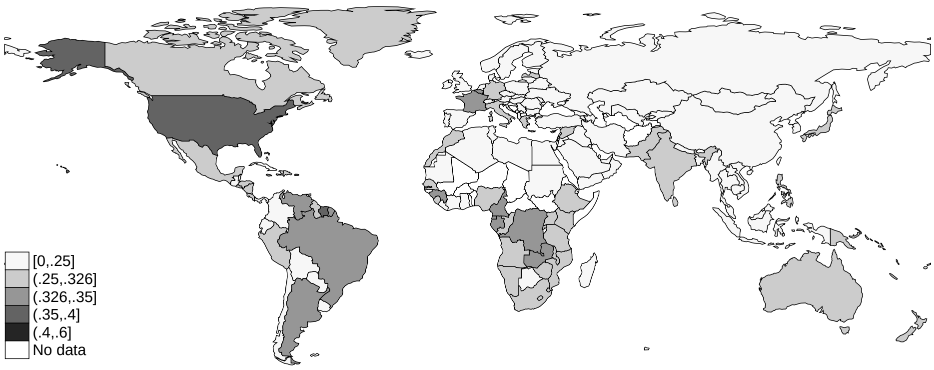
[19]In Figure 2.A.1 in the Appendix, for each country, we pool the annual STRs over the period from 1996 to 2016 and subtract the global average STR (26.09%) from each country's time average.

Figure 2.4.4: *Statutory taxes across countries (1996)*




*Notes:* The darker in color a country's area, the higher is the STR.

Figure 2.4.5: *Statutory taxes across countries (2016)*




*Notes:* The darker in color the country's area, the higher is the STR.

#### 2.4.1.2 NPV of depreciation allowances

Since depreciation rules are the second major factor influencing ETRs, we will first provide information on the NPVs of depreciation allowances for 142 countries over the time period 2004 to 2016. A higher NPV of depreciation allowances implies a reduction in taxable income (tax base) and therefore leads to a lower effective tax burden. The values presented in Figure 2.4.6 are calculated following the method established in Egger and Loretz (2010).[20] Devereux et al. (2002) have identified a pattern of *base-broadening* throughout the 1980s and 1990s. According to Figure 2.4.6, it seems that the more recent cuts in STRs in the 2000s have also been ac-

[20]See the Appendix for more information.

companied by less generous depreciation rules. However, particularly since 2009, there appears to be some convergence to a value of about 0.482. The largest changes in the NPV happened between 2005 and 2006 (0.011) as well as between 2007 and 2008 (0.0035). The average NPV has dropped by roughly 0.017 from 2004 to 2016. Over the 13 years covered in our data, the NPV of depreciation allowances has decreased in 70 countries, increased in 41 and has not changed in 31.

Figure 2.4.6: *NPV of tax depreciation allowances*

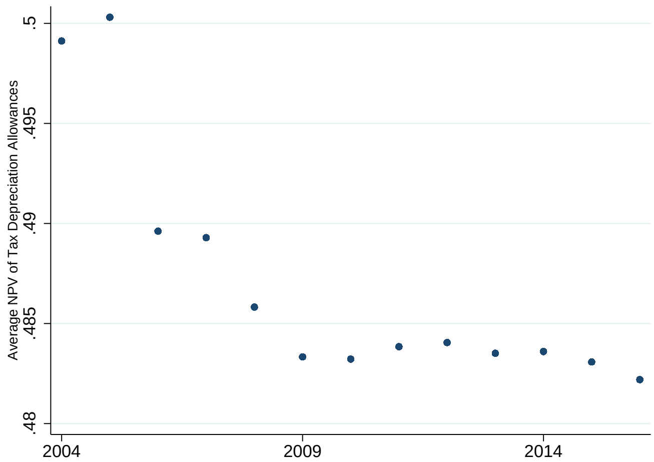
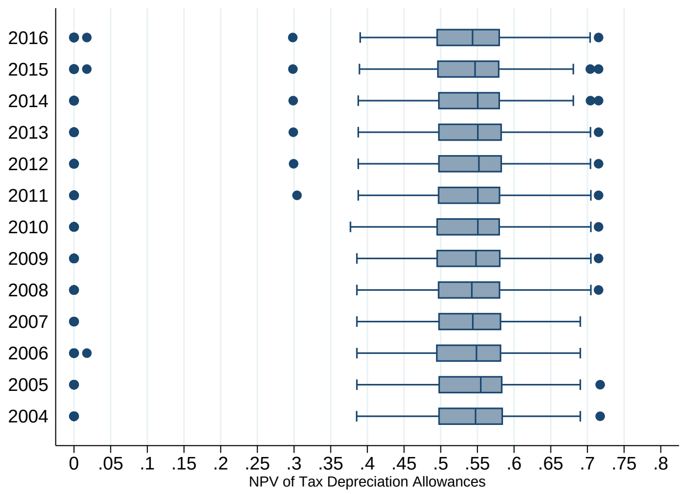



Figure 2.4.7: *NPV of tax depreciation allowances*




*Notes:* The box portrays the interquartile range (IQR) of the NPV distribution. The vertical line in the box represents the median. The whisker's range includes the most extreme values within the 1.5 × IQR. The dots indicate extreme values outside of the 1.5 × IQR.

Concerning the distribution of the NPVs, illustrated in Figure 2.4.7, we see that the median NPV has not shifted to the left but remained relatively stable. Moreover, our data suggest that also the whisker's range, i.e., the distance between the 1.5 × interquartile range, and also the most extreme values outside of this range do not change significantly. To conclude, while earlier contributions have observed tax-cut-cum-base-broadening, in particular for the 1980s and 1990s, our findings indicate that no clear base-broadening trend can be identified for the last 13 years.

#### 2.4.1.3 Effective marginal tax rates

This section presents our data on EMTRs. The EMTR, as outlined in Section 2.2, is a measure to quantify the corporate tax burden for a marginal investment, which just earns the cost of capital. All calculations concerning the EMTR follow the theoretical model introduced above.

We have demonstrated that between the years 1996 (2004) and 2016, tax policy is, on the one hand, characterized by substantial corporate tax cuts; on the other hand, no distinct base-broadening pattern can be observed. While Devereux et al. (2002) do not identify any clear trend when analyzing EMTRs – although they find a tendency for falling rates in the late 1990s –, Figure 2.4.8 suggests that the average EMTR has substantially declined between 2004 and 2011, but has then remained rather stable in the years until 2016. Over the whole time period, i.e., from 2004 to 2016, the average EMTR has dropped from roughly 13.97% to 11.19%. In 98 countries, the EMTR has decreased, it has increased in 13 countries and has not changed in 31 countries between 2004 and 2016. While there is a positive increase from 2013 to 2014, it is a relatively small one (0.00015 percentage points). Figure 2.4.9 demonstrates that the downward trend in Figure 2.4.8 is not only driven by the disappearance of extreme values, but also by a shift of the whole distribution.

Figure 2.4.8: *Effective marginal tax rates*

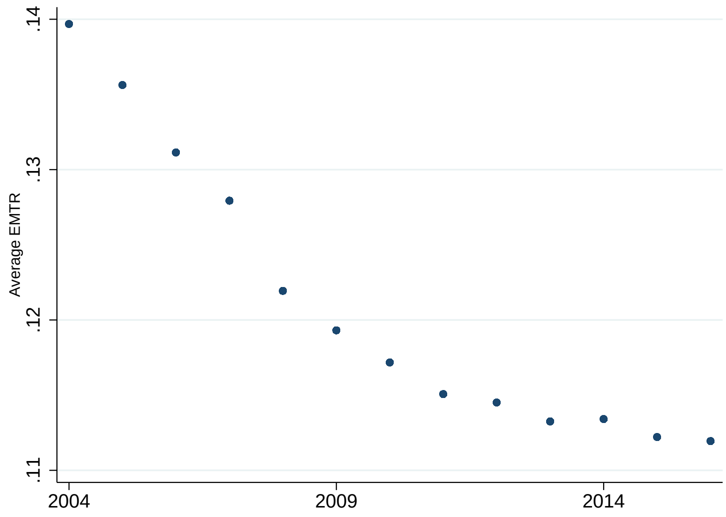
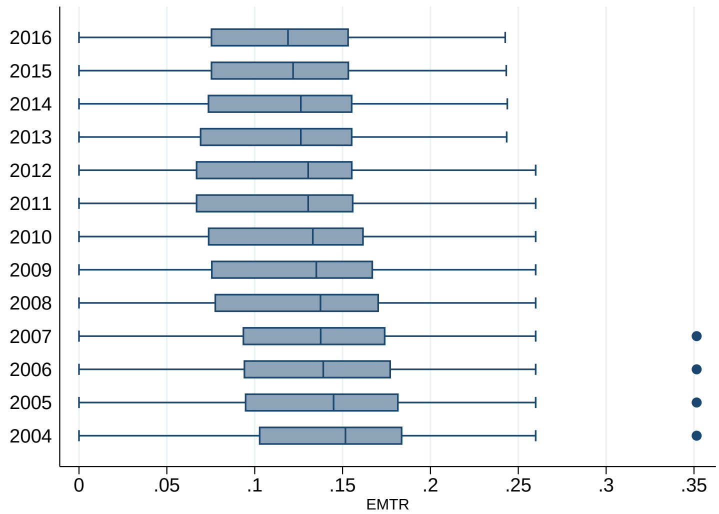



Figure 2.4.9: *Effective marginal tax rates*




*Notes:* The box portrays the interquartile range (IQR) of the EMTR distribution. The vertical line in the box represents the median. The whisker's range includes the most extreme values within the 1.5 × IQR. The dots indicate extreme values outside of the 1.5 × IQR.

To sum up, given the findings of the previous sections, we can conclude that cutting taxes outweighs the effect of a somewhat broader tax base, so that the average EMTR has been declining for most of the time. Figure 2.4.8 suggests that the average value has converged to a level of approximately 11.2%.

#### 2.4.1.4 Effective average tax rates

This section focuses on the measure of the average tax burden, the effective average tax rate (EATR) for the years 2004 until 2016. As explained in Section 2.2, the EATR is a more appropriate measure for discrete or extensive-margin investment decisions. We calculate it according to equation (2.2.5) above.

Devereux et al. (2002) have demonstrated that the average EATR has mostly decreased in the 1980s and 1990s. Figure 2.4.10 suggests that this trend has continued for the years from 2004 to 2016. In particular, the EATR has decreased by 3.94 percentage points from 22.3% in 2004 to 18.36% in 2016. It seems that it has stabilized at a value of below 18.5% since 2011. Over the whole time span, the EATR has decreased in 98 countries, increased in 13 and has not changed in 31 countries. Similar to the EMTR, the decrease in the average value happened at a relatively fast pace between 2004 and 2011. Thereafter, however, the EATR remains at a rather constant level.

Figure 2.4.11 depicts the same pattern as the figures for the STR and the EMTR. Extreme values (e.g., Kuwait) have disappeared over time; the median value has slightly shifted to the left; the variance has declined.

Figure 2.4.10: *Effective average tax rates*

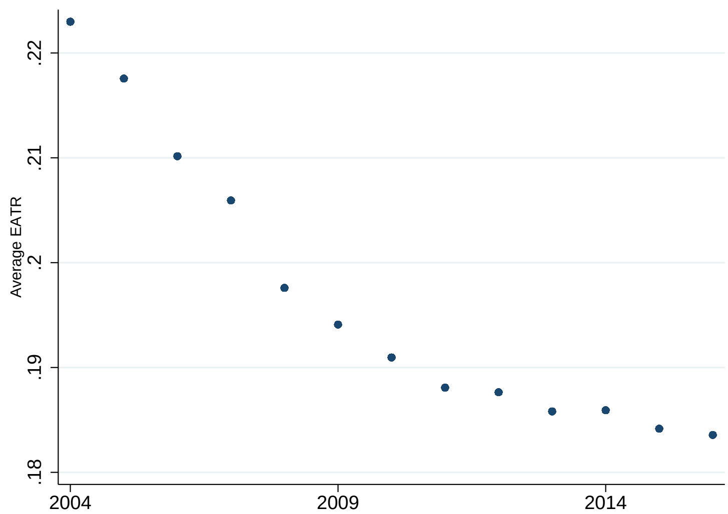
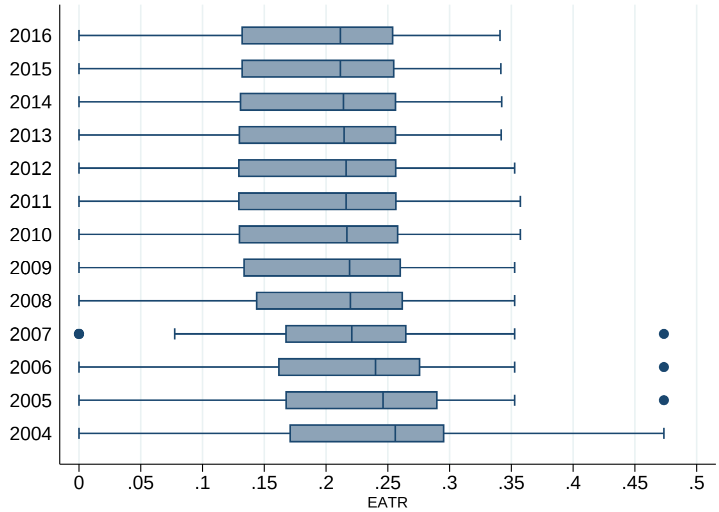


Figure 2.4.11: *Effective average tax rates*




*Notes:* The box portrays the interquartile range (IQR) of the EATR distribution. The vertical line in the box represents the median. The whisker's range includes the most extreme values within the 1.5 × IQR. The dots indicate extreme values outside of the 1.5 × IQR.

### 2.4.2 Firm-industry-level tax measures

The conceptual framework presented in Section 2.2 has shown that the forward-looking effective tax measures are non-linear functions of numerous determinants, most notably (i) statutory tax rates, (ii) depreciation allowances specific to the type of investment, (iii) asset composition, and (iv) modes of financing (Egger and Loretz, 2010). While statutory corporate tax rates are country specific (abstracting from the distinction between state, federal and local taxes), the asset composition of an investment as well as the share of debt financing are naturally specific to the individual firm. In this section, we show how the country-level statutory tax rates can be combined with firm- and industry-specific data in order to yield firm-industry-level tax measures. The latter may be particularly useful when analyzing behavioral incentives at the micro level, such as firms' investment decisions (see Section 2.5.2).

In the preceding analysis of *country-specific* effective tax measures, we have assumed a given set of asset types (*Buildings*, *Machinery*, *Office equipment*, *Computers*, *Intangible fixed assets*, and *Vehicles*) and financing opportunities (debt and equity) to calculate EMTR and EATR as weighted averages over these investment and financing opportunities (Egger et al., 2009b). In line with most of the existing literature referred to above, the weights we employ are defined as identical across all countries. However, to the extent that asset composition and the shares of debt-financed investment vary considerably across firms, effective tax measures at the country level may be inaccurate. Disregarding the heterogeneous nature of firms with respect to their investment and financing opportunities implies that tax measures based on uniform weights may not capture the correct incentive effects for future decisions. In a sense, we would neglect that firms are in different situations, reflecting choices made in the past (Egger and Loretz, 2010). We therefore combine the collected (country-level) data on statutory taxes and depreciation allowances with micro-level data for a large sample of firms, provided in Bureau van Dijk's *Orbis* database.[21]

In the country-level analysis (Section 2.4), assumptions on debt-financing shares and asset composition necessarily have to be made. With respect to the first point, exploiting balance-sheet data allows us to get firm-specific information in this regard. More specifically, we calculate a firm's long-term debt (non-current liabilities) ratio, i.e., long-term debt relative to total assets.[22] When it comes to the composition of a firm's capital stock, the *Orbis* database does not report firm-specific asset-type distributions. Similar to Egger et al. (2009b), however, we exploit variation at the industry-level to account for heterogeneous asset composition. We do so by using industry-specific asset-type shares provided by Fabling et al. (2014), matching their industry codes with the ones available in *Orbis*.[23]

Based on the asset composition specific to industry $i$ and the firm-$j$-specific debt-equity ratio in year $t$, we then calculate effective tax measures at the firm-

[21] *Orbis* is a commercial database, providing comprehensive balance-sheet data for firms from across the globe. In particular, we make use of 17,024,351 firm observations for the time period 2004 to 2014.

[22] In contrast to Egger and Loretz (2010), who employ the sum of non-current and current liabilities, we think that long-term debt is the relevant measure to be considered in terms of a firm's investment opportunity. Only non-current liabilities can be harnessed to finance investment projects. The long-term debt-to-total assets ratio, of course, underestimates a firm's (total) debt ratio, yet seems to be more accurate in the given context.

[23] Fabling et al. (2014) use data from Statistics New Zealand's Longitudinal Business Database, which combines administrative and survey data on New Zealand firms and provide the asset-type shares based on two-digit *ANZSIC96* codes. The latter are very closely related to the commonly used *ISIC* codes.

industry level ($EMTR_{jict}$ and $EATR_{jict}$, respectively). To this end, we consider the 17,024,351 firm observations in our *Orbis* sample. Table 2.4.1 presents industry-specific average ETRs for every industry $i$ in country $c$, pooling all firm observations from 2004 to 2014.

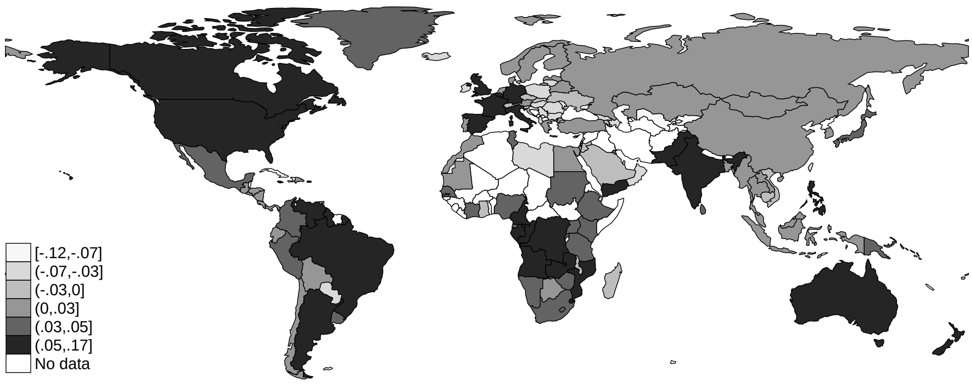
Table 2.4.1: *Firm-industry-level effective taxes, pooled over time (2004-2014)*

| Industry | Firm observations | EMTR | EATR |
|---|---|---|---|
| Accommodation and Food Services | 228,124 | 0.1401 | 0.2577 |
| Agriculture, Forestry, Fishing | 514,975 | 0.1293 | 0.2303 |
| Information Media and Telecommunication | 71,455 | 0.1277 | 0.2433 |
| Construction | 2,334,641 | 0.1388 | 0.2828 |
| Cultural and Recreational Services | 180,568 | 0.1410 | 0.2615 |
| Electricity, Gas, Water, Waste Services | 351,376 | 0.1287 | 0.2487 |
| Education and Training | 105,443 | 0.1392 | 0.2518 |
| Financial and Insurance Services | 1,636,346 | 0.1336 | 0.2661 |
| Health Care and Social Assistance | 386,035 | 0.1434 | 0.2792 |
| Manufacturing | 4,581,178 | 0.1325 | 0.2504 |
| Mining | 145,685 | 0.1373 | 0.2467 |
| Other Services | 99,588 | 0.1435 | 0.2619 |
| Rental, Hiring and Real Estate Services | 1,706,884 | 0.1409 | 0.2631 |
| Retail Trade | 1,411,142 | 0.1398 | 0.2614 |
| Transport, Postal, Warehousing | 796,796 | 0.1313 | 0.2563 |
| Wholesale Trade | 2,474,115 | 0.1342 | 0.2555 |

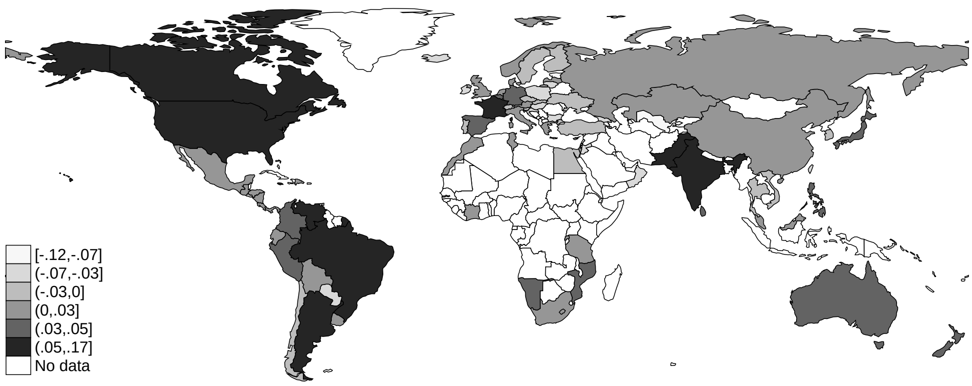
*Notes:* We use two-digit *ANZSIC96* industry codes to determine industry-specific asset compositions. Firm-specific debt and equity shares are taken from *Orbis.* For all industries, we pool firm observations over the years 2004-2014 and calculate average firm-industry-level ETRs.

We see that there is substantial variation across industries. For the EMTR, we observe values between 12.77% and 14.35%, values of the EATR lie in the range of 23.03% and 28.28%. While the (pooled) industry-specific EMTRs are only slightly larger than the average EMTRs at the country level (12.32%), it becomes evident that the industry-specific EATRs are much higher than their country-level counterpart, calculated in Section 2.4.1.4 (19.96%). A straightforward explanation for this is that the firm-specific long-term debt ratio, which is our measure for the share of debt financing, is on average substantially lower than before, where we assume a share of 1/3. This, in turn, leads to a higher weighted market interest rate and a ceteris paribus higher EATR. A further source of variation lies in the industry-specific capital stock composition. As depreciation allowances for asset types vary considerably, this may either increase or decrease the EATR. In Figures 2.4.12 and 2.4.13, we compare the country-level ETRs with the firm-industry-level ETRs.

Figure 2.4.12: *EMTRs across countries – Country vs. firm-industry-level*




a) Country level

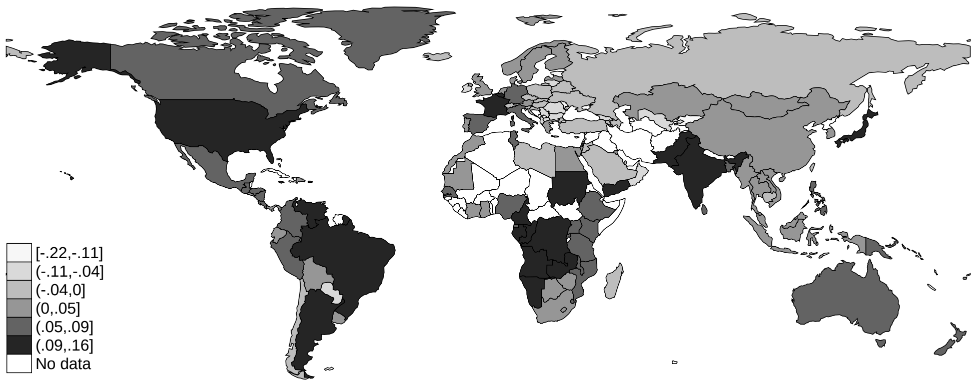



b) Firm-industry level

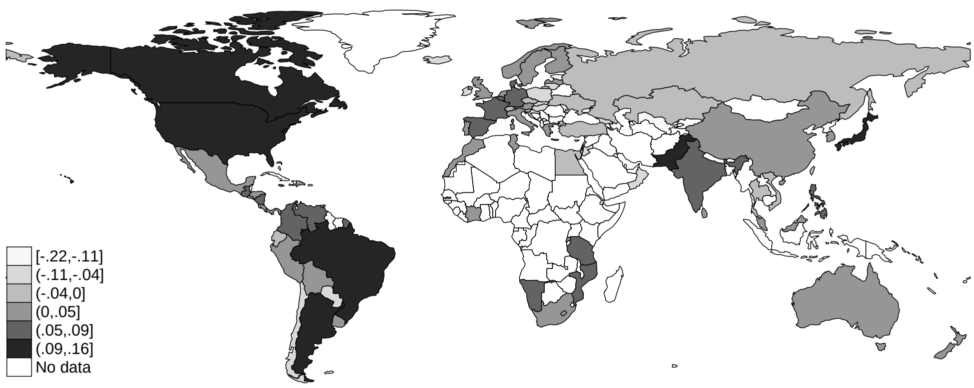
*Notes:* The darker in color a country's area, the higher the respective country's EMTR.

For both figures, we pool the ETRs for each country and depict the time average, demeaned by the global mean over the whole sample period. Considering the EMTR, we see that countries like Canada, France, and India tend to exhibit taxes exceeding the average more distinctly than in the country-level analysis. In contrast, the UK, Italy, Portugal, Sweden, and Finland seem to decrease EMTRs compared to the average EMTR. Turning to the EATR, only for very few countries (Canada and Brazil), taxes in relation to the average become higher when we exploit variation at the firm-industry level. Numerous countries both in Europe (France, Poland, Slovakia, and Hungary), South America (Venezuela, Peru, Chile) and Australia exhibit lower firm-industry EATRs than country-level EATRs (compared to the respective world average).

Figure 2.4.13: *EATRs across countries – Country vs. firm-industry-level*




a) Country level




b) Firm-industry level

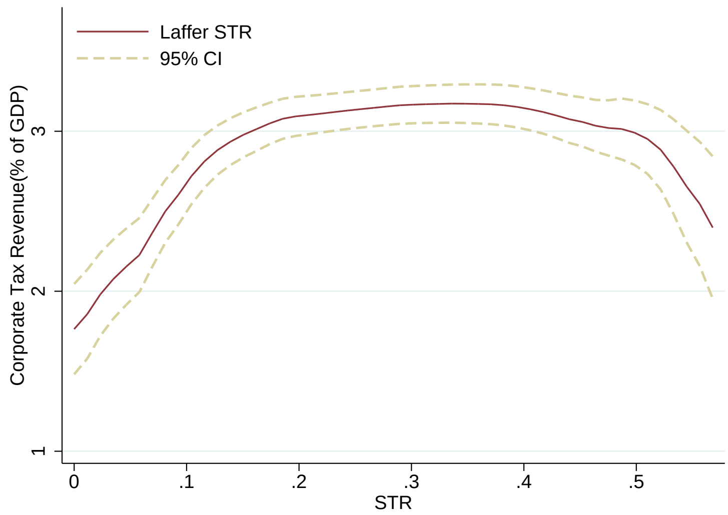
*Notes:* The darker in color a country's area, the higher the respective country's EATR.

# 2.5 Two applications

## 2.5.1 Laffer-Curve estimates

The objective of this section is to estimate whether corporate income tax revenue (expressed relative to GDP) and statutory tax incentives are related in a way known as the Laffer-Curve.[24] The latter is supposed to show an inverted-U-shape as depicted in Figure 2.5.1, where we present the smoothed values of a kernel-weighted local polynomial regression of tax revenue on the statutory tax rate for the period between 1996 and 2014.[25]

Figure 2.5.1: *Non-parametric Laffer-Curve (STR)*




The concept of the Laffer-Curve reflects the insight that tax revenue is determined by statutory rate and tax base, where the latter is not a fixed quantity but rather an endogenous outcome of tax-avoidance activities. Economists would broadly agree on the existence of the concept and the associated notion of the presence of a statutory tax rate that maximizes tax revenue. At which exact point (or tax rate), however, the slope of the revenue function becomes negative depends on the extent of behavioral responses of firms and individuals to a tax and the specific design of the tax under consideration. Comprehensive empirical

[24] Arthur Laffer, economist and member of Reagan's Economic Policy Advisory Board (1981 to 1989), became famous for making the argument that the relationship between tax revenue and statutory tax incentives is such that a tax rate between 0% and 100% maximizes tax revenue. Piketty and Saez (2013) argue that economists have known the idea of the inverted-U-shaped revenue curve long before, early contributions going back more than 170 years (e.g., Dupuit, 1844). Loretz (2008) alike discusses the historical background of the concept, stating that its origin dates back as far as the 14th century.

[25] Note that more recent tax revenue data have not been made available.

investigations in this regard are surprisingly scarce.[26] Clausing (2007) provides empirical support for a parabolic Laffer-Curve relationship between statutory tax rates and revenues for OECD countries and the years 1979 to 2002.[27] In contrast to this, Kawano and Slemrod (2012), who likewise focus on OECD countries, find that the relationship between tax rates and revenue is rather tenuous.

In the following, we will illustrate how corporate income tax revenue in percent of GDP ($TAX\ REVENUE_{c,t}$) is related to our measures of tax burden (STR, EMTR, and EATR). The data for the corporate income tax revenue are taken from the IMF's World Revenue Longitudinal Data (WoRLD). The analysis is based on 1,073 observations from 2004 to 2014 and 112 countries. To the best of our knowledge, no previous study has examined such a large sample of countries in this context. Our estimation approach accounts for time-constant country-specific characteristics and aggregate year effects. To control for time-varying determinants of tax revenue, we also include the variable $GROWTH_{c,t}$.[28] In particular, we estimate the following linear regression model:

$$\begin{aligned} TAX\ REVENUE_{c,t} = \alpha + \beta_1 TAX_{c,t} + \beta_2 TAX^2_{c,t} \\ + \beta_3 GROWTH_{c,t} + Y_t + C_c + \epsilon_{c,t} \end{aligned} \tag{2.5.1}$$

The variable $TAX_{c,t}$ is one of our measures of tax burden (STR, EMTR, or EATR). $Y_t$ and $C_c$ are year and country effects. The Laffer-Curve concept would suggest that $TAX_{c,t}$ and $TAX^2_{ct}$ predict an inverted U-shape relationship with $TAX\ REVENUE_{c,t}$.

The estimation results presented in Table 2.5.1 suggest that $GROWTH_{c,t}$ is always positively related to tax revenue, as expected. $TAX_{c,t}$ and $TAX^2_{c,t}$ (or the respective measures thereof, to be precise) are always estimated with a positive

[26] Most of the previous contributions to the literature have either (i) focused on trends in corporate income tax revenue, without providing a thorough analysis of the sources of the observed variations (Bénassy-Quéré et al., 2000; Gropp and Kostial, 2000; Devereux et al., 2002, 2004; Loretz, 2008), or (ii) calculated country-specific Laffer-Curves (Trabandt and Uhlig, 2011; Strulik and Trimborn, 2012).

[27] Very broadly, our paper and Clausing (2007) differ in terms of the following aspects: the observed time periods (1979-2002 vs. 2004-2016), the sample (29 OECD countries vs. 112 countries from all over the world), and the empirical approach.

[28] $GROWTH_{c,t}$ is taken from the World Bank's World Development Indicators (WDI) database and is defined as GDP growth per capita of country $c$ in period $t$.

($TAX_{c,t}$) and negative ($TAX^2_{c,t}$) sign.[29]

Table 2.5.1: *Laffer-Curve estimates (OLS regressions)*

| | $STR$ | $EMTR$ | $EATR$ |
|---|---|---|---|
| $TAX_{c,t}$ | 9.801*** | 13.589** | 11.309*** |
| | (3.722) | (5.828) | (4.318) |
| $TAX^2_{c,t}$ | -15.695** | -39.764** | -21.239** |
| | (6.785) | (17.715) | (9.127) |
| $GROWTH_{c,t}$ | 0.056*** | 0.056*** | 0.056*** |
| | (0.011) | (0.011) | (0.011) |
| $Constant$ | 1.295** | 1.663*** | 1.318** |
| | (0.535) | (0.484) | (0.535) |
| Year effects | Yes | Yes | Yes |
| Country effects | Yes | Yes | Yes |
| Observations | 1,073 | 1,073 | 1,073 |
| Adj. R-squared | 0.8587 | 0.8584 | 0.8587 |
| Within R-squared | 0.100 | 0.098 | 0.099 |

Standard errors in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Note that we have also produced results where we include higher-order polynomials, which turned out to be insignificant. Formal testing, where we compare higher-order polynomials to the squared term specification, show that the latter captures the shape of the revenue curve better than the former specifications. The tests, based on the Bayesian information criterion (BIC) as well as the Akaike information criterion (AIC), clearly suggest that a polynomial function of order two best fits the data (see Table 2.5.2).

[29] Note that the constant in these estimates is not zero. At first glance, this may seem contradictory to theory, which would suggest zero tax revenue at a zero tax rate. However, in a fixed effects regression, this coefficient is not interpretable in a reasonable way (Wooldridge, 2010). When it comes to Figures 2.5.2 to 2.5.4, where we illustrate the predicted tax revenue curves, we see in fact a non-zero intercept. However, this is justifiable as these figures visualize the predictions from our linear regression model and hence, the model may predict a non-zero tax revenue even with a zero tax rate.

Table 2.5.2: *Laffer-Curve estimation: Comparison of polynomials*

| Tax measure | Polynomial order | BIC | AIC |
|---|---|---|---|
| STR | 2 | 2946.18 | 2876.49 |
| | 3 | 2952.88 | 2878.21 |
| | 4 | 2959.41 | 2879.76 |
| EMTR | 2 | 2948.20 | 2878.51 |
| | 3 | 2953.38 | 2878.71 |
| | 4 | 2960.22 | 2880.57 |
| EATR | 2 | 2946.37 | 2876.67 |
| | 3 | 2953.00 | 2878.33 |
| | 4 | 2959.59 | 2879.94 |

Figures 2.5.2 to 2.5.4 visualize the predicted revenue curves for the three tax measures. The first insight of these estimates is that the shape of the revenue curve looks quite similar, with a specific maximum point depending on the respective tax.

Figure 2.5.2: *Parametric Laffer-Curve (STR)*

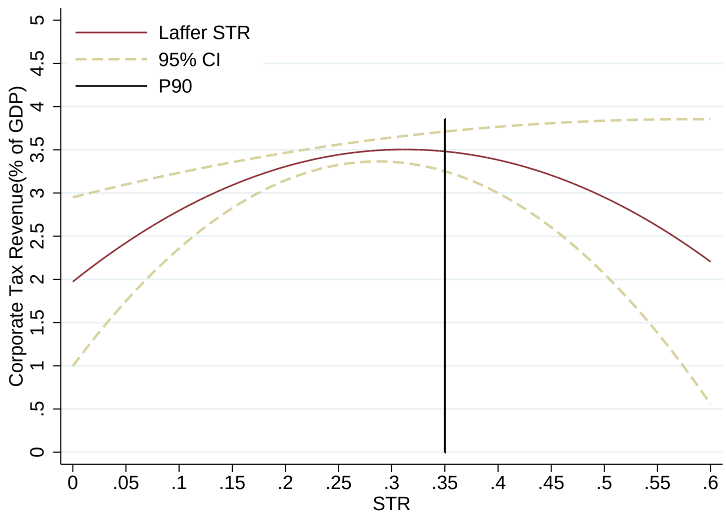


Figure 2.5.3: *Parametric Laffer-Curve (EMTR)*

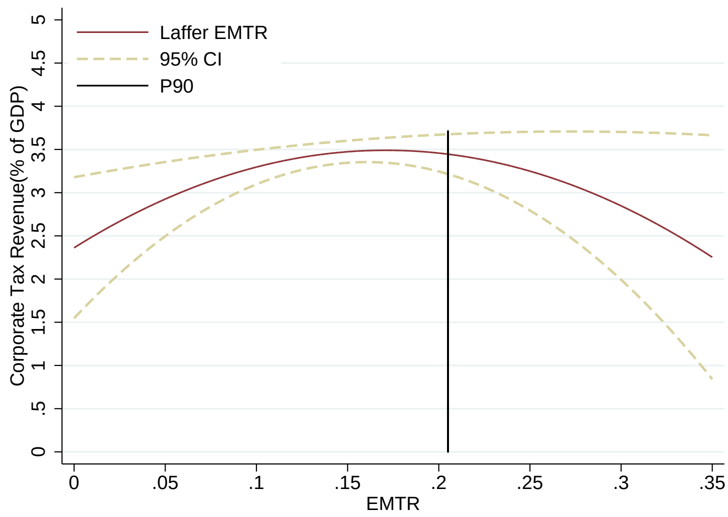



Figure 2.5.4: *Parametric Laffer-Curve (EATR)*

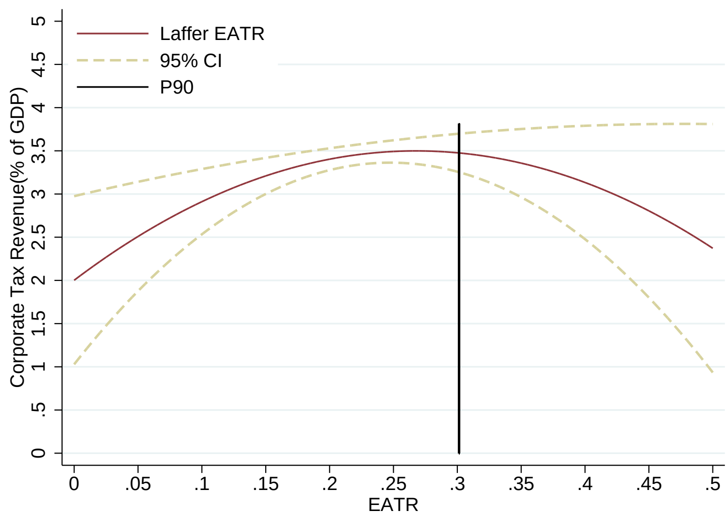



Table 2.5.3 illustrates the estimated revenue-maximizing values of the respective measures, the tax revenue associated with these revenue-maximizing rates and the mean tax rates actually observed in our data. The revenue-maximizing STR is estimated to be roughly 31%, the EMTR that maximizes tax revenue is about 17%, and the EATR is around 27%.

Table 2.5.3: *Laffer-Curve estimation: Maximum and observed tax rates*

| Tax measure | Tax rate at maximum | Maximum tax revenue | Average tax rate |
|---|---|---|---|
| STR | 31% | 3.5038 | 25% |
| EMTR | 17% | 3.4946 | 14% |
| EATR | 27% | 3.4991 | 22% |

*Notes:* The maximum tax values are those of the specific maximum points from the Laffer-Curves in Figures 2.5.2 to 2.5.4. The average tax values are those actually observed in the sample used for the Laffer-Curve estimates.

Comparing these rates with the actual averages reveals that all measured mean values lie clearly below the predicted revenue maximum: the means of STR, EMTR, and EATR are 25%, 14%, and 22%, respectively (see Table 2.5.3). This suggests that taxes are, on average, below the revenue-maximizing rates, which is consistent with arguments on tax competition resulting in lower taxes in equilibrium (see, e.g., Oates, 1972; Zodrow and Mieszkowski, 1986; Bucovetsky, 1991; Wilson, 1999). As a large literature on profit shifting argues that countries compete not only for productive capital but also for taxable profits, it is not surprising that the difference between revenue-maximizing tax and average tax is largest for the STR.[30]

In order to underpin the robustness of the estimated Laffer-Curve relationship, we include 95% confidence bands depicted by the dotted lines in the figures. Taking into account that, as indicated by the vertical lines for the 90th percentiles in Figures 2.5.2 to 2.5.4, the vast majority of countries have implemented tax rates in a range where the confidence bands are rather narrow, the predicted revenue curves prove to be precisely estimated. We see that in both tails of the respective tax measures' distributions, the confidence bands are broadening. Particularly for high values of the tax measures, this can be explained by a lower support of observations. Hence, the larger the deviation from the predicted optimal rates, the more difficult it is to precisely estimate the Laffer-Curves. All

[30]The STR, which does not consider depreciation rules, is the relevant indicator when the goal is to measure incentives in the context of profit shifting.

in all, though, the estimates seem to predict a very plausible and robust pattern of the relationship between tax rates and tax revenue. Let us mention that in the Appendix, we provide some statistics on the difference in tax-setting behavior, distinguishing between small and large countries. This difference is not relevant for the way we estimate the Laffer-Curve. The reason is that we remove all cross-sectional variation between countries: the regressions condition on country-specific effects so that all time-constant country characteristics are controlled for. Moreover, the dependent variable in our regressions is the tax-revenue-to-GDP ratio. This implies that the estimated shape of the Laffer-Curve reflects the inefficiencies and distortions produced by the tax system. This is exactly what we are interested in.

Note that, finally, we could use our approach to assess the potential revenue consequences of the recent US corporate tax cut. Our estimates suggest that the US moves from the right-hand side of the Laffer-Curve to the left-hand side. Applying the relative change in the corporate-tax-to-GDP ratio implied by a 14 percentage points tax cut for the US to actual US tax revenue numbers (corporate tax revenue over the last 10 years), we find that the yearly loss in revenue is equal to about 16 billion US dollars. The advantage of our approach is that the Laffer-Curve estimates directly account for potential growth effects through the tax cut, which allows us to come up with a plausible estimate without having to speculate about potential behavioral effects of lower taxes. However, according to our prediction, these growth effects are not sufficient to compensate for the loss through the direct tax-cut effect. We should be aware of the fact that any quantification of a big tax reform implemented by a big country has major general equilibrium implications. This naturally makes quantifications of such events very difficult.

### 2.5.2 Taxes and investment

This section utilizes our tax data to better understand the micro-level investment behavior of firms. For this purpose, we combine the tax data with firm-level information on firm $j$'s tangible fixed assets reported in the *Orbis* database. Tables 2.5.4 and 2.5.5 provide OLS results where we define the logarithm of the fixed assets of firm $j$ as the dependent variable. The two tables crucially differ with respect to the definition of the employed tax measures: In Table 2.5.4, we use taxes measured at the country level, while in Table 2.5.5, we analyze the impact of the firm-industry-specific taxes calculated above (Section 2.4.2).

All regressions include firm and year effects, descriptive statistics of all variables are presented in Table 2.A.2 in the Appendix.[31] As to Table 2.5.4, we are mainly interested in the following tax variables measured at the level of country $c$ at time $t$: $EMTR_{c,t}$, $EATR_{c,t}$, $STR_{c,t}$, and $NPV_{c,t}$ (see above). We further include two firm-$j$-specific variables: the one-period lagged log of sales ($log\ SALES_{j,t-1}$), and the one-period lagged log of the number of employees, ($log\ EMPL_{j,t-1}$).[32] At the level of countries $c$, we control for the host country's GDP ($log\ GDP_{c,t}$), GDP per capita ($log\ GDPPC_{c,t}$), and GDP growth ($GDP\ growth_{c,t}$) (all GDP measures are taken from the World Bank's World Development indicator database). The variable $CPI_{c,t}$ is an index measuring corruption perception. It takes values from 0 to 10, where 10 is the hypothetical case of a country that is completely free from corruption (the variable is provided by Transparency International). $FIF_{c,t}$ is an index measuring financial freedom. It takes values from 0 to 100, where higher values indicate more financial freedom ($FIF_{c,t}$ is provided in the Heritage indicator database). The variable domestic credit provided by the banking sector (in % of GDP), $DCB_{c,t}$, is included to capture the depth of country $c$'s financial market (the variable is taken from the World Bank's World Development indicator database). $NDTT_{c,t}$ and $NBIT_{c,t}$ count the number of double taxation treaties (DTTs) and the number of bilateral investment treaties (BITs) concluded by country $c$ in year $t$ ($NDTT_{c,t}$ and $NBIT_{c,t}$ are based on own calculations, where the respective information is taken from UNCTAD). Finally, we condition on $log\ TCAP_{c,t-1}$ to capture the general attractiveness of a location. It is measured as the sum over the total assets of all firms included in our data in a given country $c$ and year $t-1$.

[31]Note that our sample basically captures information from all unconsolidated balance-sheets reported in *Orbis* for the years 2004 until 2014. We exclude firms operating in the financial and insurance business as well as all firms associated with public administration, as these are often subject to different tax rules and regulation. We finally require that a firm is observed for at least 4 years in our data.

[32]We have chosen control variables in line with the paper by Egger et al. (2014), as far as the respective information was available in *Orbis*.

Table 2.5.4: *Taxes and fixed asset investment - country level*

| | (1) | (2) | (3) |
|---|---|---|---|
| $EMTR_{c,t}$ | -2.2426*** | | |
| | (0.5167) | | |
| $EATR_{c,t}$ | | -1.6069*** | |
| | | (0.4035) | |
| $STR_{c,t}$ | | | -1.2908*** |
| | | | (0.3645) |
| $NPV_{c,t}$ | | | 1.6051* |
| | | | (0.9055) |
| $log\ SALES_{j,t-1}$ | 0.0676*** | 0.0675*** | 0.0675*** |
| | (0.0055) | (0.0055 ) | (0.0055) |
| $log\ EMPL_{j,t-1}$ | 0.2968*** | 0.2967*** | 0.2972*** |
| | (0.0150) | (0.0150) | (0.0150) |
| $log\ GDP_{c,t}$ | -0.2262 | -0.2747 | -0.1647 |
| | (0.3868) | (0.3899) | (0.3705) |
| $log\ GDPPC_{c,t}$ | 0.6396* | 0.6997* | 0.5397 |
| | (0.3800) | (0.3827) | (0.3676) |
| $GDP\ growth_{c,t}$ | 0.0071** | 0.0073** | 0.0074** |
| | (0.0031) | (0.0031) | (0.0031) |
| $CPI_{c,t}$ | 0.0144 | 0.0136 | 0.0133 |
| | (0.0235) | (0.0230) | (0.0228) |
| $FIF_{c,t}$ | 0.0007 | 0.0008 | 0.0006 |
| | (0.0010) | (0.0010) | (0.0010) |
| $DCB_{c,t}$ | 0.0003 | 0.0004 | 0.0003 |
| | (0.0006) | (0.0006) | (0.0006) |
| $NDTT_{c,t}$ | -0.0052** | -0.0044* | -0.0051** |
| | (0.0024) | (0.0024) | (0.0023) |
| $NBIT_{c,t}$ | 0.0007 | 0.0004 | 0.0006 |
| | (0.0013) | (0.0014) | (0.0014) |
| $log\ TCAP_{c,t-1}$ | 0.0478* | 0.0451 | 0.0453* |
| | (0.0269) | (0.0280) | (0.0259) |
| Year effects | Yes | Yes | Yes |
| Firm effects | Yes | Yes | Yes |
| Observations | 569,002 | 569,002 | 569,002 |
| Adj. R-squared | 0.9440 | 0.9440 | 0.9440 |
| *EMTR (elast.)* | -0.3321*** | | |
| *EATR (elast.)* | | -0.3927*** | |
| *STR (elast.)* | | | -0.3677*** |
| *NPV (elast.)* | | | 0.9030* |

Dependent variable in all specifications: Logarithm of fixed asset investment. Robust and clustered (country-year level) standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

The results provided in Table 2.5.4 are based on 569,002 observations and 99,198 firms.[33] The panel is unbalanced with most observations in the year 2012 (71,727). The results indicate that taxes are negatively related to investment in fixed assets. Below each column, for each tax measure, we provide the corresponding tax elasticity. The estimated coefficient on the EMTR is highly significant at the 1% level. Note that reported standard errors are robust and clustered at the country-year level. The coefficient on the EATR is estimated to be slightly smaller. Given the specification of the estimation equation (focusing on the intensive margin of asset investment), and particularly given that we focus on time variation by conditioning on firm-specific effects, we would expect that the EMTR captures tax incentives in a more appropriate way.

Column (3) shows that the tax parameters can also be estimated when we separate tax rate and tax base effects. Expressing the tax semi-elasticities as elasticities demonstrates that our results are in a reasonable range and comparable to previous studies (see De Mooij and Ederveen (2003), De Mooij and Ederveen (2008) and Feld and Heckemeyer (2011) for an overview, Zwick and Mahon (2017)). The recent study by Zwick and Mahon (2017) suggests that US firms (particularly small ones) are very responsive to changes in bonus depreciation.

Their average semi-elasticity of 3.7 with respect to bonus depreciation compares to the NPV-semi-elasticity of 1.6 shown in the last column of Table 2.5.4. They also provide a tax-term elasticity of -1.6, which is about 4.4 times larger than the estimated elasticity on STR.[34]

The estimated effects of the control variables are in line with previous findings. The negative effect of $NDTT_{c,t}$ can be interpreted as the consequence of more regulation and information exchange – for example, to reduce profit-shifting activities of multinational firms – between countries when concluding DTTs. The positive effect of $NBIT_{c,t}$ suggests that bilateral investment treaties facilitate foreign direct investment in a country (the effect is not statistically significant, however). Before we discuss the results of Table 2.5.5, we should note that the time variation of the country-specific measures used above is substantial, as, given

[33] A firm in our data is an entity (affiliate) of a multinational enterprise. All $j$-specific variables are taken from (unconsolidated) balance-sheet information provided for these entities.

[34] While both our estimates are smaller than in Zwick and Mahon (2017), we should also note that the average change in $NPV_{c,t}$ is only -.002 (over all observations in our sample).

the estimation sample, the $EMTR_{c,t}$ changes its value more than 80 times (focusing on within-country variation and neglecting all cross-country differences).

Note that we may be concerned about how precisely the tax variables capture incentive effects as firms differ in asset composition and financial choices. We may therefore make use of the weighted tax variables as calculated in Section 2.4.2. The main advantage of using the weighted variables is that they introduce additional variation through weights at the industry- and firm-level. The estimation results of this latter analysis are presented in Table 2.5.5. Both EMTR and EATR measured at the firm-industry-country-time level are significant at the 1% level, and the reported elasticities also suggest a quantitatively very similar influence of taxes on investment as above (where we focus on country-time variation). To be precise, a 1% increase in $EMTR_{jict}$ triggers a 0.33% decrease in fixed asset investment. If we ignore the between-country variation of the industries and focus on global year-industry averages ($EMTR_{jict}^{IND}$ and $EATR_{jict}^{IND}$), the EMTR is still significant at the 5% level.[35] The EATR, however, does not seem to have a significant impact on fixed asset investment, which is consistent with the notion explained above, namely that the EMTR is the appropriate measure when we are focusing on the intensive margin investment. But of course, variation in the EATR may still be related to changes in investment as many big projects are less marginal but rather lumpy. Note, finally, that if we include both measures (the EMTR as well as the EATR), we always find a negative and significant impact for the EMTR, and a positive though insignificant impact of the EATR. Both variables are, however, strongly correlated with each other which inflates the estimated standard errors to some extent.

Surprisingly, the variable $NDTT_{c,t}$ turns out to be insignificant in the last two columns of Table 2.5.5. This means that a higher level of regulation and information exchange seems to be less relevant in the last two specifications. One way to explain this result is that including (possibly endogenous) variation at the firm and industry level implies that we allow for firms engaging in tax-planning behavior.

[35]Note that, of course, $EMTR_{jict}^{IND}$ and $EATR_{jict}^{IND}$ still contain variation at the country level as the industry-specific weights are applied to the respective countries' tax law variables.

Table 2.5.5: *Taxes and fixed asset investment - firm-industry level*

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $EMTR_{jict}$ | -2.5880*** | | | |
| | (0.6083) | | | |
| $EATR_{jict}$ | | -1.4160*** | | |
| | | (0.3961) | | |
| $EMTR^{IND}_{jict}$ | | | -2.1153** | |
| | | | (1.0099) | |
| $EATR^{IND}_{jict}$ | | | | -0.5513 |
| | | | | (0.6207) |
| $log\ SALES_{j,t-1}$ | 0.0676*** | 0.0676*** | 0.0681*** | 0.0681*** |
| | (0.0055) | (0.0055) | (0.0055) | (0.0055) |
| $log\ EMPL_{j,t-1}$ | 0.2968*** | 0.2968*** | 0.2965*** | 0.2962*** |
| | (0.0150) | (0.0150) | (0.0152) | (0.0152) |
| $log\ GDP_{c,t}$ | -0.2229 | -0.2684 | -0.4092 | -0.4097 |
| | (0.3865) | (0.3939) | (0.3854) | (0.3867) |
| $log\ GDPPC_{c,t}$ | 0.6466* | 0.6923* | 0.8601** | 0.8626** |
| | (0.3797) | (0.3879) | (0.3896) | (0.3909) |
| $GDP\ growth_{c,t}$ | 0.0072** | 0.0074** | 0.0078** | 0.0078** |
| | (0.0031) | (0.0032) | (0.0033) | (0.0033) |
| $CPI_{c,t}$ | 0.0148 | 0.0121 | -0.0065 | -0.0066 |
| | (0.0233) | (0.0229) | (0.0242) | (0.0243) |
| $FIF_{c,t}$ | 0.0007 | 0.0008 | 0.0007 | 0.0007 |
| | (0.0010) | (0.0010) | (0.0011) | (0.0011) |
| $DCB_{c,t}$ | 0.0003 | 0.0004 | 0.0007 | 0.0007 |
| | (0.0006) | (0.0006) | (0.0006) | (0.0006) |
| $NDTT_{c,t}$ | -0.0048** | -0.0045* | -0.0035 | -0.0035 |
| | (0.0024) | (0.0024) | (0.0025) | (0.0025) |
| $NBIT_{c,t}$ | 0.0007 | 0.0005 | 0.0010 | 0.0010 |
| | (0.0013) | (0.0014) | (0.0016) | (0.0016) |
| $log\ TCAP_{c,t-1}$ | 0.0462* | 0.0469* | 0.0605** | 0.0604** |
| | (0.0274) | (0.0280) | (0.0267) | (0.0266) |
| Year effects | Yes | Yes | Yes | Yes |
| Firm effects | Yes | Yes | Yes | Yes |
| Observations | 569,002 | 569,002 | 569,002 | 69,002 |
| Adj. R-squared | 0.9440 | 0.9440 | 0.9440 | 0.9440 |
| $EMTR_{jict}$ $(elast.)$ | -0.3295*** | | | |
| $EATR_{jict}$ $(elast.)$ | | -0.3570*** | | |
| $EMTR^{IND}_{jict}$ $(elast.)$ | | | -0.2786** | |
| $EATR^{IND}_{jict}$ $(elast.)$ | | | | -0.1392 |

Dependent variable in all specifications: Logarithm of fixed asset investment. Robust and clustered (country-year level) standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

We finally address two concerns about the estimations in Tables 2.5.4 and 2.5.5. First, it may be that adjustment costs are relevant when analyzing the log of the fixed assets. We therefore first-difference the estimation equation and run dynamic regression models by including the lagged dependent variable as explanatory variable. Since the latter approach violates strict exogeneity, we apply the difference GMM estimator as suggested by Arellano and Bond (1991). Second, we instrument $EMTR_{jict}$ as the weights used to capture financing and asset composition may cause endogeneity issues (as mentioned above).

Table 2.5.6: *Dynamics and endogeneity*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $log\ FA_{j,t-1}$ | 0.6333*** | 0.6367*** | 0.5980*** | 0.7012*** | 0.6081*** |
| | (0.0219) | (0.0219) | (0.0232) | (0.0224) | (.0216) |
| $STR_{c,t}$ | -0.4714*** | | | | |
| | (0.080) | | | | |
| $NPV_{c,t}$ | 0.4173*** | | | | |
| | (0.1811) | | | | |
| $EMTR_{jict}$ | | -1.0954*** | -1.194*** | -7.8075*** | -5.5948*** |
| | | (0.1421) | (0.1416) | (0.4561) | (.3809) |
| Test for AR(1) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Test for AR(2) | 0.381 | 0.383 | 0.362 | 0.221 | 0.243 |

*Notes:* 384,606 observations, dynamic panel-data estimation, two-step difference GMM (see Arellano and Bond, 1991). Robust standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. AR(1) and AR(2) report z-values on the Arellano and Bond tests for autocorrelation. Specification (1): differenced lag ($\Delta log\ FA_{j,t-1}$) instrumented by the two-period lagged level ($log\ FA_{j,t-2}$); Specification (2): differenced lag ($\Delta log\ FA_{j,t-1}$) instrumented by the two-period lagged level ($log\ FA_{j,t-2}$); Specification (3): differenced lag ($\Delta log\ FA_{j,t-1}$) instrumented by all available lagged level variables ($log\ FA_{j,.}$); Specification (4): differenced lag and $EMTR_{jict}$ instrumented by the one-period lagged levels; Specification (5): differenced lag and $EMTR_{jict}$ instrumented by all available lagged level variables.

The results of the dynamic model are presented in Table 2.5.6. Note that we include all additional control variables as before. The specifications differ in the number of instruments used. Columns (1), (2), and (4) are parsimonious specifications employing only the two-period lagged level (of the dependent variable) to instrument $log\ FA_{j,t-1}$; columns (3) and (5) use all available instruments (lagged levels), where we also treat $EMTR_{jict}$ as endogenous in columns (4) and (5). The approach seems to produce reliable estimates for the following reasons: (i) the estimate on the lagged fixed asset variable lies in a plausible range; (ii) we always reject (cannot reject) the hypothesis of no autocorrelation of order 1 (2) at the 1% significance level; (iii) the estimated tax coefficients are negative; the coefficient on $EMTR_{jict}$ is estimated to be -1.0954, which corresponds to a long-run effect of about -3.0, which we can roughly compare to the coefficient of -2.6 in Table 2.5.5. The results where we instrument $EMTR_{jict}$ suggest substantially higher semi-elasticities. These estimates need to be interpreted in light of the quantitatively very moderate average change in $EMTR_{jict}$ of -0.0024.

## 2.6 Conclusions

This study demonstrates that there is significant variation in taxes on corporate profits across countries and over time. To the best of our knowledge, no study has calculated tax measures for such a large sample of countries as we do (including measures of tax base, as well as effective marginal and average tax measures). We describe the recent trends in tax policy and highlight salient features of the cross-country distributions of different tax measures. We then combine statutory rules with firm- and industry-level information on financing behavior as well as asset composition. This allows us to calculate effective tax measures that account for a typical firm with respect to financing and asset composition, given the specific industry and country a firm is operating in. The latter may be interesting for various reasons. For example, firms in high-tax countries use more debt financing, on average, to avoid part of the profit tax through deductible interest cost. A generic effective tax measure, neglecting weights at a more micro level, may overestimate the effective tax burden faced by a typical firm.

We demonstrate that our data can be utilized for a number of interesting research questions. First, we show that the predicted relationship between tax revenue and statutory tax rates is inverse-U-shaped. This shape is known as the Laffer-Curve. The maximum values, i.e., the revenue-maximizing tax rates, are estimated to be above the mean (and median) tax rates observed in our data, a finding we ascribe to strategic tax setting and international tax competition. While it is beyond the scope of this paper to provide more evidence that international tax competition is the driving force behind low tax rates, it is consistent with the clear downward trend in taxes we observe in the descriptive statistics. Furthermore, we make sure that the Laffer-Curve shape is not imposed on the data by specifying tax revenue as a polynomial function of taxes: additional results show that higher-order polynomials in taxes are not significantly related to tax revenue; non-parametric specifications of the relationship produce very similar results. Finally, we believe that business cycle effects and other spurious correlations are well captured by running regressions which control for country- as well as year-specific shocks.

Second, we combine our tax data with firm-level information on investment in fixed assets. We find very plausible tax and tax base elasticities. For example, the firm- and industry-weighted EMTR elasticity is estimated to be -0.33. Separating the statutory tax rate elasticity from the tax base (measured as NPV) elasticity suggests an estimate of -0.37 for the former, and an estimate of 0.90 for the latter. Future research may use our tax data to analyze numerous firm decisions not analyzed in this paper, particularly in an international context.

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# 2.A Appendix

## Depreciation allowances

The following formulas depict how the NPVs of tax depreciation allowances are calculated for a given depreciation allowance regime and asset type $i$. The formulas are adapted from OECD (1991).

Declining-Balance method:

$$A_D^i = \frac{\phi_D^i \cdot (1+\rho)}{\rho + \phi_D^i} \tag{2.A.1}$$

Straight-Line method:

$$A_S^i = \frac{\phi_S^i \cdot (1+\rho)}{\rho} \cdot \left(1 - \frac{1}{(1+\rho)^N}\right) \tag{2.A.2}$$

Straight-Line method with initial allowance:

$$A_{S,IN}^i = \left[\frac{\phi_{S,IN}^i \cdot (1+\rho)}{\rho \cdot (1 - \frac{1}{(1+\rho)^N})}\right] + A_S^i \cdot \left(\frac{1}{(1+\rho)^N}\right) \tag{2.A.3}$$

Declining-Balance method with initial allowance:

$$A_{D,IN}^i = (\phi_{D,IN}^i \cdot (1+\rho)) \cdot (\phi_{D,IN}^i) + \left(\frac{\phi_D^i \cdot (1+\rho)}{\phi_D^i + \rho}\right) \cdot (1 - \phi_{D,IN}^i) \tag{2.A.4}$$

In the following, $\phi_D^i$ ($\phi_S^i$) is the depreciation rate under the declining-balance (straight-line) method, $\rho$ is the market interest rate, $N$ is the depreciation period, $\phi_{D,IN}^i$ ($\phi_{S,IN}^i$) is the initial allowance rate under the declining-balance (straight-line) method.

### Equality of cashflow-based NPV model and neoclassical investment model

As mentioned in Section 2.2, we derive the specifications of our effective tax measures from a neoclassical investment model. Previous approaches (e.g., Devereux et al., 2002; Egger et al., 2009a) primarily rely on a cashflow-oriented representation of NPVs to define the *EMTR* formula. Nonetheless, both approaches lead to the same results:[36]

$$R = -(1-\tau A) + \frac{(1+\pi)(1-\tau)(p+\sigma)+(1+\pi)(1-\sigma)(1-\tau A)}{1+\rho} \stackrel{!}{=} 0 \quad (2.A.5)$$

$$p = \frac{(1-\tau A)((1+\rho)-(1+\pi)(1-\sigma))}{(1+\pi)(1-\tau)} - \sigma \quad (2.A.6)$$

If we ignore $\pi$, we get:

$$R = -(1-\tau A) + \frac{(1-\tau)(p+\sigma)+(1-\sigma)(1-\tau A)}{1+\rho} \stackrel{!}{=} 0 \quad (2.A.7)$$

$$p = \frac{(1-\tau A)(\rho+\sigma)}{(1-\tau)} - \sigma \quad (2.A.8)$$

Comparing with Equation (2.2.3) above, it becomes clear that both methods lead to an equivalent term for the required pre-tax rate of return.

### EATR Calculation

The calculation of the EATR follows Devereux et al. (2002). The following expression depicts the pre-tax NPV of the hypothetical investment.

$$R^* = -I + \frac{1}{1+\rho}[(p+\sigma)(1+\pi)+(1-\sigma)(1+\pi)] \cdot I \quad (2.A.9)$$

Setting investment I=1 and disregarding inflation, we can simplify this to

$$R^* = -1 + \frac{1}{1+\rho}[(p+1)] = \frac{p-\rho}{1+\rho} \quad (2.A.10)$$

[36]The only difference compared to Devereux et al. (2002) and Egger et al. (2009a) lies in the way we define the NPV of depreciation allowances. In this regard, we follow Egger and Loretz (2010) and separate the NPV of depreciation allowances ($A$) from the STR ($\tau$).

The NPV of a hypothetical investment subject to taxation is

$$\begin{aligned} R &= -(1-\tau A) + \frac{(1-\tau)\cdot(p+\sigma) + (1-\tau A)(1-\sigma)}{1+\rho} \\ &= \frac{(1-\tau)(p+\sigma) - (1-\tau A)(\rho+\sigma)}{1+\rho} \end{aligned} \tag{2.A.11}$$

Combining these two present values, we get

$$\begin{aligned} R^* - R &= \frac{p-\rho}{1+\rho} - \frac{(1-\tau)(p+\sigma) - (1-\tau A)(\rho+\sigma)}{1+\rho} \\ &= \frac{\tau\Big(p + \sigma(1-A) - \rho A\Big)}{1+\rho} \end{aligned} \tag{2.A.12}$$

and finally

$$EATR = \frac{R^* - R}{p/(1+\rho)} = \frac{\tau\Big(p + \sigma(1-A) - \rho A\Big)}{p} \tag{2.A.13}$$

## The role of economic depreciation

As an alternative to the results assuming zero economic depreciation (i.e., $\sigma = 0$), we have modified our calculations of the effective tax measures and rerun our estimations based on the adapted tax measures, using various values for $\sigma$. Incorporating economic depreciation in the model increases the required pre-tax rate of return (thus, the user cost of capital) and consequently leads to larger ETRs. The following comparative statics exercise shows this:

$$\frac{\partial \hat{p}}{\partial \sigma} = \frac{1-\tau A}{1-\tau} - 1 > 0 \tag{2.A.14}$$

$$\frac{\partial EMTR}{\partial \sigma} = \frac{(1-\tau)\cdot\rho}{((1-\tau A)\cdot\rho + (1-A)\cdot\tau\sigma)^2} \cdot (1-A)\cdot\tau > 0 \tag{2.A.15}$$

$$\frac{\partial EATR}{\partial \sigma} = \frac{\tau(1+A)}{p} > 0 \tag{2.A.16}$$

We have calculated the ETRs with a non-zero economic depreciation rate and compare various values for the latter: 0.01, 0.025, and 0.0608, where the latter value is in line with the assumptions in OECD (1991) and Egger et al. (2009b). Table 2.A.1 suggests that, in line with the theoretical predictions, the ETRs (i) are higher than with economic depreciation assumed to be zero and (ii) are increasing in the economic depreciation rate.

Table 2.A.1: *The role of economic depreciation*

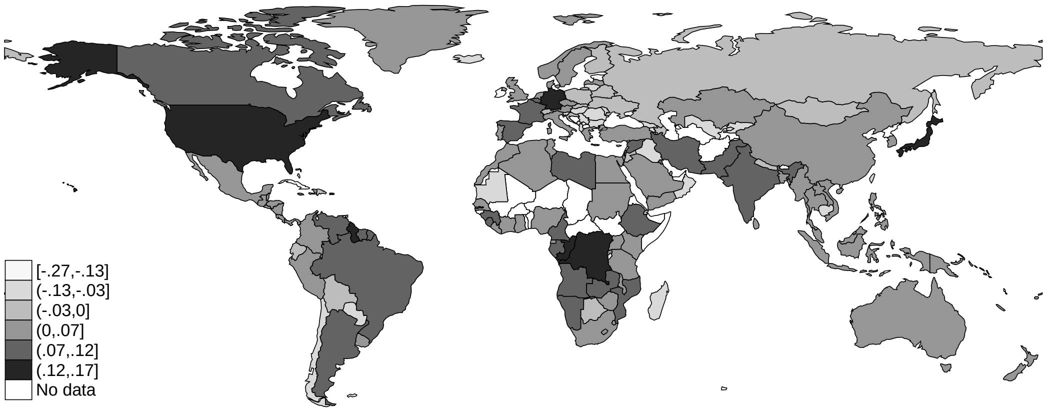
| | $EMTR(\sigma = 0)$ | $EMTR(\sigma = 0.01)$ | $EMTR(\sigma = 0.025)$ | $EMTR(\sigma = 0.0608)$ |
|---|---|---|---|---|
| $MEAN$ | 0.135 | 0.1571 | 0.1878 | 0.2517 |
| $SD$ | 0.0554 | 0.0632 | 0.0736 | 0.0933 |
| $Min$ | 0 | 0 | 0 | 0 |
| $Max$ | 0.3515 | 0.3941 | 0.4485 | 0.5458 |
| | $EATR(\sigma = 0)$ | $EATR(\sigma = 0.01)$ | $EATR(\sigma = 0.025)$ | $EATR(\sigma = 0.0608)$ |
| $MEAN$ | 0.2182 | 0.2239 | 0.2324 | 0.2528 |
| $SD$ | 0.0778 | 0.0799 | 0.083 | 0.0905 |
| $Min$ | 0 | 0 | 0 | 0 |
| $Max$ | 0.4735 | 0.4857 | 0.504 | 0.5477 |

## Statutory taxes: cross-country variation

For each country, we pool the annual STRs over the period from 1996 to 2016 and subtract the global (time-) average STR (26.09%) from each country's time average. These demeaned tax rates are illustrated in Figure 2.A.1; the darker in color a country's area, the higher the respective country's STRs.

One can see that there is substantial variation across countries, indicating that the tax-setting behavior of countries vastly differs. Highly developed countries like the US, Germany, and Japan, but also a considerable number of very poor countries in Sub-Saharan Africa exhibit STRs that are well above the global average. In contrast to this, the majority of Eastern European countries, including Russia, have comparatively low statutory tax rates.

Figure 2.A.1: *(Demeaned) Statutory taxes across countries, 1996-2016 (pooled)*




*Notes:* The darker in color a country's area, the higher the respective country's STRs.

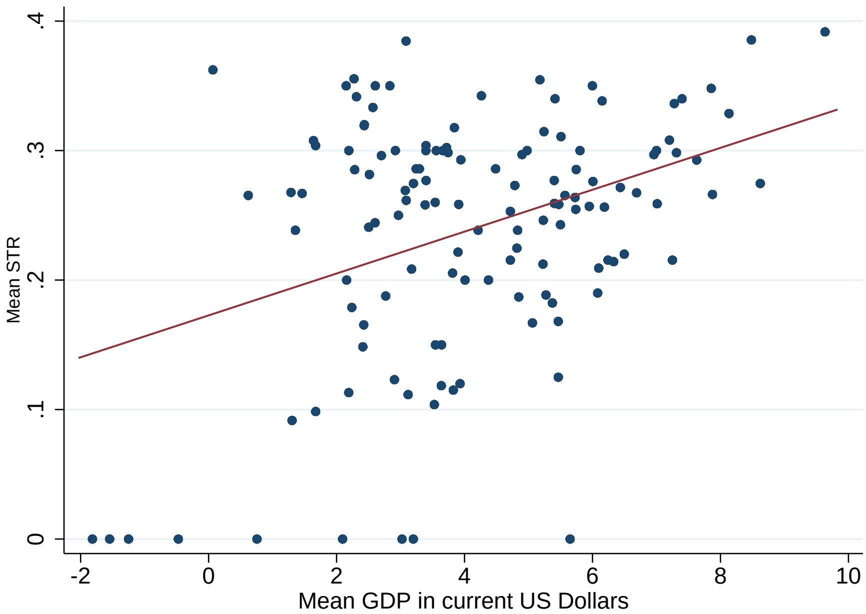
## Laffer-Curve estimates and country size

In the Laffer-Curve estimates above, we assume identical (average) tax base elasticity coefficients for all countries. However, in general, one could argue that country size affects optimal tax-setting behavior. The seminal work here goes back to Bucovetsky (1991), who shows that small and large countries face a capital outflow after an increase in their tax rate. Yet, the larger country faces a less elastic tax base and therefore chooses a higher tax rate.

While Figure 2.A.2, depicting the correlation between log(GDP) and the statutory tax rate, confirms this pattern, we should be aware of the point that this comparison is based on cross-sectional differences in country size.

The point about the cross-sectional comparison between countries becomes crucial when interpreting the Laffer-estimates. There, we regress tax revenue (relative to GDP) of a country on country-specific (fixed) effects (which should take out all cross-sectional variation, including the different tax-setting behaviour of countries of different size), GDP growth and time dummies (which should account for business cycle effects), and tax as well as tax squared (we also test for higher order polynomials). The dependent variable is normalized by country size and all cross-sectional variation is removed. As a consequence, the estimated shape of the Laffer-Curve must be related to inefficiencies and distortions produced by the tax system. This is exactly what we want but it makes an interpretation of the

Figure 2.A.2: *(Log) GDP and statutory tax rates*




Laffer-Curve in light of the literature on asymmetric tax competition difficult.

To conclude, if (at all) a distinction between small and large countries is made, then this should be in the spirit of the seminal theoretical paper of Bucovetsky (1991), i.e., in a cross-sectional analysis. In addition, in any empirical analysis, the definition of a 'small' country is highly arbitrary, and a wide range of fundamentally different results could be produced, depending on how we define a 'small' country.[37]

[37]In our estimation approach, the difference in the tax-setting behavior between small and large countries cannot be analyzed in a meaningful way. This is because identification is based on changes in tax rates over time and all cross-sectional differences in country size are removed. This generally implies that in the fixed effects approach, a marginal increase in GDP (which is used to normalize the dependent variable, anyway) cannot be interpreted as the effect of becoming larger. For example, a marginal increase in the GDP of Latvia would not make Latvia a large country. We do not see a way to capture these discrete jumps in the definition of being small.

## Descriptive statistics, variable definitions and sources (Section 2.5.2)

Table 2.A.2: *Descriptive statistics*

| | *Mean* | *Std.Dev.* | *Minimum* | *Maximum* |
|---|---|---|---|---|
| $log\ FA_{j,t}$ | 7.379 | 2.540 | -1.978 | 18.512 |
| $STR_{c,t}$ | 0.285 | 0.070 | 0.000 | 0.410 |
| $NPV_{c,t}$ | 0.563 | 0.076 | 0.000 | 0.705 |
| $EMTR_{c,t}$ | 0.148 | 0.041 | 0.000 | 0.231 |
| $EATR_{c,t}$ | 0.244 | 0.059 | 0.000 | 0.339 |
| $EMTR_{jict}^{IND}$ | 0.132 | 0.011 | 0.117 | 0.160 |
| $EATR_{jict}^{IND}$ | 0.252 | 0.017 | 0.214 | 0.298 |
| $EMTR_{jict}$ | 0.127 | 0.036 | 0.000 | 0.207 |
| $EATR_{jict}$ | 0.252 | 0.063 | 0.000 | 0.374 |
| $log\ SALES_{j,t-1}$ | 9.839 | 2.048 | 0.000 | 19.064 |
| $log\ EMPL_{j,t-1}$ | 4.161 | 1.599 | 0.000 | 12.545 |
| $log\ GDP_{c,t}$ | 27.538 | 1.227 | 23.056 | 30.475 |
| $log\ GDPPC_{c,t}$ | 10.364 | 0.365 | 8.331 | 11.479 |
| $GDP\ growth_{c,t}$ | 1.024 | 3.314 | -14.800 | 15.316 |
| $CPI_{c,t}$ | 6.256 | 1.743 | 2.100 | 9.600 |
| $FIF_{c,t}$ | 65.169 | 12.253 | 30.000 | 90.000 |
| $DCB_{c,t}$ | 146.989 | 72.856 | 15.306 | 376.955 |
| $NDTT_{c,t}$ | 86.756 | 22.937 | 0.000 | 128.000 |
| $NBIT_{c,t}$ | 77.091 | 29.141 | 1.000 | 136.000 |
| $log\ TCAP_{c,t-1}$ | 20.763 | 1.525 | 11.251 | 22.673 |

*Notes:* $569,002$ Observations. For variable definitions and sources, see 2.5.2

Table 2.A.3: *Variable definitions and sources*

| Variable | Definition and Source |
|---|---|
| $STR_{c,t}$ | Statutory corporate income tax rate of country $c$ in period $t$; Source: *EY, OECD, WB* |
| $NPV_{c,t}$ | NPV of depreciation allowances of country $c$ in period $t$; Source: *EY, PwC* |
| $EMTR_{c,t}$ | Effective marginal tax rate of country $c$ in period $t$; Source: *EY, OECD, IBFD, WB* |
| $EATR_{c,t}$ | Effective average tax rate of country $c$ in period $t$; Source: *EY, OECD, IBFD, WB* |
| $EMTR^{IND}_{jict}$ | Firm($j$)-industry($i$)-country($c$)-level effective marginal tax rate in period $t$ with industry-specific weights; Source: *EY, OECD, IBFD, WB* |
| $EATR^{IND}_{jict}$ | Firm($j$)-industry($i$)-country($c$)-level effective average tax rate in period $t$ with industry-specific weights; Source: *EY, OECD, IBFD, WB* |
| $EMTR_{jict}$ | Firm($j$)-industry($i$)-country($c$)-level effective marginal tax rate in period $t$; Source: *EY, OECD, IBFD, WB* |
| $EATR_{jict}$ | Firm($j$)-industry($i$)-country($c$)-level effective average tax rate in period $t$; Source: *EY, OECD, IBFD, WB* |
| $TAX\ REVENUE_{c,t}$ | Corporate income tax revenue in % of GDP of country $c$ in period $t$; Source: *IMF; World Revenue Longitudinal Data (WoRLD)* |
| $TAX_{c,t}$ | Tax rate (STR, EMTR or EATR) of country $c$ in period $t$; Source: *EY, OECD, IBFD, WB, PwC* |
| $GROWTH_{c,t}$ | GDP growth (in %) per capita of country $c$ in period $t$; Source: *World Bank, World Development Indicator (WDI) database* |
| $FA_{j,t}$ | Fixed asset investment of firm $j$ in period $t$; Source: *Orbis* |
| $SALES_{j,t-1}$ | Total sales of firm $j$ in period $t-1$; Source: *Orbis* |
| $EMPL_{j,t-1}$ | Number of employees of firm $j$ in period $t-1$; Source: *Orbis* |
| $GDP_{c,t}$ | GDP of country $c$ in period $t$; Source: *World Bank, WDI database* |
| $GDPPC_{c,t}$ | GDP per capita of country $c$ in period $t$; Source: *World Bank, WDI database* |
| $GDP\ growth_{c,t}$ | GDP growth of country $c$ in period $t$; Source: *World Bank, WDI database* |
| $CPI_{c,t}$ | Corruption perception index of country $c$ in period $t$; Source: *Transparency International* |
| $FIF_{c,t}$ | Financial freedom index of country $c$ in period $t$; Source: *Heritage Foundation* |
| $DCB_{c,t}$ | Domestic credit provided by the banking sector in % of GDP of country $c$ in period $t$; Source: *World Bank, WDI database* |
| $NDTT_{c,t}$ | Number of double tax treaties concluded by country $c$ in period $t$; Source: *United Nations Conference on Trade and Development (UNCTAD) database* |
| $NBIT_{c,t}$ | Number of bilateral investment treaties concluded by country $c$ in period $t$; Source: *UNCTAD database* |
| $TCAP_{c,t-1}$ | Sum of total assets of all firms in country $c$ in period $t-1$; Source: *World Bank WDI database* |

# Chapter 3

# Tax Revenue, Tax Competition, and the Laffer-Curve

ABSTRACT

This study contributes to a better understanding of how countries generate corporate tax revenue in a globalized economy with increasing international integration. First, we illustrate that the amount of tax revenue countries raise from different sources is substantial. Second, we investigate the relationship between international statutory corporate tax rates and tax revenue. Using a comprehensive dataset for 134 countries, we estimate Laffer-Curves, reflecting the link between a country's statutory corporate tax rate and tax revenue. In addition, we control for foreign, competing countries' tax-setting behavior in our empirical framework. We find that tax-avoidance activities give rise to a robust inverse-U-shaped Laffer-Curve relationship which is insensitive to the inclusion of foreign countries' tax rates. The latter have no significant effect on corporate tax revenue and neither affect the revenue-maximizing tax rate nor the corresponding maximum tax revenue predicted by the Laffer-Curve. Our findings suggest that the responsiveness of firms to foreign statutory tax rates is, on average, very limited. The revenue-maximizing statutory tax rate is considerably higher than the average, observed tax rate in our sample. While this is most likely due to international tax competition, our results show that such strategic tax-setting behavior implies too low statutory tax rates and adverse tax revenue outcomes.

## 3.1 Introduction

Thinking of global tax policy these days, a good deal of the recent public as well as academic discussion centers around the comprehensive US tax reform signed into law in December 2017. The focal point of the "Tax Cuts and Jobs Act" (TCJA) attracting a lot of attention is a substantial lowering of the federal corporate income tax rate from 35% to 21%. As to the insights from the discussion about the TCJA, one can broadly distinguish between two different angles. First, a number of contributions assess the reform from a domestic perspective and evaluate potential effects on different margins of the US economy (e.g., Auerbach, 2018; Chalk et al., 2018; Hanlon et al., 2018; Slemrod, 2018). While these contributions predict positive domestic investment and labor market effects associated with the reform, they also expect a substantial increase in federal deficits, as the amount of (corporate) tax revenue raised will decline considerably.[1] Second, some contributions (e.g., Beer et al., 2018; Spengel et al., 2018; Boumans et al., 2019) adopt an international perspective and discuss the expected impact of the reform on other countries which might be worried about potential net outflows of capital to the US.[2] Many, mostly European, countries (e.g., France, UK, and Belgium) have announced to react to the US tax cut by also decreasing statutory tax rates on corporate profits (Mintz, 2018). From a theoretical perspective, and related to an extensive literature in public finance (see Wilson, 1999, for an overview), this can be explained by the notion that countries compete for mobile tax bases over

[1] The Joint Committee of Taxation (JCT) predicts an increase of 330 billion USD in federal deficit related to the changes in corporate taxation over the next ten years, of which about one third is expected to be offset by positive growth effects (JCT, 2017). Note that, in this regard, two important aspects have to be kept in mind. First, there is large variation in the estimates of the net revenue impact, mainly due to differences in the expected growth effects, which vary between 0.6-1.1% (Penn Wharton Group) and 3% (Tax Foundation). Second, apart from corporate taxation, the TCJA involves a lot of additional changes to the overall US tax system. Hence, estimates trying to precisely assess the consequences of changes to the corporate tax system should be interpreted with caution. In particular, growth effects are difficult to attribute immediately to specific aspects. Moreover, substantial general equilibrium effects remain a concern with any quantification of a far-reaching tax reform.

[2] The latter, however, is difficult to assess and forecasts vary a lot. While US inbound investment by, for example, European multinational enterprises (MNEs) is likely to increase, some features of the TCJA such as the move towards a territorial system and the GILTI and BEAT provisions may also create incentives for US firms to increase investments abroad (Chalk et al., 2018).

statutory tax rates. Lowering statutory tax rates as a response to the TCJA may help to mitigate a possible shrinking of the (domestic) tax base. Nevertheless, the intensification of tax competition is, altogether, likely to lead to losses in tax revenue in these countries.

Taken together, the insights from this discussion show that adverse revenue effects of tax cuts should be a major concern - not only in the country implementing lower rates in the first place, but also in an international context. How do these considerations relate to the link between a country's tax-setting behavior and the amount of corporate tax revenue raised? To the extent that we observe strategic tax setting and international tax competition between countries to prevent an outflow of capital, can the trend towards lower tax rates be considered 'optimal'? Taking into account the revenue consequences of changes to the international tax system seems to be increasingly important. This paper contributes to a better understanding of how corporate tax revenue is related to statutory tax incentives in an international context. We conduct an empirical analysis that explicitly incorporates the notion that tax revenue in one country may be affected by the tax-setting behavior in other countries. To this end, we use a rich dataset for 134 countries and the time period from 2004 to 2014 and suggest a Laffer-Curve framework, which typically reflects that statutory tax rate and revenue in one country show an inverse-U-shaped relationship. We extend this basic framework and link tax revenue in one country not only to the own tax rate and other domestic determinants, but also to a weighted average of other countries' tax rates. To the best of our knowledge, no previous contribution has considered the revenue consequences of foreign tax rates in a global empirical assessment of the Laffer-Curve relationship.

We find that the weighted-average foreign tax rate has no significant effect on corporate tax revenue. Comparing our results to a purely domestic setting as in Steinmüller et al. (2019), we show that taking into account the effects of competing countries' statutory tax rates on the Laffer-Curve relationship leaves the optimal rate-revenue combination virtually unchanged. Moreover, the suggested revenue-maximizing tax rate is considerably higher than the actual, global average tax rate observed in the sample. Strategic interaction between countries may be the driving force behind this finding. However, our predicted Laffer-Curves controlling for this competitive pressure show that tax revenue is not maximized at such a low tax rate. Our results suggest that the amount of tax revenue raised by a country is, on average, insensitive to foreign tax rates. From a policy perspective, this indicates that international tax competition should not play a dominating role in single countries' tax-setting behavior.[3] Reacting to other countries' tax-setting behavior, i.e., competing over statutory tax rates, leads to adverse revenue effects. Considerations about marginal changes in the corporate tax rate should therefore be mainly driven by the country's current rate-revenue combination and, hence, its location on the Laffer-Curve. We finally provide a number of stylized facts to derive possible explanations for our findings. These explanatory approaches are related to the, on a global scale, very large share of purely domestic firms and the limited tax-responsiveness of some (often very large) MNEs due to their ability to avoid taxes through shifting corporate income to affiliates in low-tax countries.

Our paper relates to several strands of previous literature, which can be distinguished along three general lines. First, a number of contributions discuss the development in corporate income tax revenue collection in a broader context (e.g., Devereux et al., 2004; Loretz, 2008; Fuest et al., 2019). De Mooij and Nicodème (2008) as well as Caiumi et al. (2018) analyze the determinants of tax revenue and discuss why, in spite of a significant downward trend in statutory corporate tax rates, tax revenue numbers have remained on a fairly constant level in the last decades. For the most part, this can be explained by an increasing degree of incorporations and a more profitable corporate sector. A second, not too extensive strand of literature is concerned with an empirical assessment of the link between statutory corporate tax rates and tax revenues, testing whether an inverse-U-shaped Laffer-Curve relationship can be confirmed using country-level data. Brill and Hassett (2007) as well as Clausing (2007) provide evidence for

[3]Note that in this paper, we focus on one particular form of 'international tax competition' – cross-country competition over *statutory tax rates* on corporate income–, and any statements about the role of 'international tax competition' refer to the specific policy instrument of statutory tax rates. We are fully aware that countries moreover compete over a number of other tax-policy instruments. We comment on this in Section 3.6 and, in the Appendix, discuss the robustness of our results against considering *effective* rather than *statutory* tax rates.

a Laffer-Curve relationship for OECD countries. Steinmüller et al. (2019) use a considerably larger sample of 112 countries and find (i) a robust parabolic relationship between statutory as well as effective tax rates and corporate tax revenue and (ii) actual, global average tax rates to be significantly lower than the revenue-maximizing rates suggested by the Laffer-Curves.[4] Third, our study relates to the comprehensive tax competition literature. Theoretical tax competition models often predict a 'race to the bottom' with respect to statutory corporate tax rates, as countries compete for mobile capital (or taxable profits) through strategic tax-setting behavior.[5] Apart from a few tax haven countries, admittedly, there is hardly any empirical evidence of such a 'race to the bottom'. However, Devereux et al. (2002) and Steinmüller et al. (2019) illustrate a downward trend in statutory taxes throughout the past decades. A number of empirical contributions analyze whether this decline can be explained by strategic interaction in tax rates between countries.[6] While empirical results as to the latter are not as clear-cut as those of the classical theoretical tax competition models, these contributions generally confirm that governments compete over statutory taxes, which explains the downward trend in tax rates (Devereux et al., 2008; Overesch and Rincke, 2011; Redoano, 2014; Egger and Raff, 2015).

The remainder of the paper is organized as follows. Section 3.2 presents a general overview and some stylized facts on tax revenue and the public budget. In Section 3.3, we discuss the conceptual framework of the Laffer-Curve. Sections 3.4.1 and 3.4.2, respectively, outline our estimation approach and provide information on the data we use. Sections 3.4.3 and 3.4.4 present the empirical results and some sensitivity checks. In Section 3.5, we discuss our results in light of fur-

[4] All these approaches have in common that corporate tax revenue is regressed on domestic determinants only. However, the fundamental difference with respect to the empirical approach taken by Steinmüller et al. (2019), compared to previous contributions, is that all cross-sectional variation in the sample is removed because country-specific effects are included in the estimation equation. Hence, identification is based on variation over time only.

[5] Seminal contributions to the theoretical tax competition literature include Zodrow and Mieszkowski (1986); Wilson (1986, 1999); Wildasin (1988, 1989), and Haufler and Wooton (1999). More recently, the New Economic Geography literature (see, e.g., Ludema and Wooton, 2000; Andersson and Forslid, 2003; Baldwin and Krugman, 2004) has suggested an explanation for the empirical regularity that most countries are still able to set non-zero tax rates. The latter is, in short, related to location-specific rents due to agglomeration economies.

[6] Brückner (2003) and Devereux and Loretz (2013) provide reviews of the empirical tax competition literature.

ther descriptive evidence and findings from previous literature. Finally, Section 3.6 offers some concluding remarks.

## 3.2 Tax revenue and the public budget

How do countries generate tax revenue and, more fundamentally, how can we justify that governments levy taxes on different types of income, goods and services? From a very general perspective, the discipline of public finance unifies two sides of one coin. While the coin in this idiom is a country's public budget, the two sides are, on the one hand, public expenditures, and, on the other hand, public revenue. A government's public expenditures most notably serve two purposes: the financing of public goods and services and the redistribution of income through some form of a social security system.[7] Broadly speaking, the costs of public sector activity are, for the most part, offset by public income. The main source of public income is, by far, tax revenue: Considering a panel of 27 EU countries, Mourre and Reut (2019) find that the average share of tax revenue in total public revenue is 88%.[8] This share is slightly smaller for less developed economies, but still represents the vast majority of public revenue. Figure 3.2.1 illustrates the evolution of total tax revenue over time, grouped by world regions, and offers three insights.[9] First, one can see that the amount of (total) tax revenue raised is substantial. Second, it varies considerably across world regions. There seems to be a positive correlation between a world region's level of economic development and the share of total tax revenue relative to GDP. In particular, the level of tax revenue raised by highly developed economies in Europe is distinctly above average. Third, Figure 3.2.1 suggests that, in most regions, revenue has either

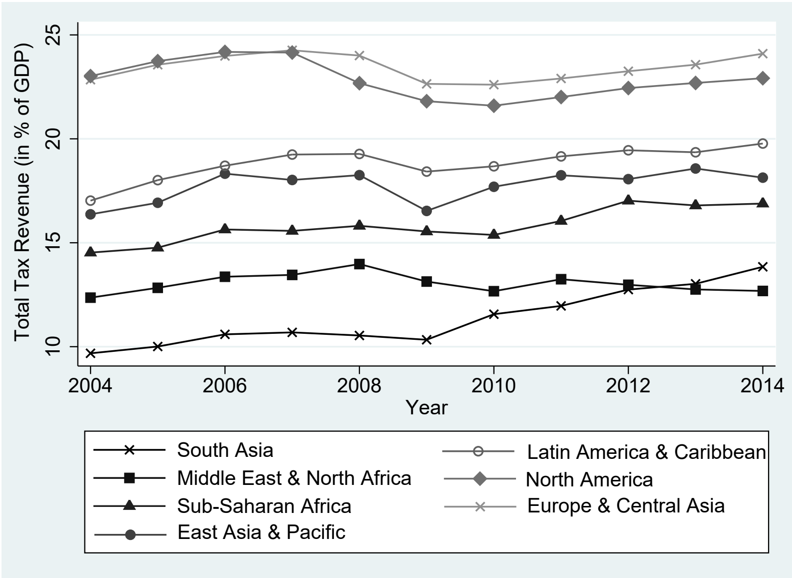
[7] In Germany, for example, 60.3% of total public expenditures in 2017 are attributed to social security and health (data taken from Eurostat). Further major public expenditure categories are related to education (9.3%), economic development & support (7.1%), and public security & legal protection (3.5%).

[8] Other (non-tax) sources of public revenue include, for example, dividends distributed by state-owned enterprises, fees for public health services, road and bridge tolls, and rental income from government land and buildings (Mourre and Reut, 2019).

[9] We follow the classification scheme of world regions in the World Bank's World Development Indicator (WDI) database, distinguishing between the seven regions depicted.

remained on a rather stable level or increased slightly since 2004.[10]

Figure 3.2.1: *Total tax revenue (2004-2014, 151 countries) by world regions*



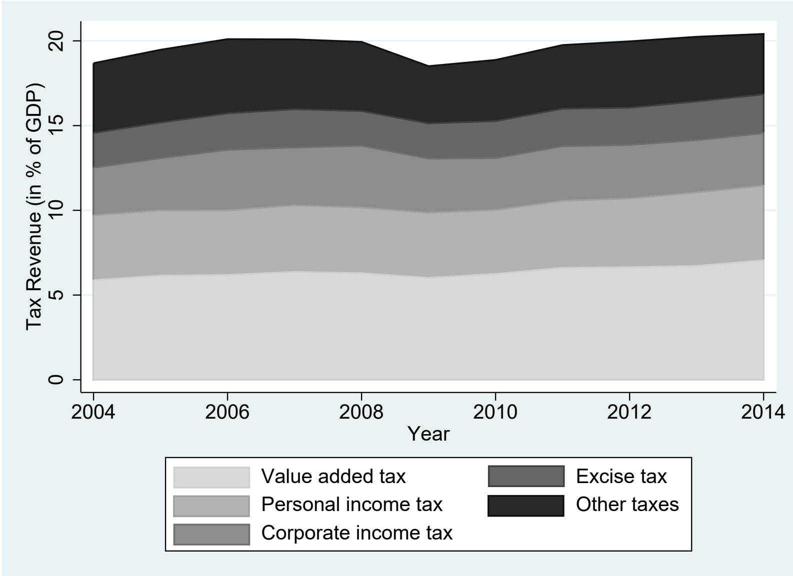

*Notes:* The labeling refers to the depicted lines from the bottom up, i.e., the lowest line represents South Asia, the highest line represents Europe & Central Asia. Source: IMF

Total tax revenue can be roughly subdivided into taxes levied on (personal and corporate) income and consumption (value added taxes (VAT) and excise taxes on specific goods).[11] Figure 3.2.2 illustrates the global average shares of the most important sources of tax revenue. It shows that these shares are quite stable over time and the largest shares of revenue stem from VAT (lightest gray area) and personal income taxation (second lightest gray area).

[10]Note that this seems consistent with the observation that public expenditures have steadily increased over the last decades (as indicated by the World Bank's World Economic Outlook (WEO) database). A straightforward consequence of this would be that also public income should have increased over time. If this was not the case, public debt would have increased significantly. Many countries manage to offset public expenditure costs to a large extent, thus maintaining a more or less stable debt level. However, in some countries, (e.g., Japan, Greece, and Italy), public expenditures and revenue have diverged over the past years, leading to increasing public debt levels.

[11]Other sources of tax revenue include, among others, property taxes, trade taxes, and payroll taxes.

Figure 3.2.2: *Tax revenue by source (2004-2014, 151 countries), global average*

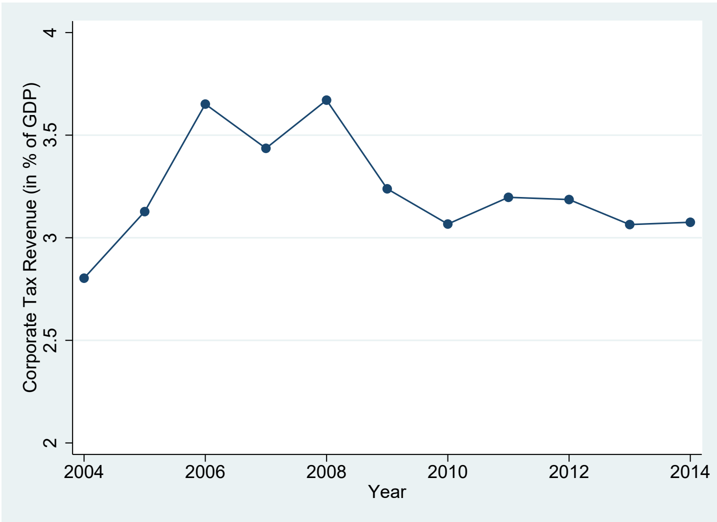



*Notes:* The labeling refers to the depicted areas from the bottom up, i.e., the lowest area represents revenue raised from VAT, the second lowest area represents revenue from personal income taxes. Source: IMF

In this paper, however, we focus on corporate income tax revenue. Figure 3.2.2 shows that the fraction of revenue raised from corporate income taxes is lower compared to VAT and personal income taxes. In light of the significant decline in corporate tax rates in the 1980s and 1990s, Weichenrieder (2005) argues that one can expect this development to continue and statutory corporate taxes to eventually go down to zero. This would be consistent with classical models of tax competition suggesting a race to the bottom. However, more recent evidence shows that this has not happened and the clear downward trend in tax rates seems to have slowed down since 2011 (Steinmüller et al., 2019). Nonetheless, due to the ever increasing economic integration observed in the past decades, the taxation of (potentially) mobile corporate profits remains a challenging task and a persistent and controversial topic in policy debates (Haufler and Stähler, 2013). In short, two (very different) arguments in favor of maintaining a corporate tax can be established. First, related both to current policy discussions and a very fundamental ability-to-pay-principle, most people would argue that a fair and socially desirable tax system includes a tax on corporate profits. Second, and more technically, a corporate tax may act as an important backstop to the personal income tax (Slemrod, 2004; Clausing, 2013).[12]

In our empirical analysis below, we use data on corporate income tax revenue for 134 countries from all over the world.[13] Several interesting, descriptive insights can be inferred from these data. As already suggested by Figure 3.2.2, we do not see any clear trend as to the development of global average corporate tax revenue (in % of GDP) over time (Figure 3.2.3).

Figure 3.2.3: *Corporate tax revenue (2004-2014, 134 countries), global average*



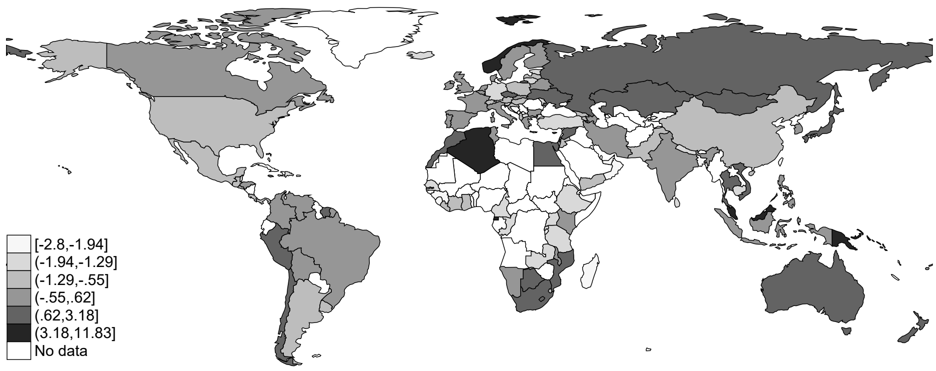

*Notes:* Source: IMF

If at all, corporate tax revenue seems to have increased in the years prior to 2007, then decreased and eventually remained rather stable in recent years. However, this development is, to the greatest extent, similar for the other sources of tax revenue depicted in Figure 3.2.2. Moreover, we see that corporate income tax revenue varies substantially across countries. This is shown in Figure 3.2.4, where we illustrate the global distribution of corporate tax revenue, pooling the latter for each country and depicting the time average, demeaned by the global mean over the whole sample period.

[12]Suppose that only personal income is subject to taxation and the statutory corporate tax rate is zero. Then, a loophole emerges in the sense that the income tax can be avoided by classifying labor income (or any other form or personal income) as corporate income. These retained, seemingly 'corporate' earnings could then be distributed to shareholders by other, tax-preferred means (Slemrod, 2004). Together with the decline in corporate tax rates in recent decades, this incentive is consistent with the result of De Mooij and Nicodème (2008), who find a steady increase in the extent of incorporations.

[13]The data are taken from the IMF's World Revenue Longitudinal Data (WoRLD). For more information, see Section 3.4.2.

Figure 3.2.4: *Corporate tax revenue across countries (2004-2014)*




*Notes:* The darker in color a country's area, the higher is corporate tax revenue (in % of GDP). The classification of countries is based on the following percentile ranges of the global distribution of (demeaned) corporate tax revenue: [1-10], (10-25], (25-50], (50-75], (75-90], (90-99]. Source: IMF

## 3.3 The Laffer-Curve and tax revenue maximization

### 3.3.1 Conceptual framework

When it comes to a government's tax-policy considerations, how can we define a suitable objective function? As an instrument to derive statutory corporate tax rates which can serve as an optimality benchmark, we suggest the use of Laffer-Curves. The concept of the Laffer-Curve reflects the idea of an inverse-U-shaped relationship between tax rate and tax revenue and thus suggests that there exists a statutory tax rate that maximizes tax revenue. The exact shape of the Laffer-Curve and hence the specific, revenue-maximizing tax rate (and corresponding revenue) depends on two factors: first, the specific design of the respective tax and, second, the extent of behavioral responses to the tax under consideration (Steinmüller et al., 2019).

We typically distinguish between a *mechanical* (or direct) and a *behavioral* (or indirect) effect of a tax rate change on tax revenue. As to the first effect, without any behavioral responses, a tax increase (decrease) merely implies a proportionate increase (decrease) in tax revenue. In most cases, however, the tax base is not perfectly inelastic with respect to the tax rate.[14] Rather than that, the tax base is endogenously determined by the aggregate responses to changes in the tax rate. The tax base itself varies with the tax rate, an increase in the latter usually leads to increasing efforts by taxpayers to reduce their tax burden and, as a consequence, to a reduction of the tax base. Due to these tax-avoidance endeavors, the behavioral effect is negative, which makes the overall effect of a tax rate change on tax revenue ambiguous. In particular, this implies that the marginal effect of a change in the tax rate crucially depends on the exact position on the Laffer-Curve.

Note that, broadly speaking, the behavioral effect induced by a tax change and the corresponding shape of the Laffer-Curve can reflect two types of avoidance activities: domestic and international ones. As to the first type, firms may, in a general sense, respond to higher taxes by reducing overall domestic investment, implying lower profits and, hence, a lower tax base.[15] As to the second type, firms may shift real economic activity and/or paper profits abroad. While the first type of avoidance activities can apply to all kind of firms – purely domestic as well as multinational ones –, the second type is restricted to MNEs.[16] In related literature on the Laffer-Curve, the behavioral response restricted to MNEs is merely embodied implicitly as one of many avoidance activities. Moreover, all previous empirical contributions model a Laffer-Curve where corporate tax revenue is related to domestic determinants only (see, e.g., Clausing, 2007; Steinmüller et al., 2019). On the contrary, a large body of literature (for a survey and a meta-study, see De Mooij and Ederveen, 2003) discusses international investment activities of MNEs as being determined not only by domestic tax rates, but also by the tax rates of foreign countries. To the extent that firms respond to changes in these

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[14]In case of a perfectly inelastic tax base, obviously, the tax would be lump-sum and a revenue-maximizing tax rate would not exist by definition.

[15]Note that tax-avoidance efforts in a broader sense can take numerous forms, comprising different activities that allow a firm to reduce the tax burden. These may include, for example, an increased use of debt financing or shifting part of the tax burden to other production factors (Egger et al., 2014). Moreover, lower aggregate investment may also reflect a (partial) shift of economic activity into the informal sector as a response to a tax increase. This is often observed in developing and newly-industrialized countries, as documented by Rachter et al. (2018), Ulyssea (2018), and Waseem (2018).

[16]It is important to note that this does not imply that all MNEs are equally responsive to corporate tax rates in this context. We discuss this issue in more detail below (Section 3.5).

foreign countries' statutory tax rates, the latter may affect domestic tax revenue. To the best of our knowledge, however, there is no thorough empirical evidence as to this question.

In this context, to what extent would we hence expect that taking into account foreign tax rates in the Laffer-Curve framework could alter the revenue-maximizing statutory tax rate and the corresponding revenue level, compared to a purely domestic setting as in Steinmüller et al. (2019)? First, suppose that we would see significant differences between the predicted Laffer-Curves. This could imply that, at the margin, the majority of firms in one country (country A) respond to changes in, say, country B's tax rate.[17] If this was the case, then these tax-responsive firms would react to a decline in country B's statutory corporate tax rate by shifting economic activity and/or paper profits from country A to country B. This potentially triggers a comparable tax cut in country A, which seeks to prevent severe outflows of taxable profits and, as a consequence, a shrinking tax base. Hence, if firms are mostly responsive to foreign tax rates, then we should see a lower revenue-maximizing corporate tax rate and a lower level of tax revenue associated with this rate. In contrast, if we do not see any sizable difference between the two settings and the respective Laffer-Curves predicted, then this could point towards a very limited responsiveness of firms to foreign statutory tax rates. In this case, a country's tax base and, accordingly, its revenue-maximizing statutory tax rate would not be affected by the competitive pressure of other countries' tax rates.

### 3.3.2 Revenue maximization as government objective

Note that the framework outlined in Section 3.3.1 inherently assumes the maximization of tax revenue as a government's objective. In previous literature, assuming revenue maximization is often referred to as having in mind a Leviathan-type government (e.g., Brennan and Buchanan, 1977; Oates, 1985; Kanbur and Keen, 1993; Haufler and Stähler, 2013; Haufler and Mardan, 2014). In this con-

[17] To be precise, what we measure in our empirical setting is a change in the weighted-average foreign statutory tax rate. This, in turn, is affected by the changes in the (separate) competing countries' tax rates - to intuitively illustrate the mechanisms at play, we may refer to two countries A (domestic) and B (foreign).

text, however, it is important to distinguish between two fundamentally different perceptions of governments in general and (tax) policy-making in particular (Kanbur and Keen, 1993; Edwards and Keen, 1996). On the one hand, a public choice approach would interpret governments as trying to exploit as much revenue as possible out of entirely self-serving motives.[18] On the other hand, one can think of revenue maximization as an act of benevolence with strongly redistributive rather than self-serving intentions.

Regardless of this distinction, a number of reasons can be pointed out to justify that assuming a revenue-maximizing government is appropriate. First, it is a frequently used assumption in the tax competition literature. Second, given the substantial amounts of tax revenue raised in most countries (as illustrated in Section 3.2), it is natural to argue that tax revenue generation is an important objective for governments.[19] Third, and related to the latter, there is considerable public and political pressure on governments to raise adequate revenue from taxing corporate profits. Widespread public attention on issues of international taxation (and the aggressive tax-avoidance activities of large MNEs) has led to far-reaching discontent with the overall tax system and the aim to enforce that firms, and particularly large MNEs, pay their 'fair share' in profit taxes (Haufler and Stähler, 2013; Haufler et al., 2018).

Moreover, from a more theoretical perspective, to what extent is the premise of revenue maximization consistent with plausible assumptions on the preferences of the involved economic agents? Thinking of consumers, the revenue-maximization approach corresponds to a situation in which consumers value consumption of public goods to be financed through tax revenue highly, compared to private good consumption (Kanbur and Keen, 1993; Bucovetsky and Haufler, 2008). A similar reasoning can be brought forward thinking of firms if we argue that they

[18]Another strand of literature pioneered by Oates (1985) interprets competition among governments as a welfare-improving constraint on self-interested Leviathans. This holds true in particular for federal systems with different levels of local government because horizontal fiscal competition restrains the opportunities of Leviathans to channel resources into the public sector.

[19]Note that, in contrast to most previous contributions, we consider countries from all over the world and with different levels of economic development in our empirical analysis. Particularly in developing countries, for which comprehensive empirical studies on tax revenue and its determinants are scarce, a comparatively large share of tax revenue is raised through corporate income taxation (Gordon and Li, 2009; Crivelli et al., 2016).

rely heavily on (i) public goods and services such as infrastructure or the institutional environment, and/or (ii) subsidies and other means of governmental support financed via a tax and transfer system. Accordingly, governments can justify that they are pursuing the goal of tax revenue maximization. In general, revenue maximization with predominantly redistributive motives can also be seen as ascribing a lot of importance to the equity objective of fiscal policy.

One alternative way of modeling a government's objective function would be to additionally include the profits of domestically owned firms. As Haufler and Mardan (2014) argue, such a more general welfare function would then define national welfare as a weighted sum of tax revenue and the sum of net-of-tax profits of domestic firms.[20] Obviously, including firm profits in a government's objective function would lead to a different optimal tax-setting behavior (in terms of lower welfare-maximizing tax rates). However, explicitly taking into account firm profits in the government's (national) welfare function is also subject to plausibility concerns. Empirical evidence indicates that households mostly invest capital through financial intermediaries (e.g., insurance companies, pension or investment funds), leading to highly diversified global portfolios (Haufler and Mardan, 2014). As a consequence, it seems problematic to include 'firm' profits in a government's objective function which is concerned with *national* welfare.

## 3.4 Empirical analysis

### 3.4.1 Estimation approach

As outlined in Section 3.1, empirical investigations of the relationship between statutory corporate tax rates and revenue are generally scarce. Previous contributions, such as Steinmüller et al. (2019), have implemented empirical estimations of the Laffer-Curve focusing on domestic variation only: changes in tax revenue of country $c$ are induced by changes in country $c$'s own tax rate and, indirectly, tax base. The latter is elastic with respect to tax rate changes, reflecting firms' efforts to reduce the tax burden.

[20] The aggregate profits of domestic firms can be assumed to reflect the private (capital) income of a representative domestic consumer (Haufler et al., 2018).

In the empirical analysis of this paper, we explicitly incorporate the notion that corporate tax revenue in one country may be affected by the tax-setting behavior in other countries, competing for mobile tax bases over statutory corporate tax rates. A number of recent empirical papers (see Devereux and Loretz, 2013, for a survey) find evidence for strategic interaction between countries competing over statutory tax rates. This behavioral pattern seems to be, to a considerable extent, responsible for the observed downward trend in corporate taxes. However, no previous contribution has considered the impact of foreign statutory tax rates on corporate tax revenue in an empirical assessment of the Laffer-Curve framework. We do this by relating corporate tax revenue in country $c$ not only to the statutory tax rate in this country, but also to a weighted average of (potential) competitor countries' statutory tax rates.[21] We estimate the following linear regression model, predicting corporate tax revenue from variation in both domestic determinants and international tax-setting behavior:

$$\begin{aligned} TAX\ REVENUE_{c,t} = \alpha + \beta_1 TAX_{c,t} + \beta_2 TAX^2_{c,t} + \beta_3 FTAX^W_{c,t} \\ + \beta_4 GROWTH_{c,t} + Y_t + C_c + \epsilon_{c,t} \end{aligned} \tag{3.4.1}$$

Corporate income tax revenue in percent of GDP ($TAX\ REVENUE_{c,t}$) in country $c$ and at time $t$ is modeled as a function of the following observable determinants. $TAX_{c,t}$ is the statutory corporate tax rate in country $c$ and period $t$, where the squared term specification reflects the suggested inverse-U-shaped relationship between statutory corporate tax rate and tax revenue. For each country $c$, $FTAX^W_{c,t}$ is the weighted (indicated by superscript $W$) average of the corporate tax rates of foreign, potential competitor countries.[22] $GROWTH_{c,t}$ is country-level GDP growth per capita, which we include to control for time-varying determinants of corporate tax revenue. Moreover, this ensures that our estimates directly account for potential growth effects induced by a tax cut. $Y_t$ and $C_c$ are year and country effects, respectively. Accounting for these in our estimation, we capture (i) aggregate, year-specific shocks as well as (ii) any po-

[21] Note that we focus on the relationship between *statutory* corporate tax rates and revenue. In the Appendix, we discuss the robustness of our results to the use of *effective* (average and marginal) tax rates.

[22] We provide more details on the employed weighting schemes below.

tentially confounding, time-invariant country-specific characteristics, including political and institutional aspects which may be of particular importance in the context of tax revenue collection. Hence, we remove all cross-sectional variation between countries, and identification is based on variation over time.

Let us go into more detail on how we construct the composite competitor tax rate:

$$FTAX_{c,t}^{W} = \sum_{j=1,j\neq c}^{N} w_{c,j} TAX_{j,t} \tag{3.4.2}$$

From the perspective of country $c$, $FTAX_{c,t}^{W}$ is a linear combination of other ($j = 1, ..., N$, and $j \neq c$) countries' corporate tax rates in the given period $t$, with weights $w_{c,j} \geq 0$. Moreover, $\sum_{j=1,j\neq c}^{N} w_{c,j} = 1$, i.e., weights sum up to unity. It is important to note that these weights are not estimated but defined a priori (Overesch and Rincke, 2011; Redoano, 2014).[23] In the empirical tax competition literature, spatial weighting matrices have been defined according to a number of different approaches. The specific weighting scheme is crucial in the sense that it reflects what we consider an appropriate choice of the relevant foreign tax rates exerting competitive pressure between countries (Devereux and Loretz, 2013). A first parsimonious method in early work by Devereux et al. (2008) is to assume a uniform weighting scheme, meaning that the tax rates of all other countries in a given year affect country $c$'s tax policy alike. This, however, does not seem suitable in our large country sample for two reasons. First, in this case, the composite competitor tax is (almost) collinear to a year effect which is common to all countries. In other words, it would be impossible to identify the effect of a change in the (average) competitor tax rate separately from a year effect.[24] Second, from an intuitive perspective and also based on the theoretical tax competition literature, it is natural to assume a heterogeneous impact of different countries' tax policies on a given country $c$'s tax revenue. To account for this heterogeneity, most of the previous contributions, such as Egger et al. (2005), Heinemann et al. (2010), Overesch and Rincke (2011), Redoano (2014),

[23] As illustrated in Equation (3.4.2), all weights employed in the various specifications in our empirical analysis are constant over time. We address this issue in more detail below.

[24] Instead, omitting the year effects in the estimation equation would imply that the effect attributed to $FTAX_{c,t}^{W}$ rather measures a common, year-specific shock.

and Egger and Raff (2015), have employed weights that are predetermined based on some measure of inverse geographical distance. This can be justified by robust empirical evidence that distance has a negative effect on FDI.[25]

Apart from geographical distance, one can also think of other (inverse) distance measures that determine the degree of interdependencies between different countries' tax policies. For example, Mardan (2018) argues that tax competition between 'similar' countries is more intense because many MNEs have the greater part of their affiliates located in countries with a similar level of development.[26] Following this notion, one can construct bilateral inverse-'distance' measures for two countries $c$ and $j$ with respect to economic development, measured by, for example, GDP per capita levels or GDP per capita growth rates.

We can capture a more general idea of 'distance' ($DIST_{c,j}$) between two countries $c$ and $j$ to illustrate how the weights are constructed. For a total of $N$ countries, the row-normalized element $w_{cj}$ of the spatial weighting matrix gives us the weight assigned to the tax rate of country $j$ from the perspective of country $c$:

$$w_{c,j} = \frac{\frac{1}{DIST_{c,j}}}{\sum_{k=1,k\neq c}^{N} \frac{1}{DIST_{c,k}}} \tag{3.4.3}$$

Let us finally address one potential concern with regard to the choice of appropriate weights. It is important that the predetermined weighting scheme guarantees a separate identification of the effect of changes in the foreign statutory tax rates. More specifically, we have to make sure that changes in the weighted-average competitor tax rate $FTAX_{c,t}^{W}$ are only driven by changes in foreign countries' taxes and not in the weights. This is why, in all weighting schemes employed, we rely on time-constant spatial weights. If the latter are defined according to geographical distance, this is not an issue, as geographical distance is constant

[25] Seminal contributions in this regard include, e.g., Carr et al. (2001), Markusen and Maskus (2002), and Blonigen and Piger (2014). Baier and Bergstrand (2001) highlight that transport costs are closely related to geographical distance. Portes and Rey (2005) emphasize that, on top of that, distance also increases information costs, which may additionally hamper FDI. Furthermore, previous contributions, such as Overesch and Rincke (2011), have argued that also pure paper-profit shifting should be inversely related to geographical distance. While this is probably true when we think of intra-firm trade, transactions and transfer pricing, recent developments with regard to information and communication technologies may to some extent mitigate the influence of geographical distance in the context of profit shifting.

[26] Particularly in the case of horizontal FDI, this view is supported by empirical evidence (e.g., Becker et al., 2005; Buch et al., 2005; Krautheim, 2013).

over time by definition and can therefore be safely considered exogenous in this context. In case of other measures, such as the ones based on distance in terms of GDP per capita or GDP growth per capita, we cannot use year-specific values of, for example, GDP per capita and GDP growth per capita distances to construct year-specific weights. Doing so would imply that changes in $FTAX^{W}_{c,t}$ may originate from both changes in the determinants of the weights and changes in foreign tax rates, which means that we would get biased estimates of the tax competition effect (Overesch and Rincke, 2011). To overcome this problem in our analysis, we use the averages of GDP per capita and GDP growth per capita distances between two countries in the sample period. This should still provide a suitable measure for (average) 'distance' between countries in this context, while ensuring that variation in $FTAX^{W}_{c,t}$ comes from changes in tax rates only.

### 3.4.2 Data

For our empirical analysis, we create a rich dataset with 1,247 observations from 134 countries for the years 2004 to 2014, relying on several sources. This dataset mainly includes self-collected tax data (see Steinmüller et al., 2019, for more information) and data provided by international organizations.[27] Statutory corporate tax rates are self-collected from various sources and tax revenue data are taken from the IMF's World Revenue Longitudinal Data (WoRLD). Information on GDP growth per capita is provided by the World Bank's World Development Indicator (WDI) database.

To calculate the spatial weights determining the respective average competitor countries' tax rates, we rely on information from two sources, depending on the particular weighting scheme. In case of weights defined according to inverse geographical distance, we use the geodesic distance between the most populated cities or agglomerations of two countries, provided by the CEPII GeoDist Database.[28] The latter database also includes the information on countries' population size, which we use in alternative calculations of the weighting matrices. In further specifications, we impose weights based on the similarity of countries with re-

[27]Table 3.A.1 in the Appendix summarizes all variables and their respective sources.
[28]For more information on the CEPII data, see Mayer and Zignago (2011).

spect to economic development and wealth. To this end, we use data from the World Bank's WDI database: GDP and GDP per capita as well as a classification scheme for countries according to their regional location and information on whether a country is an OECD member.

### 3.4.3 Results

In this subsection, we present the findings from our empirical analysis, estimating to what extent a country's corporate tax revenue is related to the various determinants outlined in Section 3.4.1 above. Table 3.4.1 displays regression results in this regard. In all specifications, we account for outliers potentially distorting our predictions by omitting the observations with the 1% largest values of the dependent variable.[29]

In the first column, for the sake of comparability, we include a specification in the spirit of Steinmüller et al. (2019), where tax revenue is modeled as a function of domestic determinants only. In all other empirical specifications, however, we explicitly incorporate the notion that tax revenue in one country may as well be affected by the tax-setting behavior of other countries. Hence, the estimates provided in column 1 serve as a benchmark in the analysis of the results of all other empirical specifications below. Other countries' tax-setting behavior is reflected by the weighted averages of competitor countries' tax rates, $FTAX_{c,t}^{W}$. The specifications in columns 2 to 4 differ with respect to the choice of the weighting matrix. We first employ weights based on the inverse squared geographical distance between countries to calculate $FTAX_{c,t}^{W}$. Thereafter, we impose two different similarity measures – the 'distances' between two countries with respect to GDP per capita and GDP growth per capita, respectively – to determine the weighted-average foreign tax rate.

[29]Note, however, that our results are robust against using (i) the full sample of observations and (ii) alternative outlier treatments (see Tables 3.A.3, 3.A.4, and 3.A.5 in the Appendix.)

Table 3.4.1: *Laffer-Curve estimates (OLS regressions)*

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Weights based on... | | inverse squared geographical distance | inverse GDPPC distance | inverse GDP growth distance |
| $TAX_{c,t}$ | 10.26*** | 10.39*** | 9.905*** | 10.26*** |
| | (3.214) | (3.218) | (3.233) | (3.215) |
| $TAX^2_{c,t}$ | -16.58*** | -16.74*** | -16.07*** | -16.54*** |
| | (5.828) | (5.832) | (5.851) | (5.832) |
| $GROWTH_{c,t}$ | 0.0194** | 0.0197** | 0.0194** | 0.0194** |
| | (0.00869) | (0.00869) | (0.00869) | (0.00869) |
| $FTAX^W_{c,t}$ | | -1.578 | -2.455 | 0.748 |
| | | (2.033) | (2.448) | (2.306) |
| $Constant$ | 1.202*** | 1.608** | 1.940** | 0.990 |
| | (0.464) | (0.699) | (0.869) | (0.803) |
| Year effects | Yes | Yes | Yes | Yes |
| Country effects | Yes | Yes | Yes | Yes |
| Observations | 1,234 | 1,234 | 1,234 | 1,234 |
| Adj. R-squared | 0.8369 | 0.8368 | 0.8369 | 0.8368 |

The dependent variable in all specifications is $TAX\,REVENUE_{c,t}$. Standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

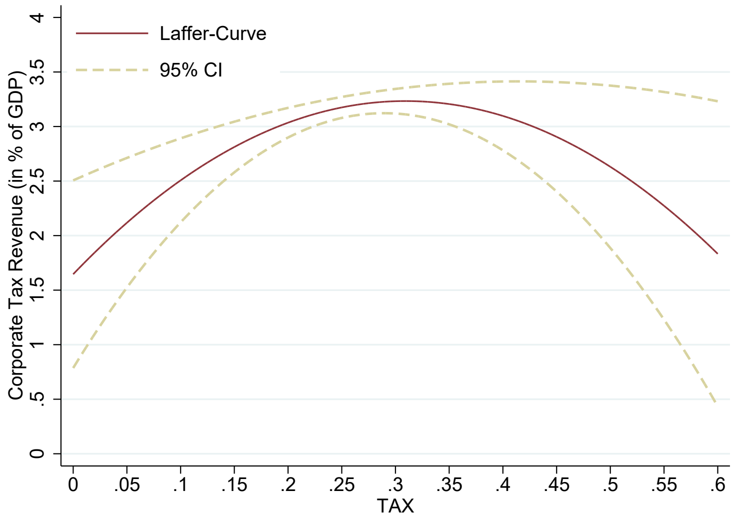
The results in the first column are in line with previous contributions, suggesting a highly significant inverse-U-shaped Laffer-Curve relationship between tax revenue and tax rate (Clausing, 2007; Steinmüller et al., 2019).[30] The estimates presented in columns 2 to 4 provide two main insights. First, the coefficients on $TAX_{c,t}$ (positive) and $TAX^2_{c,t}$ (negative) are both highly significant. This indicates that tax-avoidance activities imply a robust Laffer-Curve relationship, also when controlling for other countries' tax rates. Second, no matter which weighting scheme is applied, we do not see any significant effect of the average competitor tax rate on tax revenue in a given country. Quantitatively, the coefficients on $TAX_{c,t}$ and $TAX^2_{c,t}$ are very close to those in the first specification. Together with the fact that there is no significant relation between tax revenue and the competitor tax rates, this suggests a similar shape of the Laffer-Curves.[31]

[30] To be precise, however, results differ quantitatively compared to Steinmüller et al. (2019) because (i) we drop outliers from the sample and (ii) we use a more comprehensive sample (134 compared to 112 countries). Nevertheless, the qualitative insights are the same.

[31] Note that, apart from these two insights which are crucial to our research question, the results for all specifications in Table 3.4.1 show that $GROWTH_{c,t}$ is positively related to tax revenue, as expected. Moreover, controlling for $GROWTH_{c,t}$ implies that our estimates of the Laffer-Curve already take into account potential growth effects induced by a tax cut.

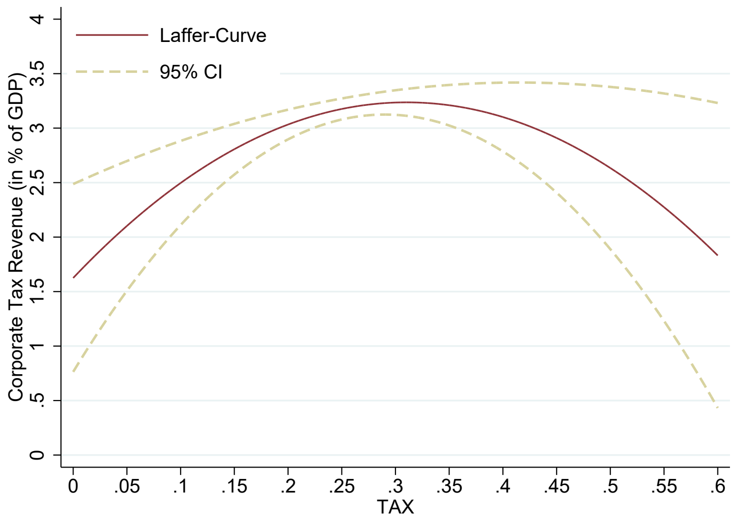
An immediate impression from this result is that the domestic tax policy trade-off reflected by the link between (own) statutory tax rate and tax revenue is virtually not affected by the competitive pressure from other countries. In order to elaborate on this finding, we provide further illustrations of our results in the following. In Figures 3.4.1 and 3.4.2, we depict the predicted Laffer-Curves for the estimates in column 1 (domestic determinants only) and 2 (controlling for geographical distance-weighted competitor tax rates), respectively.

Figure 3.4.1: *Laffer-Curve (Table 1, column 1), domestic determinants only*




*Notes:* The solid line depicts the predicted revenue curve, the dashed lines indicate the 95% confidence intervals (CI) of our estimates.

Figure 3.4.2: *Laffer-Curve (Table 1, column 2), including foreign tax rates*




*Notes:* The solid line depicts the predicted revenue curve, the dashed lines indicate the 95% confidence intervals (CI) of our estimates.

One can see that the shape as well as the position of the predicted revenue curves are indeed very similar.[32] The estimated revenue-maximizing statutory corporate tax rates are 30.94% and 31.03%, respectively, the corresponding predicted maximum corporate tax revenues are 3.23% and 3.24% of GDP.

One finding of Steinmüller et al. (2019) is that the tax rates actually observed are, on average, considerably lower than the revenue-maximizing rates. This is consistent with the extensive tax competition literature and the idea that competition forces imply lower statutory tax rates, which was a central motivation to explicitly control for other countries' tax rates in the empirical approach of the study at hand. However, the Laffer-Curve in Figure 3.4.2 shows that taking into account the competitive pressure of other countries' tax-setting behavior still leads to a revenue-maximizing rate (31%) which is significantly higher than the global average statutory tax rate over the whole time period in our sample (25.8%). While cross-country tax competition may still be a driving force behind this pattern, our results indicate that these comparatively low rates are far from optimal in the sense of the Laffer-Curve. The estimates in Table 3.4.1 and the corresponding Figures 3.4.1 and 3.4.2 suggest that taking into account the effects of competing countries' tax rates on the rate-revenue relationship reflected by the Laffer-Curve neither affects the revenue-maximizing tax rate nor the corresponding tax revenue. In other words, even if strategic interaction between countries drives down the equilibrium statutory tax rate, our predicted Laffer-Curves controlling for this competitive pressure show that tax revenue is not maximized at such a low rate. We discuss this result at length in Section 3.5, where we provide several explanatory approaches for our findings and underpin the plausibility of the latter with additional descriptive statistics.

### 3.4.4 Sensitivity analysis

We assess the robustness of our empirical results against several alternative specifications outlined in the following. First, we employ different weighting schemes to calculate the weighted averages of competitor countries' statutory tax rates.

[32] We include 95% confidence bands in the figures. The predicted revenue curves are precisely estimated, as statutory tax rates in the majority of countries are in a range where the confidence bands are rather narrow.

More specifically, we use alternative weighting metrics which can be classified in the context of the broad distinction between some form of geographical proximity on the one hand, and similarity with respect to economic development on the other hand. As to the first category, we include a measure where the inverse geographical distance between countries determines the weight assigned to a specific (foreign) country's tax rate (Table 3.4.2, column 1). Compared to using the squared inverse distance as above, naturally, this implies that the assigned weights do not decline as strongly with distance. Moreover, additionally incorporating size and market potential of foreign countries, we calculate (log) population-adjusted squared distance weights and (log) GDP-adjusted squared distance weights (Table 3.4.2, columns 2 and 3, respectively).[33] In any case, it is advisable to test whether our main results are robust against modifications with respect to the exact measure of geographical distance employed.[34]

Furthermore, in Table 3.4.3, we include four alternative foreign tax measures, where, along two criteria, we narrow the set of foreign countries a given country (potentially) competes with. First, we only take into account the statutory tax rates of countries in the same world region, weighted by (i) the inverse squared geographical distance and (ii) the inverse 'distance' of two countries with respect to GDP per capita (Table 3.4.3, columns 1 and 2, respectively).[35] Second, distinguishing between countries according to economic development, we calculate average foreign tax rates based on the notion that OECD countries only compete with other OECD countries, and vice versa for non-OECD countries.[36] Again, and in addition to this binary distinction, we weight the tax rates within the two

[33]Taking into account country size and market potential in the weights is a common way to capture the idea that 'large' countries are usually assumed to be stronger and more important competitors than smaller ones (see, e.g., Overesch and Rincke, 2011; Egger and Raff, 2015).

[34]Note that we do not implement a weighting scheme based on the so-called contiguity criterion of a common border. This is a frequently used approach in the literature on spatial competition on a more local level (see, e.g., Case et al., 1993; Egger et al., 2005). At the country level, however, this is rather inappropriate, due to the fact that a non-negligible share of the countries in our sample are islands or only have maritime borders with closely connected economies (e.g., Sweden and Denmark).

[35]Following the classification scheme in the World Bank's WDI data, we distinguish between 7 regions: North America, Latin America and Caribbean, Europe and Central Asia, Middle East and North Africa, Sub-Saharan Africa, South Asia, and East Asia and Pacific.

[36]Note that the distinction between OECD and non-OECD countries is almost congruent with the World Bank's former categories of 'developed' and 'developing' countries, which it stopped using in 2016.

groups by (i) the inverse squared geographical distance and (ii) the inverse 'distance' of two countries with respect to GDP per capita (Table 3.4.3, columns 3 and 4, respectively). Tables 3.4.2 and 3.4.3 present the results of the estimations using the average foreign tax rates based on these alternative weighting matrices.

Table 3.4.2: *Laffer-Curve estimates: alternative weighting schemes (1)*

| | (1) | (2) | (3) |
|---|---|---|---|
| Weights based on... | inverse geographical distance | inverse squared population-adjusted geographical distance | inverse squared GDP-adjusted geographical distance |
| $TAX_{c,t}$ | 10.57*** | 10.44*** | 10.26*** |
| | (3.223) | (3.218) | (3.216) |
| $TAX^2_{c,t}$ | -16.96*** | -16.79*** | -16.59*** |
| | (5.835) | (5.831) | (5.831) |
| $GROWTH_{c,t}$ | 0.0203** | 0.0198** | 0.0194** |
| | (0.00872) | (0.00869) | (0.0087) |
| $FTAX^W_{c,t}$ | -7.512 | -2.277 | -0.0696 |
| | (6.138) | (2.158) | (1.852) |
| *Constant* | 3.190* | 1.802** | 1.221* |
| | (1.689) | (0.733) | (0.679) |
| Year effects | Yes | Yes | Yes |
| Country effects | Yes | Yes | Yes |
| Observations | 1,234 | 1,234 | 1,234 |
| Adj. R-squared | 0.8370 | 0.8369 | 0.8367 |

The dependent variable in all specifications is $TAX\ REVENUE_{c,t}$. Standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

Similar to Table 3.4.1, we see that throughout all specifications in Tables 3.4.2 and 3.4.3, the weighted-average competitor countries' tax rate does not have a significant effect on corporate tax revenue. Overall, the estimates clearly show that the main results presented in Table 3.4.1 are robust against these alternative weighting schemes. Thus, we can safely argue that the empirical findings are not specific to the metrics employed in this regard.

Table 3.4.3: *Laffer-Curve estimates: alternative weighting schemes (2)*

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Weights based on... | same world region, inverse squared geographical distance | same world region, inverse GDPPC distance | OECD/non-OECD, inverse squared geographical distance | OECD/non-OECD, inverse GDPPC distance |
| $TAX_{c,t}$ | 10.57*** | 10.21*** | 10.32*** | 10.19*** |
| | (3.219) | (3.217) | (3.215) | (3.228) |
| $TAX^2_{c,t}$ | -17.01*** | -16.52*** | -16.61*** | -16.46*** |
| | (5.831) | (5.832) | (5.829) | (5.855) |
| $GROWTH_{c,t}$ | 0.0202** | 0.0193** | 0.0196** | 0.0194** |
| | (0.00870) | (0.00870) | (0.00869) | (0.00869) |
| $FTAX^W_{c,t}$ | -2.709 | -1.699 | 0.919 | -0.584 |
| | (1.812) | (2.044) | (1.970) | (2.408) |
| *Constant* | 1.897*** | 0.958 | 1.661** | 1.376 |
| | (0.657) | (0.699) | (0.721) | (0.852) |
| Year effects | Yes | Yes | Yes | Yes |
| Country effects | Yes | Yes | Yes | Yes |
| Observations | 1,234 | 1,234 | 1,234 | 1,234 |
| Adj. R-squared | 0.8371 | 0.8368 | 0.8368 | 0.8367 |

The dependent variable in all specifications is $TAX\ REVENUE_{c,t}$. Standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

A further way to assess the sensitivity of the empirical results is to test whether different outlier treatments, i.e., the removing of the most extreme values of the dependent variable, alter our findings.[37] Tables 3.A.3, 3.A.4, and 3.A.5 in the Appendix provide results in this regard. The latter show that outliers do not drive our estimates, which are robust against (i) making use of the full sample of observations (Table 3.A.3) and (ii) different outlier treatments (Tables 3.A.4 and 3.A.5).

Taken together, the empirical results presented in this section suggest a very robust pattern concerning the relationship between a country's corporate tax revenue and international statutory tax incentives. Our estimates indicate that tax-avoidance activities give rise to a Laffer-Curve relationship which is insensitive to the inclusion of other, potentially competing countries' statutory tax rates in the estimation equation. We do not observe any significant effect of these weighted-average competitor tax rates on tax revenue in a given country. This

[37]Tables 3.A.1 and 3.A.2 in the Appendix provide descriptive statistics of (among others) the dependent variable, indicating that outliers may potentially affect our estimation results.

result proves to be very robust against the use of alternative weighting schemes and outlier treatments. Moreover, comparing these results to a purely domestic setting as in Steinmüller et al. (2019), the graphical illustrations of our predictions (Figures 3.4.1 and 3.4.2) show that the corresponding Laffer-Curves have a very similar position as well as shape and, as a consequence thereof, suggest virtually identical revenue-maximizing tax rates.

Considering these findings, a preliminary conclusion from a tax-policy perspective is that international tax competition forces should not play a defining role in single countries' tax-setting behavior. To put it differently, if a country considers a marginal change in its corporate tax rate, this decision should not be driven by other countries' tax-setting behavior, but mainly be based on the country's current location on the Laffer-Curve.[38] At first sight, this may seem to be a fairly strong conclusion. This is particularly true in the light of the far-reaching policy debate centered around international corporate tax competition and mobile tax bases and the fact that many countries feel pressured to respond to statutory tax cuts in other countries. Given the empirical results presented in this section, however, such a tax-setting behavior may lead to adverse outcomes in terms of tax revenue, even when taking into account positive growth effects induced by a tax cut.

## 3.5 Explanatory approaches

How can we explain that, taking into account the competitive pressure exerted by changes in other countries' statutory tax rates, the Laffer-optimal, revenue-maximizing tax rate is still considerably higher than the mean value of the corporate tax rate in our data? In the following, substantiated by descriptive evidence and findings in previous contributions, we present some explanations and interpretations of our empirical results with respect to the Laffer-Curve. First and foremost, we discuss the responsiveness of firms to foreign tax rates and scrutinize the role and the relative importance of MNEs in this context.

[38] More precisely, a country is typically located to the left or to the right of the Laffer-Curve's maximum point. A country's specific location hence determines the so-called 'distance to the peak', which provides a quantification of potential revenue gains in case of a move to the peak (Trabandt and Uhlig, 2011; Strulik and Trimborn, 2012).

Our empirical results suggest that the majority of firms seems to be rather insensitive to foreign statutory tax rates, because for a country, even if the own tax rate remains rather high, the tax base is sufficiently large to generate more tax revenue as with a lower tax rate. To further explain this finding, it seems worthwhile to take a closer look at the specific firm characteristics which are crucial in this context. First, foreign tax rates are irrelevant for purely domestic firms.[39] In this regard, note that domestic firms still account for 72% of global GDP and 67% of global output (Cadestin et al., 2019).[40] While these numbers may seem surprisingly high, given the on-going, controversial discussions about the dominating role of MNEs in the global economy, note that this by no means contradicts the trend towards increasingly globalized economies and the proliferation of MNEs. The latter is undeniable, as we have seen an unprecedented surge of MNEs in the last decades. Moreover, also domestic firms are often active on international markets and participate in global value chains. In the context of the specific question whether a firm is sensitive to foreign corporate taxes, however, the high share of purely domestic firms simply indicates that the majority of firms is, most likely, not responsive at all in this regard.[41]

Furthermore, as OECD (2017) and Cadestin et al. (2019) highlight, most of

[39] To be precise, this is only correct if we abstract from (i) ex ante purely domestic firms that decide to establish a foreign affiliate, possibly for tax-optimization reasons, and (ii) general equilibrium effects and spillovers resulting from the activities of firms affected by the respective foreign taxes, which in turn influence purely domestic firms.

[40] The contribution by Cadestin et al. (2019) draws on the OECD Analytical AMNE database and distinguishes between three types of firms: domestic non-MNEs, i.e., domestic firms which do not have any affiliates abroad (accounting for 72% of global GDP and 67% of global output), domestic MNEs, i.e., MNEs' headquarters and domestic affiliates (18% of GDP and 21% of output), and foreign-owned MNE affiliates (10% of GDP and 12% of output). As to the total, global number of firms, obviously, no precise information exists. The most recent available data on the number of MNEs date back to 2010, estimating the number of MNE parent corporations to amount to roughly 103,000, with almost 900,000 affiliates (UNCTAD, 2010).

[41] Apart from measuring the share of domestic and multinational firms in terms of GDP and output, it would be of particular interest to know how large the shares of the respective firm types are when it comes to (aggregate) corporate taxes paid, as these determine the tax base of a country. Unfortunately, such data are not available to the author, neither from the OECD AMNE database, nor from firm-level databases like *Orbis*. The latter generally includes firm-level information on annual corporate taxes paid. However, aggregating this information provides misleading results for two reasons. First, firm coverage for a lot of newly-industrialized and developing countries is generally poor in the *Orbis* data. Second, in particular for the latter countries, there is an overrepresentation of larger firms in general, and MNEs in particular.

these domestic firms are small and medium-sized enterprises (SMEs).[42] This has two main implications: first, thinking about potential dynamics in our context, most SMEs probably remain purely domestic firms. Setting up foreign affiliates is associated with internationalization costs (Lu and Beamish, 2001). Thus, going abroad is much less likely for SMEs, as, in contrast to large MNEs, SMEs often face more severe financial and managerial constraints (Beck and Demirgüc-Kunt, 2006). Second, SMEs are typically much smaller than MNEs, or, to be precise, the single entities of an MNE. Recent contributions, such as Egger et al. (2014), Davies et al. (2018), and Tørsløv et al. (2018), not only find that the median MNE affiliate tends to be considerably larger, but, in addition, a few very large MNEs contribute an overproportionally high share to GDP. This implies that if one considers the sheer number of firms rather than the share in GDP or output, then purely domestic firms outnumber MNE affiliates even more clearly.

While the irrelevance of foreign tax rates for purely domestic firms is straightforward, the case is less clear-cut for MNEs.[43] In general, one could think that MNE affiliates in country A respond to a statutory tax reduction in country B by relocating investment capital and taxable profits to country B. This seems particularly straightforward if the respective MNE already has an affiliate in country B. Nonetheless, it may also be the case that the tax reduction in country B induces the MNE to set up a new foreign affiliate in this very country. Provided that such (tax-motivated) relocations of capital are common, MNEs could be considered to react sensitively to international corporate taxes. A meta-study of empirical contributions in this regard, provided by De Mooij and Ederveen (2006), suggests a median semi-elasticity of MNEs' foreign investments with respect to the host country's corporate tax rate of -2.1. This means that a one-percentage-point increase in a country's tax rate is, on average, associated with a 2.1% decrease in

[42] Given the fact that we employ a very large country sample, we consider both developed, newly-industrialized, and developing economies. Particularly in the latter, purely domestic SMEs constitute the vast majority of firms (Lediga et al., 2019).

[43] In the following, speaking about MNEs and their behavioral responses to tax rates, we think of any corporate entity which is part of a multinational group, i.e., an MNE's domestic and foreign affiliates as well as its headquarters.

FDI in the respective country.[44]

However, several reasons give rise to the hypothesis that this view may be too simplistic. First, other meta-studies suggest substantially different median semi-elasticities (see, e.g., De Mooij and Ederveen, 2003; Feld and Heckemeyer, 2011). Second, the authors of these meta-studies highlight that, in general, the findings in the papers considered vary a lot, depending on the empirical specification and the data employed. Hence, the tax responsiveness of MNE investment is expected to be very heterogeneous, and fundamentally influenced by the specific characteristics of the respective MNE (Egger et al., 2014). Third, previous contributions elaborate on the heterogeneity of MNEs' tax responsiveness in relation to tax avoidance and profit shifting (Desai et al., 2006; Hong and Smart, 2010; Egger et al., 2014; Behrendt and Wamser, 2018). In a nutshell, these contributions find that the corporate tax responsiveness of MNEs is declining in their ability to shift profits. Hence, the extent to which statutory tax rates matter for MNEs depends on the degree to which these MNEs are able to avoid taxes. In the limit case where an MNE is able to fully avoid taxes, its tax burden and, thus, its tax responsiveness is zero (Egger et al., 2014). Naturally, however, MNEs differ with respect to their ability to avoid taxes. Moreover, not all affiliates should be equally able to engage in avoidance activities. As a firm's ability to avoid corporate taxes by shifting profits is inherently unobservable, it is difficult to precisely quantify the share of tax-avoiding MNEs and the tax elasticities of investment for different types of MNEs. The approach taken by Egger et al. (2014) is, to the best of our knowledge, the only one being able to identify two latent groups of MNEs: 'non-avoiders', for which investment is negatively affected by (host-country) corporate taxes, and 'avoiders', for which investment proves to be unresponsive to

[44] We are perfectly aware that this tax-semi-elasticity is concerned with, specifically, FDI and host country taxes. What we have in mind (and implicitly consider in our empirical analysis) is, first of all, the question whether statutory tax rates in country B generally matter for MNE activity (and ultimately tax revenue) in country A. However, from a more general perspective, suppose that, in the spirit of De Mooij and Ederveen (2006), MNE affiliate investment is sensitive to profit taxation in the host country. In this case, it seems plausible to think that MNEs' investment decisions are generally distorted by corporate tax rates. Hence, MNE activity in one country should also be sensitive to other, competing countries' tax rates as investment capital may be relocated within the network of MNE affiliates.

taxes.[45] Along this binary distinction, the authors find further notable differences between MNE affiliates. Non-responsive, tax-avoiding affiliates are, on average, significantly larger and belong to multinational groups with considerably more affiliated entities.

While not distinguishing explicitly between two groups within the universe of MNEs, the empirical results in Desai et al. (2006) and Behrendt and Wamser (2018) are consistent with Egger et al. (2014): larger, globally more diversified MNEs tend to be much less tax-responsive. In a similar vein, using firm-level data on French-based MNEs, Davies et al. (2018) find that a comparatively small number of very large firms accounts for the vast majority of tax-avoidance activities. Moreover, taxes are, for the most part, avoided by manipulating intra-MNE transfer pricing schemes and, by this means, shifting profits to tax haven countries. The fact that the bulk of MNEs' tax avoidance does not occur by relocating economic activity or shifting profits between 'similar' – and hence 'competing' – countries indicates that marginal changes in the statutory tax rates of 'similar' countries are not important for MNEs, as long as they are able to avoid taxes anyway.

Taken together, this section has provided some key insights that help us to interpret our empirical results, in particular when it comes to the underlying behavioral responses of firms to foreign corporate taxes. We have highlighted a number of observations which, from an aggregate perspective of a specific country, rationalize a very limited relevance of other countries' statutory tax rates for optimal tax-setting behavior. First, purely domestic firms still account for the bulk of economic activity within a country, measured by the number of firms as well as in terms of a country's economic fundamentals such as GDP and output. Second, MNEs and their affiliates should be seen as a heterogeneous mass of firms, which crucially differ with respect to their responsiveness to corporate taxes. Previous evidence clearly suggests that a sizable fraction of mostly large and globally diversified MNEs is, to the greatest extent, unresponsive to corporate

[45] Egger et al. (2014) analyze a sample of German MNEs and their foreign affiliates for the period of 1999 to 2010, relying on Census-type data from the Microdatabase Direct Investment (MiDi) provided by the German Central Bank. They find that 11% of the German-owned foreign affiliates prove to be unresponsive to corporate taxes, however, these affiliates account for 58% of the stock of foreign fixed assets.

taxes due to their distinct ability to avoid them.[46] All in all, this seems consistent with the conclusion drawn from our empirical analysis that probably only a minor fraction of all firms responds to changes in foreign tax rates. Coming back to the aggregate country perspective taken in our empirical approach, this implies that the tax base and, as a consequence, the tax revenue a country is able to generate are, on average, not responsive to foreign tax rates.

## 3.6 Conclusions

The last decades have witnessed a steady decline in statutory corporate tax rates, which has mostly been explained by international tax competition and the notion that taxing mobile tax bases has become more and more difficult. While the downward trend in statutory corporate tax rates seems to have slowed down in the last few years, it is expected to strengthen again, with many countries planning to cut tax rates as a reaction to the recent US tax reform. This development gives rise to concerns about adverse revenue effects on a larger scale.

Focusing on corporate taxation, this study contributes to a better understanding of the revenue consequences of changes to the international tax system. We first demonstrate that the amount of (total) tax revenue countries raise from different sources is substantial. Taking into consideration that governments face a budget constraint, raising sufficient tax revenue is essential, as public expenditures are, to a large extent, financed with tax revenue. Second, we take a closer look at the link between international statutory tax incentives and tax revenue. Previous approaches suggest an inverse-U-shaped Laffer-Curve relationship between a country's statutory corporate tax rate and tax revenue, which can be explained by inefficiencies and distortions induced by the tax system. Using a comprehensive dataset for 134 countries, we extend this framework to an inter-

[46] The finding that some (often very large) MNEs seem to be non-responsive to corporate taxes entails an immediate policy implication in the context of international tax competition and the current, widespread efforts to prevent profit shifting. Suppose that, as recently recommended by the OECD's BEPS proposal, countries would successfully implement and enforce anti-tax-avoidance-rules to prevent profit shifting. This would make the share of formerly tax-insensitive MNEs tax-sensitive, as the ability to avoid taxes is vastly restricted. As a consequence, this would most likely lead to intensified tax competition between countries over the highly mobile assets and affiliates of these MNEs, implying a further downward pressure on statutory corporate tax rates (Egger et al., 2014).

national context and estimate Laffer-Curves, modeling corporate tax revenue as a function of the domestic statutory tax rate (and its squared term) and, in addition, a weighted average of other, competing countries' statutory tax rates.[47] Our empirical results suggest that taking into account other countries' tax rates has no significant effect on corporate tax revenue. Moreover, compared to the results of Steinmüller et al. (2019), we see that, on average, controlling for foreign tax rates neither affects the revenue-maximizing tax rate predicted by the Laffer-Curve nor the corresponding maximum tax revenue. This result proves to be very robust against the use of a wide range of different weighting schemes for the composite competitor tax rate and alternative outlier treatments. We present a number of stylized facts, descriptive statistics, and references to previous research in order to further explain our empirical finding that, from the perspective of a single country, the relevance of other countries' tax rates is rather limited. First, on a global scale, the vast majority of firms are still purely domestic ones. Second, MNEs differ considerably in terms of their responsiveness to statutory tax incentives. In particular, large and globally active MNEs are mostly able to engage in comprehensive tax-avoidance activities, implying a low level of sensitivity to statutory taxes.

From a tax-policy perspective, our empirical results entail that international tax competition and, as a consequence thereof, concerns about shrinking tax bases should not play a dominating role in a country's optimal tax-setting behavior. However, our results indicate that precisely this might be the case: the global mean and median tax rates observed in our dataset are considerably lower than the revenue-maximizing tax rates predicted by our Laffer-Curves. International tax competition is likely to be the driving force behind this pattern. However, our estimates show that such strategic tax-setting behavior implies too low tax rates and adverse tax revenue outcomes, even if we explicitly take into account (i) the competitive pressure exerted by other countries' tax setting and (ii) positive growth effects induced by a tax cut. Instead, if a country considers a marginal change in its statutory corporate tax rate, this should be mainly related to the respective country's current rate-revenue combination and, hence, its location

[47] As explained above, in our estimations, we moreover control for GDP growth per capita, country-specific effects, and year effects.

on the Laffer-Curve. In this regard, given that statutory corporate tax rates in the bulk of countries already are considerably below the revenue-maximizing rates predicted by the Laffer-Curve, further tax cuts would most likely imply additional adverse effects on public revenue.

Finally, let us emphasize that our findings, in particular the one that international tax competition should not play the defining role in a country's optimal tax-setting behavior, refer to the statutory corporate tax rate as a policy instrument. From a broader perspective, however, to fully capture the mechanisms of and the behavioral responses to tax policy and tax institutions in an international context, it is necessary to consider how governments further compete over a wide range of other policy instruments at their disposal. The latter include both tax-policy instruments designed to attract firms and investment as well as instruments to restrict the tax-avoidance activities of, in particular, MNEs. Improving our understanding in this complex matter, however, is left to future research.

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# 3.A Appendix

## Descriptive statistics and variable description

Table 3.A.1: *Variables: descriptive statistics and sources*

| Variable | Mean | SD | Min | Max | Description |
|---|---|---|---|---|---|
| $TAX\ REVENUE_{c,t}$ | 3.2494 | 2.7549 | 0.0043 | 25.507 | Corporate income tax revenue (in % of GDP) of country $c$ in period $t$; Source: *IMF WoRLD database* |
| $TAX_{c,t}$ | 0.2583 | 0.0864 | 0 | 0.55 | Statutory corporate tax rate of country $c$ in period $t$ Source: Steinmüller et al. (2019) |
| $GROWTH_{c,t}$ | 2.7008 | 3.9984 | -17.341 | 18.488 | GDP growth per capita of country $c$ in period $t$; Source: *World Bank, WDI database* |
| $FTAX^W_{c,t}$ (sq. geo. dist.) | 0.2445 | 0.0479 | 0.0445 | 0.3526 | For country $c$ in period $t$: weighted-average foreign tax rate (weights based on inverse squared geographical distance) |
| $FTAX^W_{c,t}$ (GDPPC dist.) | 0.2500 | 0.0427 | 0.0325 | 0.3638 | For country $c$ in period $t$: weighted-average foreign tax rate (weights based on inverse GDP per capita distance) |
| $FTAX^W_{c,t}$ (growth dist.) | 0.2555 | 0.0398 | 0.1112 | 0.3656 | For country $c$ in period $t$: weighted-average foreign tax rate (weights based on inverse GDP growth per capita distance) |
| $FTAX^W_{c,t}$ (geo. dist) | 0.2437 | 0.0218 | 0.1787 | 0.3068 | For country $c$ in period $t$: weighted-average foreign tax rate (weights based on inverse geographical distance) |
| $FTAX^W_{c,t}$ (pop-adj. sq. geo. dist.) | 0.2496 | 0.0481 | 0.0483 | 0.3663 | For country $c$ in period $t$: weighted-average foreign tax rate (weights based on inverse squared (log) population-adjusted geographical distance) |
| $FTAX^W_{c,t}$ (GDP-adj. sq. geo. dist.) | 0.2469 | 0.0489 | 0.0380 | 0.3635 | For country $c$ in period $t$: weighted-average foreign tax rate (weights based on inverse squared (log) GDP-adjusted geographical distance) |
| $FTAX^W_{c,t}$ (region; sq. geo. dist.) | 0.2482 | 0.0424 | 0.1352 | 0.3390 | For country $c$ in period $t$: weighted-average foreign tax rate (weights based on inverse squared geographical distance, countries in same region only) |
| $FTAX^W_{c,t}$ (region; GDPPC dist.) | 0.2534 | 0.0607 | 0.0429 | 0.3713 | For country $c$ in period $t$: weighted-average foreign tax rate (weights based on inverse GDP per capita distance, countries in same region only) |
| $FTAX^W_{c,t}$ (OECD; sq. geo. dist.) | 0.2463 | 0.0269 | 0.1527 | 0.3253 | For country $c$ in period $t$: weighted-average foreign tax rate (weights based on inverse squared geographical distance, OECD/non-OECD countries only) |
| $FTAX^W_{c,t}$ (OECD; GDPPC dist.) | 0.2550 | 0.0444 | 0.0234 | 0.3404 | For country $c$ in period $t$: weighted-average foreign tax rate (weights based on inverse GDP per capita distance, OECD/non-OECD countries only) |

For all weighted-average foreign tax rates, we use statutory corporate tax rates from Steinmüller et al. (2019) and information from (i) the *CEPII GeoDist database* (geographical distance and population size) and (ii) the *World Bank's WDI database* (GDP, GDP per capita, GDP growth per capita, regional classification, OECD membership status) to determine the specific weights.

Note that the descriptive statistics in Table 3.A.1 refer to the full sample (1,247 observations for 134 countries). Taking a closer look at the statistics for the dependent variable, $TAX\ REVENUE_{c,t}$, potential concerns about outliers become evident. Referring to the outlier treatments employed in the sensitivity checks presented in Tables 3.A.3 to 3.A.5, the following table illustrates how, in particular, the mean and the maximum of $TAX\ REVENUE_{c,t}$ change if we remove the most extreme values of $TAX\ REVENUE_{c,t}$.

Table 3.A.2: *Descriptive statistics - outliers*

| Variable | Mean | SD | Min | Max | |
|---|---|---|---|---|---|
| $TAX\ REVENUE_{c,t}$ | 3.0664 | 2.0897 | 0.0043 | 17.0469 | [1 % outliers dropped] |
| $TAX_{c,t}$ | 0.2581 | 0.0867 | 0 | 0.55 | |
| $TAX\ REVENUE_{c,t}$ | 2.9589 | 1.7810 | 0.0043 | 11.1473 | [2 % outliers dropped] |
| $TAX_{c,t}$ | 0.2577 | 0.0869 | 0 | 0.55 | |
| $TAX\ REVENUE_{c,t}$ | 2.7708 | 1.4480 | 0.0043 | 7.4953 | [5 % outliers dropped] |
| $TAX_{c,t}$ | 0.2570 | 0.0874 | 0 | 0.55 | |

We see that gradually removing the most extreme values of $TAXREVENUE_{c,t}$ implies considerably smaller maximum and mean values of $TAX\ REVENUE_{c,t}$, while not affecting the distribution of $TAX_{c,t}$ to any substantial extent. Table 3.A.2 reinforces that it is advisable to test whether outliers may drive our empirical results. Tables 3.A.3 to 3.A.5, however, show that this is not the case.

## Sensitivity checks: outliers

Table 3.A.3: *Laffer-Curve estimates (OLS regressions): full sample*

| | (1) | (2) | (3) |
|---|---|---|---|
| Weights based on... | inverse squared geographical distance | inverse GDPPC distance | inverse GDP growth distance |
| $TAX_{c,t}$ | 9.860** | 9.992** | 9.666** |
| | (4.726) | (4.749) | (4.721) |
| $TAX^2_{c,t}$ | -17.51** | -17.74** | -17.19** |
| | (8.565) | (8.595) | (8.564) |
| $GROWTH_{c,t}$ | 0.0432*** | 0.0429*** | 0.0428*** |
| | (0.0125) | (0.0125) | (0.0125) |
| $FTAX^W_{c,t}$ | -2.367 | 2.227 | 1.326 |
| | (2.982) | (3.585) | (3.381) |
| $Constant$ | 1.969* | 0.691 | 0.983 |
| | (1.027) | (1.275) | (1.178) |
| Year effects | Yes | Yes | Yes |
| Country effects | Yes | Yes | Yes |
| Observations | 1,247 | 1,247 | 1,247 |
| Adj. R-squared | 0.7977 | 0.7976 | 0.7976 |

The dependent variable in all specifications is $TAX\ REVENUE_{c,t}$. Standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 3.A.4: *Laffer-Curve estimates (OLS regressions): 2% outlier treatment*

| | (1) | (2) | (3) |
|---|---|---|---|
| Weights based on... | inverse squared geographical distance | inverse GDPPC distance | inverse GDP growth distance |
| $TAX_{c,t}$ | 10.30*** | 9.820*** | 10.08*** |
| | (2.944) | (2.961) | (2.943) |
| $TAX^2_{c,t}$ | -17.04*** | -16.38*** | -16.68*** |
| | (5.335) | (5.357) | (5.338) |
| $GROWTH_{c,t}$ | 0.0269*** | 0.0265*** | 0.0264*** |
| | (0.008) | (0.008) | (0.008) |
| $FTAX^W_{c,t}$ | -2.792 | -1.824 | 1.395 |
| | (1.873) | (2.243) | (2.116) |
| $Constant$ | 1.858*** | 1.686** | 0.742 |
| | (0.643) | (0.797) | (0.737) |
| Year effects | Yes | Yes | Yes |
| Country effects | Yes | Yes | Yes |
| Observations | 1,222 | 1,222 | 1,222 |
| Adj. R-squared | 0.8119 | 0.8116 | 0.8116 |

The dependent variable in all specifications is $TAX\ REVENUE_{c,t}$. Standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 3.A.5: *Laffer-Curve estimates (OLS regressions): 5% outlier treatment*

| | (1) | (2) | (3) |
|---|---|---|---|
| Weights based on... | inverse squared geographical distance | inverse GDPPC distance | inverse GDP growth distance |
| $TAX_{c,t}$ | 9.106*** | 8.611*** | 8.910*** |
| | (2.441) | (2.453) | (2.439) |
| $TAX^2_{c,t}$ | -12.97*** | -12.27*** | -12.57*** |
| | (4.433) | (4.449) | (4.434) |
| $GROWTH_{c,t}$ | 0.0281*** | 0.0277*** | 0.0275*** |
| | (0.0067) | (0.0067) | (0.0067) |
| $FTAX^W_{c,t}$ | -2.263 | -2.228 | 2.167 |
| | (1.550) | (1.855) | (1.754) |
| $Constant$ | 1.530*** | 1.613** | 0.330 |
| | (0.534) | (0.659) | (0.610) |
| Year effects | Yes | Yes | Yes |
| Country effects | Yes | Yes | Yes |
| Observations | 1,184 | 1,184 | 1,184 |
| Adj. R-squared | 0.8059 | 0.8058 | 0.8058 |

The dependent variable in all specifications is $TAX\ REVENUE_{c,t}$. Standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

## Sensitivity checks: effective tax rates

Throughout our analysis in this paper, we focus on the relationship between *statutory* corporate tax rate (STR) and tax revenue. In the following, we present additional results that prove the robustness of our main findings to the use of forward-looking *effective* average and marginal tax rates (EATR and EMTR, respectively), taken from Steinmüller et al. (2019).

While the STR is the simplest indicator for the tax payments to be expected, it neglects the rules determining the tax base. In contrast, effective tax rates (ETRs) are considerably more complex measures which, in addition to the statutory tax rates, take into account the various rules related to the determination of a firm's tax base, such as specific depreciation allowances for different asset types. More precisely, the EATR measures the tax burden on an average investment and constitutes the most accurate indicator in the context of discrete, lumpy investment decisions. In contrast, the EMTR reflects the tax burden on marginal investment projects. In all cases where the way the tax base is determined is not relevant for firms (as, for example, in the context of paper-profit shifting where no real investment is involved), the STR is the appropriate measure (Overesch and Wamser, 2009). Tables 3.A.6 and 3.A.7 present the estimation results using EATRs and EMTRs, respectively. From the perspective of country $c$, $EATR_{c,t}$ and $EMTR_{c,t}$ are the (own) forward-looking effective corporate tax rates, and $FEATR^{W}_{c,t}$ and $FEMTR^{W}_{c,t}$ are the weighted (indicated by superscript $W$) averages of the effective tax rates of foreign, potential competitor countries.

Table 3.A.6: *Laffer-Curve estimates (OLS regressions): robustness (EATRs)*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Weights based on... | | inverse squared geographical distance | inverse GDPPC distance | inverse GDP growth distance | inverse squared population-adjusted geographical distance |
| $EATR_{c,t}$ | 11.60*** | 11.91*** | 11.47*** | 11.40*** | 11.49*** |
| | (3.625) | (3.624) | (3.624) | (3.637) | (3.623) |
| $EATR^2_{c,t}$ | -22.33*** | -22.57*** | -22.13*** | -22.15*** | -22.01*** |
| | (7.651) | (7.642) | (7.648) | (7.658) | (7.650) |
| $GROWTH_{c,t}$ | 0.0325*** | 0.0335*** | 0.0324*** | 0.0324*** | 0.0317*** |
| | (0.00969) | (0.00969) | (0.00969) | (0.00970) | (0.00970) |
| $FEATR^W_{c,t}$ | | -4.896* | -5.550 | -2.476 | 6.246 |
| | | (2.673) | (3.963) | (3.558) | (4.343) |
| $Constant$ | 1.351*** | 2.389*** | 2.628*** | 1.980* | -0.476 |
| | (0.451) | (0.723) | (1.017) | (1.009) | (1.347) |
| Year effects | Yes | Yes | Yes | Yes | Yes |
| Country effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,034 | 1,034 | 1,034 | 1,034 | 1,034 |
| Adj. R-squared | 0.8440 | 0.8444 | 0.8442 | 0.8439 | 0.8442 |

Standard errors in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively. In all specifications, we omit the observations with the 1 % largest values of the dependent variable ($TAX\ REVENUE_{c,t}$).

Table 3.A.7: *Laffer-Curve estimates (OLS regressions): robustness (EMTRs)*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Weights based on... | | inverse squared geographical distance | inverse GDPPC distance | inverse GDP growth distance | inverse squared population-adjusted geographical distance |
| $EMTR_{c,t}$ | 13.17*** | 13.73*** | 13.12*** | 13.28*** | 12.83*** |
| | (4.915) | (4.914) | (4.919) | (4.942) | (4.916) |
| $EMTR^2_{c,t}$ | -39.15*** | -40.09*** | -39.02*** | -39.33*** | -37.53** |
| | (14.91) | (14.89) | (14.92) | (14.94) | (14.93) |
| $GROWTH_{c,t}$ | 0.0328*** | 0.0336*** | 0.0328*** | 0.0328*** | 0.0320*** |
| | (0.00971) | (0.00970) | (0.00971) | (0.00971) | (0.00971) |
| $FEMTR^W_{c,t}$ | | -8.220** | -2.345 | 1.022 | 8.832 |
| | | (3.943) | (5.410) | (4.934) | (5.532) |
| $Constant$ | 1.741*** | 2.825*** | 2.077** | 1.577* | 0.117 |
| | (0.409) | (0.661) | (0.877) | (0.892) | (1.096) |
| Year effects | Yes | Yes | Yes | Yes | Yes |
| Country effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,034 | 1,034 | 1,034 | 1,034 | 1,034 |
| Adj. R-squared | 0.8435 | 0.8440 | 0.8433 | 0.8433 | 0.8437 |

Standard errors in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively. In all specifications, we omit the observations with the 1 % largest values of the dependent variable ($TAX\ REVENUE_{c,t}$).

We see that our results are, by and large, robust against using effective tax measures. First, the results suggest an inverse-U-shaped Laffer-Curve relationship between the (domestic) effective corporate tax rate and tax revenue. Second, when it comes to the impact of foreign ETRs, it is merely in the case of a weighting scheme based on the inverse squared geographical distance (column 2 in Tables 3.A.6 and 3.A.7, respectively) that we see a (weakly) significant impact of the average foreign ETRs on domestic tax revenue, which, surprisingly, is negative. To further assess the impact of geographical distance-weighted foreign ETRs, we also include specifications using (log) population-adjusted geographical-distance weights (column 5 in Tables 3.A.6 and 3.A.7, respectively). Doing so reflects the notion that taking into account country size and market potential in addition to the sheer geographical distance may measure competition forces better in the context of real investment decisions at the extensive and intensive margin. The results of these estimations, on the contrary, indicate that there is no significant effect of weighted-average foreign ETRs on corporate tax revenue. All in all, this suggests that our finding that, on average, foreign corporate tax rates do not affect domestic tax revenue also holds when we consider *effective* rather than *statutory* tax measures.

In the main body of the paper, we use statutory tax rates for several reasons. First, the classical Laffer-Curve framework in its origins reflects the relationship between statutory tax rates and revenue. Second, taking a distinct policy perspective, one can argue that changes in the statutory tax rate are the most prominent and immediate tax policy measure, attracting a lot of public attention. Related to this, statutory tax rates might often be the best information available to firms when it comes to their expected tax payments, particularly in an international context and compared to the more complex nature of ETRs, which comprise numerous details of tax legislation (Overesch and Wamser, 2009).[48] Third, information on STRs is available for a considerably larger set of countries. In the

[48]In addition, ETRs are inherently firm-specific in the strict sense, as they depend not only on statutory tax rates and depreciation rules, but also on firm-specific asset composition and modes of financing (Steinmüller et al., 2019). When it comes to analyzing firms' behavioral incentives at the micro level, this is of particular relevance, as Egger et al. (2009) note that especially for EMTRs, firm-specific effects are relatively important. Effective tax measures at the country level, which are the only ones we can use in our aggregate analysis, are hence less accurate in capturing the incentive effects involved.

first place, this directly affects the number of countries in our sample (108 compared to 134). In the second place, this also has an impact on the weights we use to calculate the weighted-average foreign tax rates. More precisely, the set of countries to consider competitors in our sample reduces. This is particularly salient for countries in less-developed world regions, for which we do not always have reliable information on the rules and legislations with respect to depreciation allowances.

# Chapter 4

# Understanding the Tax-Setting Behavior of Developing Countries[1]

ABSTRACT

This paper models the tax-setting behavior of a government, whose objective it is to raise revenue from taxing firm profits. Firms, however, may attempt to bribe the tax agent in charge with the aim of avoiding the profit tax. The extent to which such behavior is detected and punished by the government depends on a number of country characteristics. These characteristics affect optimal tax policy, suggesting that a country belongs to one of three possible country types and either (i) ignores, (ii) combats, or (iii) tolerates tax evasion. Countries which are characterized by widespread corruption, weak fiscal institutions, and high location-specific rents (e.g., due to natural resource abundance) are likely to set relatively high tax rates and to tolerate tax evasion. For these countries, the incentive to improve their tax system tends to be rather low and they are at risk of getting stuck in a regime of inefficient tax collection, widespread evasion, and bureaucratic corruption. We find robust evidence for this pattern in the data, and show that a *big push* – substantial and persistent improvements – towards stricter tax enforcement and more efficient revenue collection can help developing countries to escape this regime, raise sufficient tax revenue, and foster economic growth.

[1]This paper is joint work with Thomas Letsche and Georg Wamser.

## 4.1 Introduction

Functioning institutions as well as an efficient organization of the government are important preconditions for growth and development. Particularly the activities of the public sector require an efficient system of collecting taxes. This, however, appears to be one of the major problems of poorer countries. Using data from Steinmüller et al. (2019), the 25% poorest countries measured in terms of GDP per capita raise on average about 2.38% of GDP in corporate income tax revenue, whereas corporate income tax revenue amounts to about 3.68% of GDP, on average, in the 25% richest countries; the 10% richest countries even raise more than 4% revenue from taxing business profits. The fact that the average statutory tax rate is about 6 percentage points higher in the 10% poorest countries (an average tax of 32% compares to an average tax of 26%) may be interpreted in two ways. First, countries have implemented inefficiently high tax rates that lead to substantial tax-avoidance activity. In other words, these countries might be on the wrong side of the Laffer-Curve, which raises the question of why governments of these countries do not cut taxes.[1] Second, institutions in these countries do not work, irrespective of the tax level, so that significant amounts of tax revenue are lost through different forms of tax evasion or informal market activity.[2]

It is the goal of this paper to shed light on the corporate tax policy of countries operating under very different conditions with respect to a variety of aspects such as the level of corruption, the quality of fiscal institutions and tax enforcement or location-specific rents (the latter may be high in resource-abundant countries). We particularly aim at understanding (i) why some (often it seems poor) countries set comparatively high corporate tax rates and do not cut taxes to reduce inefficiencies and raise more tax revenue; (ii) why countries do not take action and fix institutions to facilitate the collection of taxes; (iii) how a substantial and permanent improvement of tax revenue collection may be achieved.

[1] The concept of the Laffer-Curve implies the notion of an inverse-U-shaped relationship between statutory taxes and tax revenue. Thus, there exists a tax rate between 0% and 100% which maximizes tax revenue.

[2] However, this argument suggests that tax revenue is lower at all potential tax levels (a downward-shift of the Laffer-Curve). As highlighted by Abbas and Klemm (2013) and Abramovsky et al. (2014), generous special tax regimes and incentives may also play an important role in this regard.

As a possible explanation for this pattern, we first propose a theory predicting that countries operate in one of three "tax-setting regimes". Tax-setting behavior is endogenously determined and crucially depends on the respective regime: under the first one, countries can ignore tax evasion; countries in the second regime will implement measures against tax evasion; countries operating in the third regime will tolerate tax evasion. To which of these regimes a country is assigned to specifically depends on the level of corruption, the quality of fiscal institutions, and on country-specific rents (e.g., associated with natural resource abundance).

In our theory model, we assume a government whose objective it is to maximize revenue from taxing firm profits. Firms, however, have an incentive to avoid taxation by the government. For this purpose, two strategies are at their disposal: they can either refrain from investing in the country's (formal) economy entirely, or evade taxes by paying a bribe to the tax agent in charge.[3] Whether it is worthwhile for firms to opt for one of these activities depends on their tax burden. Thus, the government is limited in its tax setting by firms' implicit threats to evade taxes or to leave the formal economy, and the extent to which the government is able, and willing, to prevent firms from doing so depends on a number of country characteristics. More precisely, the government's ability to detect and punish tax evasion hinges on the corruption level and the quality of fiscal institutions, while country-specific rents determine firms' gross profits and, as a consequence, their incentives to enter the economy and to evade taxes. Accordingly, these country characteristics affect optimal tax policy, suggesting that a country belongs to one of three possible country types and either (i) ignores, (ii) combats, or (iii) tolerates tax evasion. We demonstrate that countries characterized by widespread bureaucratic corruption, weak institutions, and high resource rents are very likely to be in the 'tolerating-tax-evasion' regime. In the latter regime, countries will set relatively high tax rates, thus inducing firms to evade

[3]Several studies suggest that such bribes are relatively common in many countries, especially in less developed ones. In the countries included in the World Enterprise Survey, for example, 18% of the surveyed firms have experienced at least one bribe payment request, and 13.3% expect to make informal payments in meetings with tax officials. Conducting a field experiment in Pakistan, Khan et al. (2015) demonstrate that tax collector compensation crucially affects the scope of tax evasion and the level of bribe payments, and Alm et al. (2016) identify corruption of tax officials as a significant determinant of tax evasion behavior of firms. Anecdotal evidence on the topic is provided by Besley and McLaren (1993), as well as Cheung et al. (2012).

taxes, as fines from convicted evaders contribute to total tax revenue.

Our theory further suggests that the relationship between revenue collection and tax enforcement is non-monotonic. In particular, small improvements on tax enforcement usually do not translate into higher revenue for countries operating under the 'tolerating-tax-evasion' regime. Therefore, these (often resource-rich, developing) countries lack the incentives to improve their current tax system and are stuck in a regime of inefficient tax collection, widespread evasion, and far-reaching corruption. It is only through a *big push* – that is, substantial and persistent improvements of institutions – towards stricter tax enforcement that such countries may escape the 'tolerating-tax-evasion' regime.

We then present an empirical assessment of our theoretical findings, using a large dataset on 128 countries and the time period from 2005 to 2014. We find evidence for an empirical pattern which reinforces our theoretical predictions and their policy implications: if countries want to increase tax revenue, they should aim for a stricter enforcement of tax law. In this regard, our empirical results confirm that the relationship between tax revenue and more rigorous tax enforcement is non-monotonic. In fact, and in line with the theoretical findings, our results show that it is precisely through a *big push* towards stricter tax enforcement that countries benefit substantially in terms of increased tax revenue. We find that, for the greater part, the countries putting in considerable and persistent efforts in improving tax collection are newly-industrialized countries, which is evidence for the notion that favorable economic development often goes hand in hand with improvements in tax enforcement. This finding is consistent with our theoretical model: induced by a *big push* in terms of tax enforcement and revenue collection, these countries seem to have succeeded in switching the tax-setting regime and eventually increased their capability to generate tax revenue. By contrast, we do not find any countries with very low levels of development among the ones experiencing a *big push* towards stricter tax enforcement. This is in line with our theoretical finding that the least developed countries are likely to be the ones which lack the incentive to implement changes to tax policy and tax enforcement. As a consequence, the least developed countries may be at risk of never being able to escape the regime of inefficient revenue collection and widespread evasion.

Only if institutions are fixed in a *big push*, these countries will be able to raise significantly more tax revenue.

Our paper relates to several strands of literature. In line with previous contributions on the topic, we highlight the differences between developed and developing countries with respect to optimal tax policy.[4] There are several obstacles, like, e.g., weak institutions, bureaucratic corruption, and lacking expertise of tax agents, that may hinder revenue collection and lead to widespread tax evasion and the persistence of substantial informal sectors, especially in less developed countries. For instance, La Porta and Shleifer (2014) find that economic development is associated with a decline of the informal sector, which should make it easier to raise tax revenue. Exploiting a large formalization program in Brazil, Rachter et al. (2018) demonstrate that lowering taxes reduces firm informality, yet only at the cost of lower net tax revenue. Gokalp et al. (2017) find that competition from the informal sector may induce formal firms to evade taxes, especially if institutions and regulations are inefficient and burdensome. Similarly, Schneider and Torgler (2007) identify governance and institutional quality as well as tax morale as limiting factors of informal activity, and Dreher et al. (2009) provide evidence that institutional quality reduces both the size of the shadow economy and the corruption level. Bird et al. (2008) suggest that tax revenue could be significantly higher if corruption was reduced and 'voice and accountability' were improved. Furthermore, several studies analyze governments' optimal tax policy in a setting where tax collection and enforcement are imperfect, which should be particularly true in less developed countries. For instance, Best et al. (2015) show that charging taxes on turnover, rather than profits, may reduce tax evasion by firms, which explains why many developing countries rely on such a production inefficient tax policy.[5] Dharmapala et al. (2011) demonstrate how administrative costs of tax collection can justify the exemption of firms from taxation if their output level is below a certain threshold, although such a policy leads to tax-avoidance behavior by firms and may induce a "missing middle". The latter suggests that only small

[4] General analyses of (optimal) tax policies for developing countries are provided by Besley and Persson (2014) and Tanzi and Zee (2000), while Abbas and Klemm (2013) and Abramovsky et al. (2014) discuss corporate taxation in this context.

[5] Production inefficiencies arise in this case as a turnover tax puts a wedge between the social and private returns to output.

tax-exempted and large firms exist, a phenomenon commonly observed in developing countries. Carrillo et al. (2017) stress the importance of tax authorities' enforcement capacity for revenue collection, by highlighting the limited influence of third-party reporting on tax compliance in developing countries. Finally, Gordon and Li (2009) set up a model where firms are able to evade taxes if they conduct all business in cash and avoid using the financial sector. Such a strategy seems to be more applicable in developing countries, as the value of financial intermediation tends to be smaller there. Accordingly, the threat of corporate tax evasion has a larger impact on developing countries' optimal tax policy, compared to more developed ones.

How well a country can cope with the aforementioned problems depends on the effectiveness of its tax system, or, in a broader sense, on its fiscal capacity. Following Besley and Persson (2013), the concept of fiscal capacity refers to a government's capability to generate tax revenue. The higher a country's fiscal capacity, the more tax revenue the country can potentially generate. Accordingly, differing tax policies of industrialized and developing countries may well be justified, as they are likely to result from the lower fiscal capacity of the latter type of countries. In order to increase its fiscal capacity, a country has to make investments targeted to improve, e.g., the structure of the tax system, the quality of institutions, the enforcement power of tax authorities, and the expertise of tax agents. To measure fiscal capacity, previous contributions have used various indicators of political institutions to proxy for fiscal capacity and tax enforcement. This should reflect that higher levels of political stability and cohesion as well as more inclusive political institutions are strongly correlated with a country's fiscal capacity (Besley and Persson, 2009; Besley et al., 2013). On a more specific level and with a distinct focus on tax enforcement, Besley et al. (2013) analyze investments in administrative structures that support tax revenue collection. Historically, these investments are mainly related to the implementation and, henceforth, the increasing enforcement of different types of taxes. In recent years, more and more countries have concluded Double Taxation Treaties (DTTs), which are mostly based on the OECD Model Tax Convention. The latter points out two main objectives of DTTs. While the first one is concerned with alleviating double taxation of foreign-earned income, the second major objective behind DTTs is to restrict tax avoidance and tax evasion (Blonigen and Davies, 2004; Egger et al., 2006). Blonigen and Davies (2004) argue that DTTs can reduce both tax evasion and administration costs related to tax enforcement and revenue collection. To the extent that this is the case, the number of DTTs concluded by a country may serve as a valid proxy for the strictness of a country's tax law enforcement. In the particular context of developing countries, Brumby and Keen (2016) as well as Hofmann and Riedel (2018) state that it is questionable whether less developed countries benefit from DTTs. On the one hand, these concerns are related to compliance costs for firms and uncertainty on the part of taxpayers. On the other hand, high administration costs associated with the negotiation and enforcement of DTTs may also harm developing countries or, at least, outweigh the positive revenue effects. The empirical part of this paper will use the number of DTTs as a proxy for a country's effort (strictness) in tax-law enforcement.

Concerning the interplay of improvements on tax enforcement and other dimensions of institutional progress, Besley and Persson (2013, 2014) argue that an adjustment of the tax system should be accompanied by, and be part of, a broader economic development. This reasoning is in line with Acemoglu et al. (2005), who reason that institutions are a fundamental cause of economic growth. Similarly, Mehlum et al. (2006) show that countries suffer from natural resources in terms of lower growth rates if institutions are weak and bureaucratic corruption is widespread. By contrast, resource-rich countries with good institutions experience higher growth rates than countries with less resources.[6] Note, though, that natural resources (implying high location-specific rents) by themselves constitute a main determinant of countries' tax policy and investment in fiscal capacity. Besley and Persson (2013) and Jensen (2011) argue that natural resource abundance reduces a country's non-resource tax effort and, as a consequence, its investment in fiscal capacity. Jensen (2011) estimates that a 1% increase in the

[6] The negative relationship between natural resource abundance and economic performance observed for many countries is referred to as 'resource curse' in the literature (cf. Sachs and Warner, 2001; Mehlum et al., 2006, among others). In line with Mehlum et al. (2006), several studies (e.g., Kolstad and Søreide, 2009; Leite and Weidmann, 1999; van der Ploeg, 2011) identify corruption and weak institutions as driving forces behind this pattern.

ratio of resource revenue to total revenue is associated with a 1.4% decrease in fiscal capacity, as measured by non-resource tax effort. This notion is supported by Crivelli and Gupta (2014), who estimate that each additional percentage point of GDP in resource revenue is associated with a reduction of about 0.3 percentage points of GDP in domestic non-resource revenue.

As these studies highlight the impact of corruption, institutional quality, and natural resource abundance on the (optimal) tax policy of countries, they strongly motivate the approach we take in the following. We add to the existing literature by (i) providing a rich theory that allows us to establish three tax-setting regimes in which countries may operate. A country's tax policy, in particular the way how to deal with bureaucratic corruption and tax evasion, crucially depends on the respective regime; (ii) illustrating that the corporate tax-setting behavior of less developed countries is in line with countries maximizing expected revenue, although it may differ fundamentally from the tax-setting behavior of industrialized countries; (iii) explaining why (mainly resource-rich, developing) countries often lack the incentive to improve their inefficient tax system; (iv) demonstrating (theoretically and empirically) that, for these countries, a *big push* towards stricter tax enforcement may be the only way to overcome the problems of widespread corruption and tax evasion, which proves to be an indispensable step in poor countries' economic development.

The remainder of the paper is organized as follows. In Section 4.2, we propose a theory of optimal tax policy for different country types. Thereafter, Section 4.3 analyzes the relationship between tax enforcement, revenue collection, and country development. Section 4.4 provides some basic empirical evidence strongly supporting our theoretical findings, Section 4.5 concludes.

## 4.2 Theoretical model

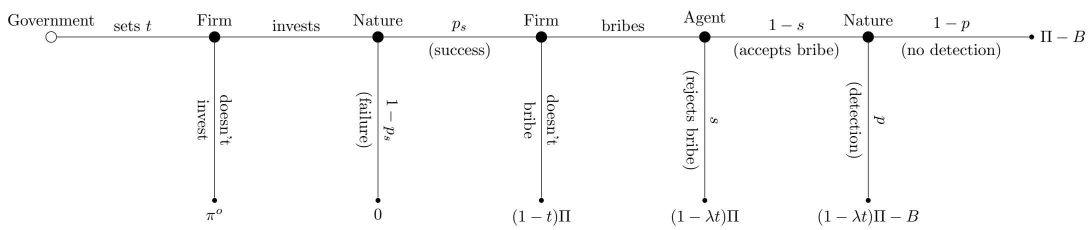
Let us consider a country hosting a continuum of identical, risk-neutral firms of mass one. Each firm can initiate an investment project generating payoff $\Pi \geq 0$ if successful (with probability $p_s$). In case of failure (with probability $1 - p_s$), the payoff is zero. Thus, a firm's expected gross profit when realizing the project is $E[\Pi] = p_s\Pi$. Alternatively, firms can settle for the exogenously given outside option $\pi^o \geq 0$. We assume that $\pi^o$ cannot be taxed by the country.[7] The probability of success $p_s$ as well as the respective profit levels are assumed to be common knowledge. By contrast, the outcome of the investment project (i.e., whether the firm is successful or not) is private information to the firm and the respective tax agent in charge, while it remains unknown to the government of the country. Profits that arise from the investment project are taxed at rate $t$. However, a firm can try to evade the tax by paying a bribe $B$ to the assigned tax agent. The latter reports a failure of the firm's investment, and hence profits of zero, to the government if he accepts the bribe. Thus, a firm does not have to pay taxes at all if the bribe payment $B$ is accepted by the tax agent (with probability $1-s$) and not detected by the government afterwards (with probability $1-p$). If the bribe attempt is rejected by the agent (with probability $s$) or detected by the government (with probability $p$), the tax burden of the firm increases by factor $\lambda > 1$, instead of being reduced.[8]

The structure of the game, which we depict in more detail in Figure 4.2.1, is as follows. In the first stage, the government decides about the corporate tax rate $t$. Afterwards, firms make their choices about investment projects. The gross profits of investing firms are realized in the third stage. Subsequently, firms attempt bribery or they behave tax-compliant. After that, tax agents account for a potential bribe offer and report firm profits to the government. Finally, tax revenue (government) as well as (net) payoffs (agents and firms) are realized. The model is solved via backward induction.

[7] We can think of $\pi^o$ as a firm's net profit after relocation to a neighboring country, for example. The outside option $\pi^o$ may also represent a firm's payoff when operating in the informal sector.

[8] While our study focuses on tax evasion, it should be noted that both legal tax avoidance and illegal evasion pose serious problems to revenue collection in developing countries, as shown by Cobham (2005). Similar to our model, several papers (Gauthier and Goyette, 2014, 2016; Sanyal et al., 2000, among others) analyze a government's optimal behavior when it has to deal with corrupt tax agents that may allow firms or individuals to cheat on their tax payments in exchange for bribes. While these models differ with respect to the government's main policy instrument, which may be the optimal public sector wage scheme (Besley and McLaren, 1993), degree of monitoring activity (Gauthier and Goyette, 2016), auditing (Sanyal et al., 2000), or tax rate (the present paper), they all share the common finding that it may be optimal for a government to tolerate tax evasion, at least to some extent. Hindriks et al. (1999) examine optimal private income taxation in the presence of corrupt inspectors and evasion. A more general analysis of the interaction between governmental policy and bureaucratic corruption is provided by Acemoglu and Verdier (2000).

Figure 4.2.1: *Game structure*




### 4.2.1 Tax agents

In the last stage before outcomes are realized, tax agents, who are randomly assigned to firms, decide on whether or not to accept a bribe. We assume two types of risk-neutral agents. The first type is susceptible to bribery, whereas the second type is not. Accordingly, we call agents of the first type *pliable* and agents of the second type *steadfast*. An agent's type is his private information. Firms and the government only know that a fraction $s$ of all agents is steadfast. Bribery is detected afterwards with probability $p$, in which case the agent loses his job and the associated wage payment $w$, but nevertheless gets the bribe $B$.[9] For simplicity, we set the opportunity wage of the agents to zero. Furthermore, corrupt behavior is associated with personal cost $m > 0$ for a tax agent.[10] This cost is assumed to be the same for all pliable agents who accept the bribe if

$$B + (1-p)w - m \geq w \quad \Leftrightarrow \quad B \geq B^* = pw + m.^{11} \tag{4.2.1}$$

[9]The results of the model are qualitatively the same if bribe payments accrue to the government and become tax revenue in case of detection.

[10]We may interpret $m$ as moral concerns or remorse associated with corrupt behavior. As a consequence, we assume $m$ to arise even in case of non-detection. Note, however, that in some contributions (like, e.g., Ades and Di Tella, 1999), corrupt agents face personal cost only in case of detection. Adopting this premise does not alter the qualitative results.

[11]For convenience, we assume that agents accept the bribe in case of indifference, while firms prefer honest behavior over evasion, as well as initiating the project over their outside option in case of indifference. Moreover, we suppose that no (further) bargaining between agent and firm takes place. Cheung et al. (2012) provide empirical evidence that supports this notion. Their findings suggest that lower-level government officials are far less able to expropriate bribery-related rents from firms, as opposed to high-ranked officials. In line with inequality (4.2.1), Khan et al. (2015) show that the scope of tax evasion and the level of bribe payments crucially depend on tax collector pay. However, as demonstrated by Fjeldstad (2003), higher public wages may simply improve the bargaining power of corrupt agents and lead to higher bribes instead of lower corruption if control mechanisms and sanctions are weak.

Thus, bribe payments are accepted if the net payoff exceeds opportunity cost $w$. $B^*$ defines the lowest bribe offer that is accepted by a pliable agent. The existence of steadfast agents may represent the fact that the personal cost $m$ is infinitely high for a fraction $s$ of all agents. For these agents, inequality (4.2.1) is never satisfied. We assume $p$, $w$, $m$, and, consequently $B^*$, to be common knowledge.

### 4.2.2 Firms

The behavior of firms is determined in the second, third, and fourth stage of the game.[12] In the fourth stage, firms decide whether to attempt bribery. If the responsible tax agent accepts the bribe, he reports a failure and zero profits of the firm to the government, implying that the firm does not have to pay taxes at all. Accordingly, failed firms, as well as firms which reject the investment project and choose the outside option, have no incentive to bribe as they do not pay taxes. Given the distribution of tax agents and the fact that firms know $B^*$, a bribe attempt fails and is reported with probability $s$. Even in case of a successful bribe attempt, tax evasion and the associated bribery are discovered with probability $p$. The corresponding penalty on the firm is assumed to be the same in both cases. In particular, we assume that a firm's payment to the tax authorities (i.e., the government) is increased by a factor of $\lambda$ if attempted or accomplished bribery is exposed. We assume $p$ and $\lambda$ to be exogenous.[13] Accordingly, a bribe attempt is

[12] Our model primarily applies to small- and medium-sized firms. Large multinational companies tend to rely on profit shifting in order to reduce their tax burden, and the associated losses in revenue seem to be even larger in developing countries, compared to advanced ones (Cobham and Janskỳ, 2018; Crivelli et al., 2016; Johannesen et al., 2017). By contrast, smaller firms often lack the possibility to legally avoid taxes and may, therefore, engage in tax evasion or migrate into informality (Djankov et al., 2010; Slemrod et al., 2017; Waseem, 2018). Consistently, Gokalp et al. (2017) find a negative relationship between firm size and tax evasion. Using data on Ugandan firms, Gauthier and Reinikka (2006) provide evidence that large companies benefit from tax exemptions, while smaller firms tend to evade taxes. In line with these findings, Campos and Giovannoni (2007) and Harstad and Svensson (2011) argue that lobbying and bribery are substitutes, with bribery being far more common for rather small firms (Campos and Giovannoni, 2007) and in less developed countries (Harstad and Svensson, 2011). Supporting this notion, Ayyagari et al. (2007) report that small- and medium-sized firms constitute most of the private sector in these countries.

[13] Allowing for endogenous $p$ and $\lambda$ should not alter the qualitative results of the model. Even if the government was able to choose these variables optimally, it is reasonable (and common in the literature) to assume that it would be limited in doing so by monitoring or auditing cost (regarding $p$) and legal and political obstacles (regarding $\lambda$). Consequently, firms may have an incentive to evade taxes, at least in some countries, even if $p$ and $\lambda$ are optimally chosen.

associated with the following expected net profit $\hat{\pi}^e$ for an *e*vading firm:[14]

$$\hat{\pi}^e = (1 - q\lambda t)\Pi - (1 - s)B^*, \tag{4.2.2}$$

where $q \equiv (1 - s)p + s$ denotes the overall probability of detection.[15] In case of compliant (or *h*onest) behavior, a firm's net profit is

$$\pi^h = (1 - t)\Pi. \tag{4.2.3}$$

Consequently, a firm attempts bribery if

$$\hat{\pi}^e > \pi^h \quad \Leftrightarrow \quad t > t^{eh} \geq 0, \tag{4.2.4}$$

where

$$t^{eh} \equiv \frac{(1 - s)B^*}{(1 - q\lambda)\Pi} \tag{4.2.5}$$

defines the tax rate for which a firm is indifferent between *e*vading and *h*onest behavior.[16]

When deciding about the investment project in the second stage, firms anticipate their subsequent compliance behavior in case of success. The necessary condition for initiating the project is given by

$$p_s\hat{\pi}^e \geq \pi^o \Leftrightarrow t \leq t^{oe} = \frac{1}{q\lambda}\left(1 - \frac{\pi^o + p_s(1 - s)B^*}{p_s\Pi}\right) \tag{4.2.6}$$

for evading firms and

$$p_s\pi^h \geq \pi^o \quad \Leftrightarrow \quad t \leq t^{oh} = 1 - \frac{\pi^o}{p_s\Pi} \tag{4.2.7}$$

for honest firms. $t^{oe}$ ($t^{oh}$) defines the maximum tax rate for which an *e*vading

[14] We refer to all firms that attempt bribery as *evading*, although actual tax evasion only takes place if the bribe attempt is successful.

[15] Note that tax evasion is never worthwhile if the expected penalty is at least one: $q\lambda \geq 1$. Therefore, $q\lambda < 1$, is often assumed in the literature. By contrast, we generally allow for $q\lambda \geq 1$. Thus, the expected penalty may be sufficiently high in some (but not all) countries to fully deter tax evasion.

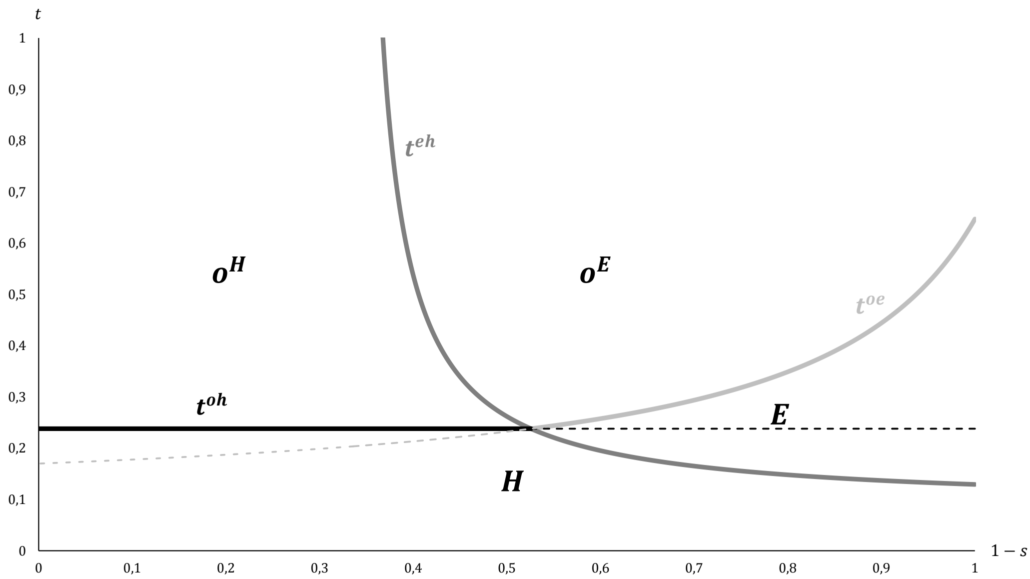
[16] Note that the threshold $t^{eh}$ only constitutes an upper limit to taxation of compliant firms if its value is positive, i.e. for $q\lambda < 1$. If $q\lambda > 1$ (implying $t^{eh} < 0$), tax evasion is never worthwhile for firms.

(*h*onest) firm just prefers the investment project over its *o*utside option.[17]

### 4.2.3 Government behavior

At the first stage of the game, the government sets the tax rate to maximize expected revenue. It is limited by firms' alternatives, which are evasion and the outside option. The attractiveness of these alternatives and the corresponding threshold values of the tax rate are defined by inequalities (4.2.4), (4.2.6), and (4.2.7). In order to understand the mechanisms of the model, it proves helpful to depict $t^{eh}$, $t^{oe}$, and $t^{oh}$ as functions of $1 - s$, the share of pliable agents. Recall that $t^{eh}$ corresponds to the tax rate for which a firm is indifferent between evading and honest behavior, $t^{oe}$ is the maximum tax rate for which an evading firm just prefers the investment project over its outside option, and $t^{oh}$ is the maximum tax rate for which an honest firm just prefers the investment project over its outside option. Let us map firms' optimal behavior for different combinations of $1 - s$ and $t$ in Figure 4.2.2. We may think of $1 - s$ as a proxy for corruption and, thus, interpret a high value of this variable as a high corruption level in the following.

Figure 4.2.2: *Threshold tax rates and possible firm behavior*




[17]If $t^{oe}$ ($t^{oh}$) is negative, $t < 0$ (i.e., a subsidy) is necessary to induce evading (honest) firms to start the investment project. However, $t < 0$ cannot be optimal in our model for a revenue-maximizing government. The latter then simply refrains from taxing the respective firms.

From the perspective of the government, we can distinguish between four different areas in Figure 4.2.2, each representing a certain behavior of firms.

The lower area denoted by $H$ captures all combinations of $1 - s$ and $t$ for which it is optimal for firms to initiate the project and behave compliant in case of success. Formally, $t \leq t^{oh}, t^{eh}$ holds in this area.

The right area denoted by $E$ captures all combinations of $1 - s$ and $t$ for which it is optimal for firms to initiate the project, but attempt bribery in case of success. Formally, $t^{eh} < t \leq t^{oe}$ and $t^{eh} < t^{oh}$ hold in this area.

The upper left ($o^H$) and upper right area ($o^E$) capture combinations of $1 - s$ and $t$ for which it is optimal for firms not to pursue a project and resort to their outside option instead. More precisely, the $o^H$-area depicts combinations for which firms would prefer paying taxes over attempting bribery if they successfully undertook the project. Formally, $t^{oh} < t \leq t^{eh}$ holds in this case. By contrast, the $o^E$-area depicts combinations for which firms would prefer tax evasion over compliant behavior if they successfully undertook the project. Formally, $t > t^{eh}, t^{oe}$ holds in that case.

As the considered firms are homogeneous, they all behave in the same way. The government can influence firm behavior through its tax setting. Firms invest and behave compliant in the country if $t$ is set sufficiently low, i.e. for $t \leq t^{oh}, t^{eh}$. Graphically, the black $t^{oh}$- and the dark grey $t^{eh}$-curves determine the upper boundary of the $H$-area in Figure 4.2.2.

Depending on the value of $1-s$ (and on the other determinants of $t^{eh}$ (4.2.5) and $t^{oh}$ (4.2.7)), either the outside option or the possibility to evade is more attractive to firms. Thus, either the $t^{oh}$- or the $t^{eh}$-threshold defines the maximum tax rate the country can implement while still inducing firms to initiate the investment project and subsequently behave compliant. In particular, firms prefer evasion over the outside option if $t^{oh} > t^{eh}$, which holds if $1-s$ is sufficiently high. In Figure 4.2.2, this applies to all points lying to the right of the intersection of the $t^{oh}$- and the $t^{eh}$-curve. The reason is obvious: the higher the corruption level $1-s$, the higher the expected profit in case of evasion $\hat{\pi}^e$ (4.2.2). That is, a high value of $1-s$ makes investment with subsequent tax evasion in the country more attractive to firms. Accordingly, $t^{eh}$ is decreasing in $1-s$, while $t^{oh}$ is independent of this parameter. As a consequence, the $E$-area in Figure 4.2.2 emerges once $t^{oh} > t^{eh}$ holds and (then) becomes larger for higher values of $1 - s$.

A key result of our analysis is the following. If $t^{oh} > t^{eh}$ holds, it may be optimal for a country (the government) to *tolerate evasion* if the expected revenue from fines on detected bribery is sufficiently high. Accordingly, we may distinguish between three different tax policies, or country types. The first type, type 1, refers to all cases where $t^{oh} \leq t^{eh}$. Then, tax evasion is no relevant alternative for firms and, hence, can be *ignored* by the country's government when setting the tax rate. Instead, the maximum attainable tax rate depends on firms' outside option and equals $t^{oh}$.[18] By contrast, firms' possibility to evade affects the tax setting of the second and third country type, for which $t^{oh} > t^{eh}$ holds. In such countries, firms will engage in evasion if the tax rate is too high. A country's government may implement a maximum tax rate equal to $t^{eh}$, making evasion unprofitable and, thus, inducing firms to behave compliant (cf. equation (4.2.4)). We refer to such a country that *combats* evasion as type 2. Alternatively, a country's government can *tolerate* tax evasion and settle for revenue from fines on detected bribery. When doing so, it is able to set a tax rate higher than $t^{eh}$. However, it has to make sure that firms' expected profit from attempted bribery in the country is at least as high as their outside option (cf. equation (4.2.6)). Therefore, the tax rate in a type 3 country must not exceed the threshold value $t^{oe}$. To summarize, the three country types are

1. **Ignoring tax evasion**[19] (since it is not a serious problem): Outside option of compliant firms as limiting factor ($t^{oh} \leq t^{eh}$). The (limit) tax rate is $t^{oh}$ (4.2.7) and increasing (decreasing) in $\Pi, p_s$ ($\pi^o$), and independent of $w, m, s, p, \lambda$.

2. **Combating tax evasion**: Tax evasion as limiting factor. (Limit) tax rate is $t^{eh}$ (4.2.5) and increasing (decreasing) in $w, m, s, p, \lambda$ ($\Pi$), and independent of $p_s, \pi^o$.

[18] Suppose that firms are internationally mobile. Then, their outside option is determined by other countries' tax rates and we may state that type 1 countries engage in "ordinary" tax competition. See Letsche (2019), for more details.

[19] Note that such countries may of course take measures to combat corruption. If this is successful, it would reflect in $s$, for example.

3. **Tolerating tax evasion**: Outside option of evading (!) firms as limiting factor. Government tolerates evasion, (expected) revenue stems from fines on detected evaders. (Limit) tax rate is $t^{oe}$ (4.2.6), and increasing (decreasing) in $\Pi, p_s$ $(\pi^o, w, m, s, p, \lambda)$.

It is worthwhile for a country to combat evasion if

$$E[R]^{eh} \geq E[R]^{oe}, \tag{4.2.8}$$

where $E[R]^{eh}$ ($E[R]^{oe}$) denotes the expected tax revenue of a type 2 (3) country. As mentioned above, tax revenue stems from fines on detected bribery in type 3 countries. Thus, tax revenue depends directly on the expected penalty $q\lambda$. In particular, the expected tax revenue is

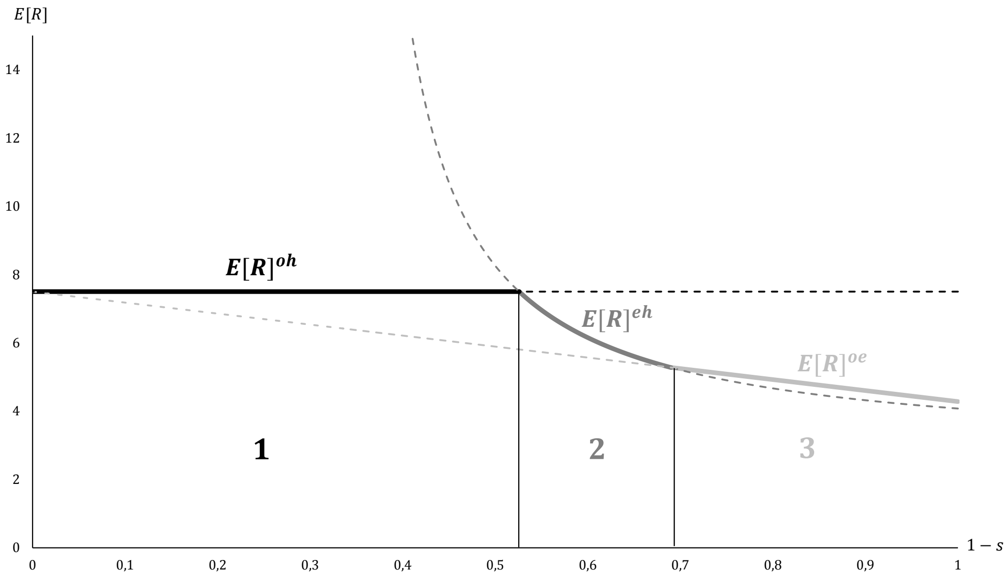
$$E[R] = \begin{cases} E[R]^{oh} = \max\{t^{oh}E[\Pi], 0\} = \max\{p_s\Pi - \pi^o, 0\} & \text{for type 1} \\ E[R]^{eh} = t^{eh}E[\Pi] = \frac{p_s(1-s)B^*}{1-q\lambda} & \text{for type 2} \\ E[R]^{oe} = q\lambda t^{oe}E[\Pi] = p_s(\Pi - (1-s)B^*) - \pi^o & \text{for type 3.}^{20} \end{cases} \tag{4.2.9}$$

Figure 4.2.3 plots $E[R]$ against $1-s$ and illustrates, together with Figure 4.2.2, how corruption influences tax rate, expected revenue, and type of a country.

The expected tax revenue is, c.p., lower and decreasing in $1-s$ for country types 2 and 3. This can be seen from equation (4.2.9) and Figure 4.2.3. In such countries, evasion constitutes an obstacle to tax policy and limits governments' ability to raise revenue. This problem is more severe, the more widespread corruption is. Note, however, that the optimal tax policies of type 2 and type 3 countries differ fundamentally. As argued above, type 2 countries combat evasion by setting their tax rate low enough to induce compliant behavior by firms. By contrast, type 3 countries tolerate evasion to some extent, which allows them to charge a relatively high tax rate. Consequently, as tax evasion is more attractive to firms if the corruption level is high ($\partial\hat{\pi}^e/\partial(1-s) > 0$), the tax rate $t^{eh}$ ($t^{oe}$) is decreasing (increasing) in $1-s$ in type 2 (3) countries (cf. Table 4.2.1).

[20] Given the definition of the three country types, $q\lambda t^{oe}E[\Pi] > 0$ always holds for country type 3.

Figure 4.2.3: *Country types and corresponding expected tax revenue*




### 4.2.4 Tax-setting behavior of different countries in light of the theory

Table 4.2.1 summarizes the effects of different tax determinants for each country type. The impact of the respective variable on the tax rate depends on the specific tax-setting regime and, thus, may differ across countries.

Table 4.2.1: *Tax rate determinants*

| | 1. ignore<br>$t^{oh}$ | 2. combat<br>$t^{eh}$ | 3. tolerate<br>$t^{oe}$ |
|---|---|---|---|
| $\Pi$ | + | - | + |
| $\pi^o$ | - | o | - |
| $s$ | o | + | - |
| $p$ | o | + | - |
| $\lambda$ | o | + | - |

Given our model setup, investment in a country is more attractive to firms if the associated gross profit $\Pi$ is relatively large, compared to the outside option $\pi^o$.

Thus, $t^{oh}$ (4.2.7) and $t^{oe}$ (4.2.6), the maximum tax rates that can be charged in regimes 1 and 3 (under which the government is limited by firms' outside option), respectively, are increasing (decreasing) in $\Pi$ ($\pi^o$). By contrast, firms' incentives to evade limits the tax rate $t^{eh}$ (4.2.5) in the 'combating-tax-evasion' regime. Accordingly, we find a positive relationship between country-specific rents $\Pi$ and the tax rate for regimes 1 and 3, whereas a higher rent implies larger tax savings in case of evasion and a lower threshold $t^{eh}$ for the second regime. By contrast, we expect the impact of $\pi^o$ on the tax rate to be negative (for country types 1 and 3) or zero (for country type 2).

It is worth noting that countries operating under the 'tolerating-tax-evasion' regime tend to be characterized by rather large location-specific rents. This follows from (4.2.5) and (4.2.8). Making use of (4.2.8), we can determine the maximum gross profit level for which a country prefers the 'combating-tax-evasion' regime over the 'tolerating-tax-evasion' regime, $\overline{\Pi}$, as

$$E[R]^{eh} \leq E[R]^{oe} \;\Leftrightarrow\; \Pi \leq \overline{\Pi} \equiv \frac{\pi^o}{p_s} + \left(1 + \frac{1}{1 - q\lambda}\right)(1 - s)B^*. \tag{4.2.10}$$

Thus, for a country to operate under the 'tolerating-tax-evasion' regime, its location-specific rents $\Pi$ must exceed the threshold level $\overline{\Pi}$.

The remaining parameters in Table 4.2.1, $s$, $p$, and $\lambda$, affect the expected net profit $\hat{\pi}^e$ (4.2.2) in case of tax evasion and, thus, firms' incentives to attempt bribery. High values of $s$ and $p$ mean that a bribe attempt is very likely to be rejected by a steadfast agent (with probability $s$) or discovered by the government (with probability $p$), and a high value of $\lambda$ implies a harsh penalty in both cases. Accordingly, $\hat{\pi}^e$ (4.2.2) is decreasing in $s$, $p$, and $\lambda$. The associated effect on the tax rate is different for each tax-setting regime. Tax evasion and, consequently, (small) changes in $\hat{\pi}^e$ can be ignored by countries operating under the first regime. By contrast, countries in the second regime combat tax evasion. This means that they have to adjust their tax rate whenever firms' incentives to evade changes. If $\hat{\pi}^e$ is reduced (due to an increase of $s$, $p$, or $\lambda$), the threshold tax rate $t^{eh}$ (4.2.5), for which firms still behave compliant, becomes higher and the government can charge a higher tax. In sharp contrast to the first and, in particular, the second regime, the third one is characterized by a tax policy that tolerates evasion. Countries operating in this regime are limited in their tax setting by evading firms' outside option $\pi^0$. Thus, an increase of $s$, $p$, or $\lambda$, implying that tax evasion becomes less worthwhile as $\hat{\pi}^e$ is reduced, forces such countries to reduce their tax rate $t^{oe}$ (4.2.6) in order to prevent evading firms from choosing the outside option.

In sum, our theory indicates that the influence of $s$, $p$, and $\lambda$ on the tax rate differs fundamentally across the three tax-setting regimes. This strongly suggests that country characteristics and, eventually, the tax-setting regime a country operates in should be taken into consideration when conducting tax-policy analysis.

## 4.3 The role of tax enforcement in revenue collection and country development

We have just argued that countries operating under the 'tolerating-tax-evasion' regime are forced to reduce their tax rate if $s$, $p$, or $\lambda$ increase – in order to induce firms to invest (and evade taxes later on). The tax rate is given by $t^{oe}$ (4.2.6) in this case. Nevertheless, as can be seen from Figure 4.2.3 and equation (4.2.9), the expected revenue $E[R]^{oe}$ of these countries depends negatively on the corruption level $1 - s$ (i.e., $E[R]^{oe}$ is increasing in $s$). Hence, if the goal of a government is to maximize $E[R]^{oe}$, it has an incentive to reduce the corruption level $1 - s$. However, doing so seems to be a challenging long-term task (at least if we think of $s$ as being determined by moral values towards corruption within society). Instead, it seems more natural and promising for governments whose goal it is to increase revenue to make tax collection more efficient by increasing the detection probability $p$.

Following (4.2.9) and the definition of $B^*$ in (4.2.1), it becomes apparent that the effect of $p$ on a country's expected revenue $E[R]$ is different for each country type. Most notably, expected revenue of a country operating in the third regime, $E[R]^{oe}$, is decreasing in $p$. This means that such a country has no incentive to increase $p$ by, for example, taking measures to improve tax enforcement or increase transparency, unless these improvements allow the country to switch the tax-setting regime it operates in.[21] By changing its tax-setting regime from 3 to 1 or 2, a country may be able to reach a higher expected revenue level $E[R]$ (4.2.9).

To see how an increase of $p$ may allow a country of type 2 or 3 (for which $t^{oh} > t^{eh}$) to switch regime, recall that a firm's expected net profit in case of evasion, $\hat{\pi}^e$, is reduced as $p$ rises. Tax evasion then becomes less attractive and it may no longer be the limiting factor of a country's tax setting. Formally, $t^{eh}$ (4.2.5) rises if $p$ is increased and it may be that $t^{oh} > t^{eh}$ no longer holds. If this is the case, the country switches from regime 2 or 3 to 1.

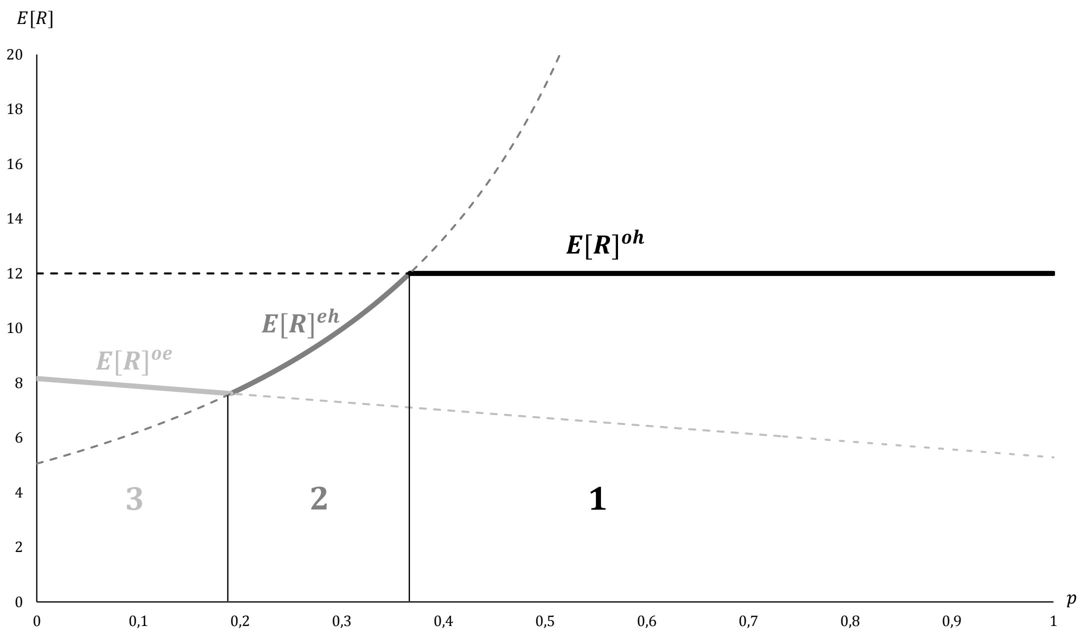
Furthermore, for a country of type 2 or 3, tax enforcement becomes stricter if $p$ is increased, allowing the country to charge a higher tax and generate more revenue under the 'combating-tax-evasion' regime ($t^{eh}$ (4.2.5) and $E[R]^{eh}$ (4.2.9) both increase). As a consequence, the condition for a country to operate in the second (instead of the third) regime, $E[R]^{eh} \geq E[R]^{oe}$ (4.2.8), may then be satisfied and a type 3 country may switch to the second regime and start to combat tax evasion. This is also shown by the fact that the maximum gross profit level for which a country combats evasion, $\overline{\Pi}$ (4.2.10), becomes larger as $p$ increases ($\partial\overline{\Pi}/\partial p > 0$).

Figure 4.3.1 illustrates the effect of an increase in $p$ on $E[R]$. The figure can be interpreted as follows. For low values of $p$, tax enforcement is too weak to make combating evasion worthwhile: the country is in the 'tolerating-tax-evasion' regime. As argued above, $E[R]$ (4.2.9) is decreasing in $p$ for this part of the function, i.e. for countries in the third regime. Better tax enforcement (a higher level of $p$) does not translate into higher expected revenue for these countries because they are forced to reduce their tax rate as the threshold $t^{oe}$ (4.2.6) declines (cf. Table 4.2.1). Instead, a higher detection probability $p$ reduces the expected tax revenue $E[R]^{oe}$.[22]

[21] Mardan (2018) obtains a similar result in the context of corporate profit shifting.

[22] An increase in $p$ reduces $t^{oe}$ (4.2.6) in two ways: by increasing the expected penalty $q\lambda$ and the bribe payment $B^*$. Given that the expected revenue of type 3 countries $E[R]^{oe} = q\lambda t^{oe} E[\Pi]$ is proportional to both $q\lambda$ and $t^{oe}$, the direct increase of $E[R]^{oe}$ and the indirect reduction via $t^{oe}$ that are induced by a raise of $q\lambda$ offset each other, implying that $E[R]^{oe}$ declines as $p$ increases (due to the additional reduction of $t^{oe}$ via a higher $B^*$).

Figure 4.3.1: *Probability of detection and expected revenue*




While $E[R]^{oe}$ is decreasing in $p$, $t^{eh}$ (4.2.5) and $E[R]^{eh}$ (4.2.9) are increasing in this variable. That is, combating evasion becomes more rewarding as tax enforcement becomes stricter. Once $p$ is sufficiently high for $E[R]^{eh} \geq E[R]^{oe}$ (4.2.8) to hold, the country switches from tolerating to combating evasion, i.e. from regime 3 to 2. This is illustrated by the first kink of the $E[R]$-function in Figure 4.3.1.

Unlike countries operating under the 'tolerating-tax-evasion' regime, countries in the 'combating-tax-evasion' regime have a clear incentive to take measures in order to improve tax enforcement, as $t^{eh}$ and $E[R]^{eh}$ are increasing in $p$. Accordingly, the second, dark grey part of the $E[R]$-function, which captures all values of $p$ for which the country operates in regime 2, is upward-sloping in Figure 4.3.1.

The second kink point of the $E[R]$-function in Figure 4.3.1 describes the level of $p$ for which

$$E[R]^{eh} = E[R]^{oh} \;\Leftrightarrow\; t^{eh}E[\Pi] = t^{oh}E[\Pi] \;\Leftrightarrow\; t^{eh} = t^{oh} \qquad (4.3.1)$$

holds. From this point, evasion is no longer the limiting factor of taxation and the country switches from regime 2 to 1, i.e., from combating to ignoring tax evasion.[23] Under the 'ignoring-tax-evasion' regime, the country's tax rate $t^{oh}$ (4.2.7) and expected revenue $E[R]^{oh}$ (4.2.9) are independent of the detection probability $p$. Therefore, the third, black part of the $E[R]$-function is parallel to the x-axis in Figure 4.3.1. The figure also shows that expected revenue $E[R]$ is always higher under regime 1, compared to regime 2 and 3. The same holds true, to a large extent, for regime 2 (compared to regime 3).

This highlights the importance of strict tax enforcement for raising sufficient revenue, as it shows that establishing a system of efficient tax collection is an essential part of a country's economic development. However, the above findings also suggest a lack of incentive for countries operating under the 'tolerating-tax-evasion' regime to increase tax enforcement. The reason is that, for these countries, improvements on tax enforcement (implying an increase in $p$) do not translate into higher expected tax revenue $E[R]$ (4.2.9), unless they are associated with a change of the tax-setting regime (from regime 3 to 2). To achieve this, however, it may take several costly steps, or a *big push*, towards better tax enforcement until a country eventually benefits from such an improvement (that is, until (4.2.8) holds). Thus, countries operating under the third regime may be unwilling to adjust their current system of tax collection and, therefore, are in danger of never being able to effectively combat tax evasion, raise sufficient revenue, and limit bureaucratic corruption. Such an outcome seems to be particularly likely for resource-abundant developing countries. The latter are often characterized by weak institutions, widespread corruption, and high location-specific rents, making them very likely to be, and get stuck, in the 'tolerating-tax-evasion' regime.

Taken together, our results suggest that, above all, it is through a *big push* in terms of tax enforcement that these countries will have the best prospects of escaping the curse of the 'tolerating-tax-evasion' regime. In this sense, our analysis provides an optimal tax perspective on the resource curse of developing countries.

[23]As $p$ rises, $t^{eh}$ and $E[R]^{eh}$ rise as well, while $t^{oh}$ and $E[R]^{oh}$ remain constant (cf. Table 4.2.1 and equation (4.2.9)). Thus, eventually, $E[R]^{eh} = E[R]^{oh}$ (4.3.1) is satisfied.

## 4.4 Empirical assessment

In light of the insights presented in Section 4.3, we now proceed to an empirical assessment of some core predictions of our theoretical model and particulary the *big push* hypothesis stated above. In this regard, it is important to note that our empirical results should be interpreted as suggestive evidence only. While we do not claim to capture causal relations, we do find robust evidence for an empirical pattern which reinforces the theoretical predictions and their policy implications: if countries want to increase tax revenue, they should aim for improved institutional quality and more efficient tax collection in general, and stricter enforcement of tax law in particular. As for the latter, and consistent with our theoretical results, we find that a potentially positive relationship between tax revenue and more rigorous tax enforcement is non-monotonic. Our results indicate that only those countries which put in great (and persistent) efforts in improving tax collection benefit in terms of substantially increased tax revenue.

### 4.4.1 Data and empirical specification

We base our empirical analysis on a comprehensive dataset containing information on 128 countries and the time period 2005 to 2014. We combine data from various sources. Corporate income tax revenue in % of GDP ($TAX\ REVENUE_{c,t}$) is taken from the IMF's World Revenue Longitudinal Data (WoRLD); statutory tax rates ($TAX_{c,t}$) are taken from Steinmüller et al. (2019). Moreover, we use the number of DTTs ($NDTT_{c,t}$) concluded in a country for a given year as a measure of tax enforcement. In the spirit of our theoretical framework, this variable should capture the probability of detecting tax evasion. $NDTT_{c,t}$ is based on own calculations, the respective information is taken from UNCTAD.[24] Further country-specific determinants of tax revenue are taken from two sources: (i) the World Bank's World Development Indicator (WDI) database: the share of total natural resource rents in % of GDP ($TORS_{c,t}$), (log of) GDP

[24]Information on the number of DTTs concluded is available for a large number of countries. Moreover, compared to other measures of institutional quality such as the various corruption indices and rule-of-law estimates frequently used in the literature, we prefer the number of DTTs as a proxy because (i) it can be directly influenced by policy-makers' decisions and (ii) it is a variable which is not based on individual perceptions and judgments.

per capita ($log\ GDPPC_{c,t}$), (log of) GDP ($log\ GDP_{c,t}$), GDP growth per capita ($GROWTH_{c,t}$), and (ii), the IMF's World Economic Outlook (WEO) database: government debt in % of GDP ($DEBTRATIO_{c,t}$) and total public expenditure in % of GDP ($PUBLICEXP_{c,t}$).

We estimate the following linear regression model:

$$\begin{aligned} TAX\ REVENUE_{c,t} = \alpha + \beta TAX_{c,t} + \gamma TAX^2_{c,t} + \delta TORS_{c,t} \\ + \zeta NDTT_{c,t} + \eta BIGPUSH_{c,t} + \boldsymbol{\theta}\mathbf{X}_{c,t} + Y_t + \epsilon_{c,t}. \end{aligned} \tag{4.4.1}$$

Equation (4.4.1) implies that, in all specifications, we assume tax revenue to depend on the tax rate, the squared term of the tax rate,[25] natural resource rents and the number of DTTs concluded. Moreover, we include the vector $\mathbf{X}_{c,t}$, which contains different country-specific determinants of tax revenue, depending on the respective specification (see Tables 4.4.1, 4.4.2 and 4.4.3 below), and aggregate year effects ($Y_t$).

The main variable of interest for our purpose is $BIGPUSH_{c,t}$. The latter is an interaction of a dummy for countries with a high (above median) share of natural resource rents ($HIGH\ TORS_{c,t}$) and a dummy for being in the upper 15 percent of the distribution of the change in the number of DTTs, $\Delta NDTT_{c,t}$ ($HIGH\ \Delta NDTT_{c,t}$):[26]

$$BIGPUSH_{c,t} = HIGH\ TORS_{c,t} \times HIGH\ \Delta NDTT_{c,t} \tag{4.4.2}$$

Hence, the coefficient $\eta$ reflects the additional revenue effect for the subset of resource-rich countries which have newly concluded a disproportionately high number of DTTs in the past year. In other words, we interpret $BIGPUSH_{c,t}$ as a variable that captures those resource-rich countries that are likely in the 'tolerating-tax-evasion' regime and have put a lot of effort in fixing institutions and particularly tax-law enforcement.

[25] This captures the notion of the Laffer-Curve, which suggests an inverse-U-shaped relationship between the statutory corporate tax rate and tax revenue (Steinmüller et al., 2019).

[26] Note that in Table 4.4.3 below, we prove the robustness of our results against using alternative definitions of the *big push* indicator, employing (i) a dummy for being in the upper 25 rather than 15 percent of the $\Delta NDTT_{c,t}$ distribution, and (ii) a dummy for countries with natural resource rents in the upper 40 (30) rather than 50 percent of the $TORS_{c,t}$ distribution.

## 4.4.2 Results

Our estimation results are displayed in Table 4.4.1. In all specifications, we employ corporate income tax revenue in % of GDP as dependent variable and relate it to various sets of determinants.[27]

Table 4.4.1: *Determinants of tax revenue: main results*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| $TAX_{c,t}$ | 14.99*** | 15.18*** | 19.12*** | 15.15*** | 19.33*** | 19.44*** | 19.68*** | 20.01*** |
| | (5.354) | (5.277) | (6.283) | (5.267) | (6.213) | (6.364) | (6.180) | (6.386) |
| $TAX^2_{c,t}$ | -24.63** | -25.24** | -31.18** | -24.52** | -30.40** | -30.37** | -31.56** | -32.24** |
| | (11.50) | (11.28) | (12.96) | (11.69) | (13.01) | (13.20) | (13.00) | (13.34) |
| $TORS_{c,t}$ | 0.0431* | 0.0447* | 0.0592** | 0.0475* | 0.0608** | 0.0621** | 0.0628** | 0.0656** |
| | (0.0250) | (0.0247) | (0.0242) | (0.0264) | (0.0241) | (0.0242) | (0.0253) | (0.0257) |
| $NDTT_{c,t}$ | 0.00448 | 0.00414 | -0.00750 | 0.00643 | -0.00423 | -0.00154 | -0.00446 | -0.00145 |
| | (0.00356) | (0.00376) | (0.00471) | (0.00612) | (0.00622) | (0.00710) | (0.00623) | (0.00717) |
| $BIGPUSH_{c,t}$ | 0.897** | 0.908** | 0.850** | 0.905** | 0.843** | 0.817** | 0.848** | 0.821** |
| | (0.434) | (0.432) | (0.427) | (0.426) | (0.410) | (0.396) | (0.410) | (0.395) |
| $GROWTH_{c,t}$ | | -0.0120 | | | 0.0360 | 0.0271 | 0.0390 | 0.0304 |
| | | (0.0293) | | | (0.0274) | (0.0257) | (0.0252) | (0.0241) |
| $log\,GDPPC_{c,t}$ | | | 0.668*** | | 0.716*** | 0.740*** | 0.721*** | 0.752*** |
| | | | (0.167) | | (0.170) | (0.177) | (0.171) | (0.180) |
| $log\,GDP_{c,t}$ | | | | -0.0498 | -0.0820 | -0.116 | -0.0833 | -0.124 |
| | | | | (0.118) | (0.100) | (0.109) | (0.101) | (0.113) |
| $PUBLICEXP_{c,t}$ | | | | | | -0.0116 | | -0.0136 |
| | | | | | | (0.0142) | | (0.0150) |
| $DEBTRATIO_{c,t}$ | | | | | | | 0.00146 | 0.00237 |
| | | | | | | | (0.0045) | (0.0046) |
| *Constant* | 0.4414 | 0.5046 | -6.0552*** | 1.5816 | -4.8392* | -3.9142 | -4.9354* | -3.9134 |
| | (0.7399) | (0.7999) | (1.7317) | (2.7917) | (2.9143) | (2.9976) | (2.8718) | (3.0194) |
| Year effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 947 | 947 | 947 | 947 | 947 | 947 | 947 | 947 |
| Adj. R-squared | 0.1076 | 0.1074 | 0.2015 | 0.1094 | 0.2073 | 0.2095 | 0.2070 | 0.2100 |

Standard errors clustered at the country level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level.

[27] Moreover, in all specifications presented in Tables 4.4.1, 4.4.2 and 4.4.3, we (i) cluster the standard errors of the coefficients at the country level, and (ii) account for outliers potentially biasing the estimation results by omitting the observations with the 3% largest values of $TAX\ REVENUE_{c,t}$ and $TORS_{c,t}$, respectively. In this regard, however, our results prove robust against a 1% and 2% outlier treatment.

Table 4.4.1 provides three main insights, which are in line with some key predictions from our theoretical framework. First, we see that tax rates are a very important determinant of tax revenue. The coefficients of both $TAX_{c,t}$ and $TAX^2_{c,t}$ are highly significant throughout all specifications, with signs suggesting an inverse-U-shaped Laffer-Curve relationship between statutory tax rate and revenue. Second, our estimates indicate that there is a positive link between tax revenue and a country's level of natural resource rents ($TORS_{c,t}$). This pattern in the data seems to be very robust against the inclusion of a wide range of different control variables. Third, and most importantly, the results reinforce our theoretical finding that the role of tax enforcement is non-monotonic: significant revenue effects are only discernible if a country has experienced a *big push* towards improved tax enforcement. Moreover, the latter should be considered in its interplay with resource rents.

In all specifications of Table 4.4.1, we include the variable $BIGPUSH_{c,t}$. In column 1, we present a parsimonious specification, only controlling for $TAX_{c,t}$, $TAX^2_{c,t}$, $TORS_{c,t}$ and $NDTT_{c,t}$. Including $NDTT_{c,t}$ allows us to assess whether there is a universal, linear effect of the number of concluded DTTs on tax revenue. In the next four columns, we gradually include $GROWTH_{c,t}$, *log* $GDPPC_{c,t}$ and *log* $GDP_{c,t}$. We do so to capture (i) time-variant determinants of tax revenue and (ii) cross-sectional differences between countries, which may both be significant drivers of corporate tax revenue. Last, in columns 6 to 8, we additionally control for two fundamentals of public sector activity: the level of public expenditures ($PUBLICEXP_{c,t}$) and government debt ($DEBTRATIO_{c,t}$), both measured in % of GDP.

Considering our estimation results on the role of tax enforcement, we do not find a significant effect of $NDTT_{c,t}$ on tax revenue in any of the specifications in Table 4.4.1. This means that there is no evidence for a positive impact of a *marginal* increase in the number of DTTs concluded. Rather than that, we find robust evidence for significant and positive revenue effects of a *big push* with respect to tax enforcement. More specifically, we estimate that being in the subset of resource-abundant countries which have concluded disproportionately many DTTs in the past year is, on average, associated with an increase in the corporate-tax-revenue-to-GDP-ratio by 0.817 to 0.908 percentage points compared to those countries which have not experienced a *big push*. In absolute numbers, given an average GDP of 1.38 trillion USD and a corporate tax revenue of 47.6 billion USD in this subset of countries, this amounts to additional revenue of 11.27 to 12.53 billion USD.

We assess the robustness of our main results in Table 4.4.1 in a series of alternative specifications, addressing two potential concerns about how to identify the effect of stricter tax enforcement. First, we consider the estimations where we control for a wide range of country-specific economic fundamentals, presented in columns 5 to 8 in Table 4.4.1. However, instead of controlling for the number of DTTs in place in a country ($NDTT_{c,t}$) as in Table 4.4.1, we now control for the change in the number of DTTs, $\Delta NDTT_{c,t}$ (columns 1 to 4 in Table 4.4.2). Doing so, we are able to analyze whether marginal changes in $\Delta NDTT_{c,t}$ rather than in the level of DTTs concluded have a significant effect on tax revenue.

The estimation results in Table 4.4.2 show, however, that there is no distinct revenue effect of a marginal increase in $\Delta NDTT_{c,t}$. This result also holds if we control for both the level of and the change in the number of DTTs in place (columns 5 to 8 in Table 4.4.2). Moreover, these alternative specifications prove the robustness of the coefficient on $BIGPUSH_{c,t}$. The estimates indicate that we maintain a positive revenue effect of a *big push* towards stricter tax enforcement (significant at the 10% level). Note that this is strong evidence for a '*big push* effect', as $BIGPUSH_{c,t}$ is a function of $\Delta NDTT_{c,t}$.

Table 4.4.2: *Determinants of tax revenue: robustness* ($\Delta NDTT_{c,t}$)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| $TAX_{c,t}$ | 20.17*** | 20.65*** | 20.51*** | 21.48*** | 20.48*** | 20.67*** | 20.92*** | 21.48*** |
| | (6.077) | (6.445) | (5.994) | (6.477) | (6.246) | (6.426) | (6.212) | (6.463) |
| $TAX^2_{c,t}$ | -32.52** | -33.39** | -33.66*** | -36.07*** | -33.45** | -33.45** | -34.94*** | -36.09*** |
| | (12.96) | (13.51) | (12.77) | (13.65) | (13.26) | (13.47) | (13.24) | (13.62) |
| $TORS_{c,t}$ | 0.0661*** | 0.0652*** | 0.0684*** | 0.0703*** | 0.0629** | 0.0650** | 0.0656** | 0.0702*** |
| | (0.0244) | (0.0239) | (0.0258) | (0.0254) | (0.0251) | (0.0249) | (0.0264) | (0.0266) |
| $\Delta NDTT_{c,t}$ | 0.0379 | 0.0550 | 0.0382 | 0.0584 | 0.0480 | 0.0554 | 0.0490 | 0.0586 |
| | (0.0450) | (0.0427) | (0.0447) | (0.0414) | (0.0439) | (0.0421) | (0.0432) | (0.0407) |
| $NDTT_{c,t}$ | | | | | -0.00433 | -0.000354 | -0.00462 | -0.000180 |
| | | | | | (0.00641) | (0.00728) | (0.00643) | (0.00740) |
| $BIGPUSH_{c,t}$ | 0.759* | 0.703* | 0.762* | 0.700* | 0.757* | 0.704* | 0.761* | 0.701* |
| | (0.425) | (0.417) | (0.425) | (0.414) | (0.433) | (0.413) | (0.432) | (0.410) |
| $log\, GDP_{c,t}$ | -0.117 | -0.128 | -0.121 | -0.139* | -0.0740 | -0.124 | -0.0761 | -0.137 |
| | (0.0790) | (0.0798) | (0.0816) | (0.0819) | (0.105) | (0.113) | (0.106) | (0.117) |
| $GROWTH_{c,t}$ | 0.0422 | 0.0239 | 0.0457* | 0.0288 | 0.0381 | 0.0240 | 0.0422 | 0.0288 |
| | (0.0275) | (0.0260) | (0.0251) | (0.0248) | (0.0281) | (0.0258) | (0.0262) | (0.0245) |
| $log\, GDPPC_{c,t}$ | 0.630*** | 0.710*** | 0.632*** | 0.727*** | 0.678*** | 0.712*** | 0.684*** | 0.728*** |
| | (0.152) | (0.177) | (0.152) | (0.182) | (0.177) | (0.185) | (0.179) | (0.189) |
| $PUBLICEXP_{c,t}$ | | -0.0180 | | -0.0209 | | -0.0176 | | -0.0207 |
| | | (0.0126) | | (0.0133) | | (0.0145) | | (0.0155) |
| $DEBTRATIO_{c,t}$ | | | 0.00151 | 0.00337 | | | 0.00189 | 0.00337 |
| | | | (0.0046) | (0.0045) | | | (0.0044) | (0.0045) |
| *Constant* | -3.310 | -3.1827 | -3.3249 | -3.1962 | -4.0796 | -3.2977 | -4.7924 | -3.2546 |
| | (2.1495) | (2.1587) | (2.1263) | (2.1363) | (3.0796) | (3.1535) | (3.0502) | (3.2002) |
| Year effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 835 | 835 | 835 | 835 | 835 | 835 | 835 | 835 |
| Adj. R-squared | 0.2016 | 0.2104 | 0.2013 | 0.2126 | 0.2035 | 0.2095 | 0.2036 | 0.2116 |

Standard errors clustered at the country level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level.

Second, we prove that our main results are robust against alternative definitions of our *big push* indicator. To this end, we construct $BIGPUSH^{A1}_{c,t}$ (Alternative 1, A1), $BIGPUSH^{A2}_{c,t}$ (Alternative 2, A2), and $BIGPUSH^{A3}_{c,t}$ (Alternative 3, A3). $BIGPUSH^{A1}_{c,t}$ defines the subset of countries (i) with an above median share of natural resource rents; (ii) which are in the upper 25 (rather than 15) percent of the $\Delta NDTT_{c,t}$ distribution. Hence, this is a less restrictive way of identifying countries which have experienced a *big push*, i.e., countries pursuing enhanced efforts in improving tax collection. In addition to this modification, in $BIGPUSH^{A2}_{c,t}$ and $BIGPUSH^{A3}_{c,t}$, we alter the definition of a resource-abundant country. More precisely, $BIGPUSH^{A2}_{c,t}$ ($BIGPUSH^{A3}_{c,t}$) determines the subset of countries with natural resource rents in the upper 40 (30) percent of the resource rents distribution and $\Delta NDTT_{c,t}$ in the upper 25 percent. We use our preferred specifications from the last three columns of Table 4.4.1 and employ these alternative *big push* definitions. Table 4.4.3 presents the estimation results.

Table 4.4.3: *Determinants of tax revenue: robustness (big push definitions)*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| $TAX_{c,t}$ | 19.74*** | 20.00*** | 20.33*** | 19.59*** | 19.82*** | 20.15*** | 19.20*** | 19.39*** | 19.72*** |
| | (6.520) | (6.341) | (6.544) | (6.501) | (6.321) | (6.521) | (6.419) | (6.238) | (6.429) |
| $TAX^2_{c,t}$ | -30.90** | -32.15** | -32.82** | -30.70** | -31.83** | -32.52** | -29.83** | -30.84** | -31.51** |
| | (13.49) | (13.28) | (13.61) | (13.44) | (13.22) | (13.55) | (13.29) | (13.05) | (13.37) |
| $TORS_{c,t}$ | 0.0601** | 0.0607** | 0.0636** | 0.0589** | 0.0593** | 0.0623** | 0.0550** | 0.0552** | 0.0582** |
| | (0.0246) | (0.0257) | (0.0261) | (0.0246) | (0.0256) | (0.0261) | (0.0244) | (0.0253) | (0.0258) |
| $NDTT_{c,t}$ | -0.00112 | -0.00405 | -0.00104 | -0.000866 | -0.00380 | -0.000782 | -0.00109 | -0.00378 | -0.00101 |
| | (0.00710) | (0.00624) | (0.00717) | (0.00713) | (0.00626) | (0.00719) | (0.00706) | (0.00624) | (0.00712) |
| $BIGPUSH^{A1}_{c,t}$ | 0.543** | 0.566** | 0.548** | | | | | | |
| | (0.253) | (0.259) | (0.253) | | | | | | |
| $BIGPUSH^{A2}_{c,t}$ | | | | 0.587* | 0.607* | 0.586* | | | |
| | | | | (0.317) | (0.324) | (0.316) | | | |
| $BIGPUSH^{A3}_{c,t}$ | | | | | | | 0.815** | 0.845** | 0.808** |
| | | | | | | | (0.336) | (0.347) | (0.333) |
| $GROWTH_{c,t}$ | 0.0269 | 0.0388 | 0.0302 | 0.0266 | 0.0385 | 0.0298 | 0.0273 | 0.0381 | 0.0302 |
| | (0.0254) | (0.0249) | (0.0238) | (0.0254) | (0.0248) | (0.0237) | (0.0255) | (0.0247) | (0.0238) |
| $log\,GDPPC_{c,t}$ | 0.751*** | 0.732*** | 0.763*** | 0.746*** | 0.726*** | 0.758*** | 0.733*** | 0.714*** | 0.744*** |
| | (0.179) | (0.172) | (0.182) | (0.178) | (0.172) | (0.181) | (0.179) | (0.172) | (0.181) |
| $log\,GDP_{c,t}$ | -0.129 | -0.0959 | -0.137 | -0.131 | -0.0973 | -0.138 | -0.128 | -0.0975 | -0.135 |
| | (0.108) | (0.101) | (0.112) | (0.109) | (0.101) | (0.112) | (0.108) | (0.101) | (0.112) |
| $PUBLICEXP_{c,t}$ | -0.0116 | | -0.0136 | -0.0118 | | -0.0137 | -0.0108 | | -0.0126 |
| | (0.0142) | | (0.0151) | (0.0143) | | (0.0152) | (0.0141) | | (0.0149) |
| $DEBTRATIO_{c,t}$ | | 0.00150 | 0.00242 | | 0.00137 | 0.00229 | | 0.00127 | 0.00212 |
| | | (0.00446) | (0.00459) | | (0.00446) | (0.00458) | | (0.00442) | (0.00454) |
| *Constant* | -3.7460 | -4.7644 | -3.7431 | -3.6261 | -4.6486 | -3.6263 | -3.541 | -4.4719 | -3.5455 |
| | (2.9805) | (2.8859) | (3.0022) | (2.9936) | (2.8877) | (3.0123) | (2.9797) | (2.8729) | (2.0964) |
| Year effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 947 | 947 | 947 | 947 | 947 | 947 | 947 | 947 | 947 |
| Adj. R-squared | 0.2085 | 0.2061 | 0.2092 | 0.2080 | 0.2053 | 0.2085 | 0.2120 | 0.2098 | 0.2124 |

Standard errors clustered at the country level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level.

One can see that the positive, additional revenue effect proves robust against these alternative definitions of the *big push* indicator. Quantitatively, the coefficients on the latter in the first six specifications are lower than before; however, this is due to the less restrictive distinction of the subset of *big push* countries and, hence, the substantially higher share of countries in this subset.[28] Moreover, the results in Table 4.4.3 reinforce the impression that there is no linear, monotonic effect of the number of DTTs concluded on tax revenue: the coefficients clearly show that there is no significant marginal effect of a change in $NDTT_{c,t}$ on tax revenue.[29]

The empirical results presented in Table 4.4.1 as well as the sensitivity checks (Table 4.4.2 and 4.4.3) have demonstrated that there is robust evidence for substantial revenue effects of a *big push* towards stricter tax enforcement. Let us finally present some descriptive evidence on the countries which, in terms of our baseline definition above, have experienced such a *big push* and are hence part of the subset for which $BIGPUSH_{c,t}$ takes the value 1. In total, there are 44 country-year observations in this group.[30] As to the latter, two interesting patterns of tax enforcement policy can be distinguished. On the one hand, there are countries for which we observe large one-time increases in the number of DTTs. This is the case, e.g., for Albania (6 newly concluded DTTs in 2010) and Bahrain (5 newly concluded DTTs in 2009). On the other hand, rather than experiencing a one-time *big push*, there are a number of countries which appear several times in the sample period. This means that these countries pursue a persistent tax policy towards stricter enforcement, with at least 2 newly concluded DTTs in several years during the sample period. This applies to, e.g., Malaysia and Mexico (4 appearances), Kazakhstan and North Macedonia (3 appearances), as

[28]With the baseline definition of $BIGPUSH_{c,t}$ used in Table 4.4.1, there are 44 (4.6%) observations in this subset. Compared to this, using the less restrictive 75th percentile of the $\Delta NDTT_{c,t}$ distribution as in $BIGPUSH^{A1}_{c,t}$, we have 112 (11.78%) observations. Strengthening the restrictions with respect to the resource rents distribution as in $BIGPUSH^{A2}_{c,t}$ and $BIGPUSH^{A3}_{c,t}$, we have 89 (9.4%) and 67 (7.1%) observations, respectively, in the subset of *big push* countries.

[29]Similar to Tables 4.4.1 and 4.4.2, the Laffer-Curve relationship between tax rates and revenue as well as the link between natural resource rents and tax revenue is very robust throughout all specifications.

[30]Note that, as described above and illustrated in Table 4.4.3, we have also employed alternative, less restrictive definitions of the *big push* indicator, implying a higher share of countries for which we identify a *big push* in terms of tax enforcement.

well as Armenia, Bulgaria, Chile, India and Morocco (2 appearances).

It should be noted that, regardless of which of the two tax enforcement policy strategies these countries pursue, they have one thing in common. They can be characterized as newly-industrialized countries, having made a first transition from developing countries to more developed economies. In this regard, we may argue that this positive economic development is often accompanied by tax-policy (including tax-enforcement regulation) reforms.[31] Note that this is perfectly consistent with our theoretical findings. From an ex-post perspective, these countries might have managed to switch the tax-setting regime and, in the end, benefit from more efficient tax collection and stricter tax enforcement in terms of increased tax revenue.

In contrast, countries with a very low level of development are not part of the subset of countries experiencing a *big push*. The least developed countries are those which, particularly from a short-run perspective, have a lack of incentive to improve tax enforcement and are therefore at risk of never being able to raise sufficient tax revenue. The example of the newly-industrialized countries clearly reveals that if countries engage in the long and costly process of improving tax enforcement, they can ultimately benefit from such an improvement. We may therefore refer to these countries as best-practice examples, demonstrating that economic development often goes hand in hand with changes in tax policy.

## 4.5 Conclusions

Bureaucratic corruption and weak fiscal institutions may encourage firms to evade taxes and limit a country's ability to raise revenue. We examine how the threat of corporate tax evasion affects a government's tax-setting behavior and demonstrate that there may be fundamental differences across countries. More precisely, we first develop a theoretical model which suggests the existence of three country types, or tax-setting regimes. Depending on the corruption level, institutional

[31] However, it is important to highlight that our empirical analysis allows us to disentangle these two aspects. We control for (i) cross-sectional differences between countries with respect to a wide range of economic fundamentals and (ii) time-varying determinants of tax revenue. Hence, we are confident that the positive revenue effect of a *big push* in terms of tax enforcement is not confounded by the effect of the general economic development on tax revenue.

quality, and location-specific rents, a country will follow a tax policy that either (i) ignores, (ii) combats, or (iii) tolerates tax evasion. In particular, we expect countries characterized by widespread corruption, weak institutions, and high location-specific rents (e.g., due to natural resource abundance) to charge a relatively high tax and to tolerate tax evasion (to a large degree).

Furthermore, our theoretical findings demonstrate that functioning institutions and powerful tax enforcement are essential preconditions not only for raising adequate tax revenue, but also for country development as a whole. Countries characterized by widespread corruption and tax evasion may never be able to overcome these problems, unless they fix the setting in which tax collection takes place, i.e., unless they put in great effort towards stricter tax enforcement. This seems to be particularly important for developing countries, especially for those with high location-specific rents, as these countries are very likely in the 'tolerating-tax-evasion' regime. Countries operating in this regime may have no incentive to increase the efficiency of tax collection, as small (but costly) improvements on tax enforcement usually do not translate into higher revenue. Thus, our model can explain why some, often resource-rich, developing countries are stuck in a regime of inefficient tax collection, widespread evasion, and a high corruption level.

We provide robust evidence for an empirical pattern which reinforces some core predictions of our theoretical model and, in particular, their policy implications. If countries want to increase tax revenue, they should aim for stricter enforcement of tax law. In line with our theoretical findings, we show that the relationship between tax revenue and more rigorous tax enforcement is non-monotonic. Our estimates show that marginal improvements on tax enforcement do not lead to a significant increase in tax revenue. Rather than that, it is only through a *big push* – substantial and/or persistent improvements towards stricter tax enforcement – that a country, in the end, benefits in terms of a sizable increase in tax revenue.

We finally illustrate which countries have experienced such a *big push* in terms of tax enforcement. Most of them are newly-industrialized countries, suggesting that a favorable economic development can and should be accompanied by improvements on tax enforcement and revenue collection. Again, this is fully consistent with our theoretical findings: these countries might have managed to switch the tax-setting regime – induced by a *big push* towards stricter tax enforcement – and finally benefit in terms of increased tax revenue. In contrast to this, in our sample, countries with a very low level of development do not experience such a *big push*. However, from a tax policy perspective, overcoming the problems related to poor tax enforcement and inefficient revenue collection proves to be an indispensable step on a country's way towards persistent growth and economic development.

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# 4.A Appendix

Table 4.A.1: *Variable definitions and sources*

| Variable | Definition and Source |
|---|---|
| $TAX\ REVENUE_{c,t}$ | Corporate income tax revenue in % of GDP of country $c$ in period $t$; |
| | Source: *IMF; World Revenue Longitudinal Data (WoRLD)* |
| $TAX_{c,t}$ | Statutory corporate income tax rate of country $c$ in period $t$; |
| | Source: Steinmüller et al. (2019) |
| $TORS_{c,t}$ | Total natural resource rents in % of GDP of country $c$ in period $t$; |
| | Source: *World Bank, World Development Indicator (WDI) database* |
| $NDTT_{c,t}$ | Number of double taxation treaties concluded by country $c$ in period $t$; |
| | Source: *United Nations Conference on Trade and Development (UNCTAD) database* |
| $\Delta NDTT_{c,t}$ | Change in the number of double taxation treaties concluded by country $c$ in period $t$; |
| | Source: *UNCTAD database* |
| $HIGH\,TORS_{c,t}$ | Dummy variable equal to 1 if $TORS_{c,t}$ is above median, and 0 otherwise; |
| | Source: *World Bank, WDI database* |
| $HIGH\ \Delta NDTT_{c,t}$ | Dummy variable equal to 1 if $\Delta NDTT_{c,t}$ is above the $85th$ percentile, and 0 otherwise |
| | Source: *UNCTAD database* |
| $BIGPUSH_{c,t}$ | Interaction between $HIGH\,TORS_{c,t}$ and $HIGH\ \Delta NDTT_{c,t}$ |
| | Source: *World Bank, WDI database* and *UNCTAD database* |
| $GROWTH_{c,t}$ | GDP growth (in %) per capita of country $c$ in period $t$; |
| | Source: *World Bank, WDI database* |
| $log\,GDP_{c,t}$ | (log of) GDP of country $c$ in period $t$; |
| | Source: *World Bank, WDI database* |
| $log\,GDPPC_{c,t}$ | (log) GDP per capita of country $c$ in period $t$; |
| | Source: *World Bank, WDI database* |
| $PUBLICEXP_{c,t}$ | Total public expenditure in % of GDP of country $c$ in period $t$; |
| | Source: *IMF World Economic Outlook (WEO) database* |
| $DEBTRATIO_{c,t}$ | Government debt in % of GDP of country $c$ in period $t$; |
| | Source: *IMF WEO database* |

# Chapter 5

# The Effect of Investing Abroad on Investment at Home: On the Role of Technology, Tax Savings, and Internal Capital Markets[1]

ABSTRACT

This paper examines the relationship between foreign and domestic investment activity of multinational enterprises. The empirical analysis is based on micro data of German firms and their operations at home and abroad, including information on investment in fixed assets. The empirical approach, which rests upon extensive and intensive margin variation, is shown to produce very robust results. These suggest a positive relationship between foreign and home investment in real capital. This positive effect seems to be mainly related to additional opportunities for tax planning and better access to financing capital. In contrast, we do not find evidence that improved production processes and technology upgrading cause the positive effect on investment at home. Our empirical approach allows us to distinguish between an extensive and intensive margin effect: setting up a new foreign affiliate leads to an immediate positive effect of about EUR 460,000 additional investment; the investment elasticity at the intensive margin is estimated to be approximately 0.13.

[1]This paper is joint work with Stefan Goldbach, Arne J. Nagengast, and Georg Wamser. The corresponding paper is published in *Journal of International Economics*.

## 5.1 Introduction

The broad consensus among economists in favor of increased international integration through trade and investment openness has always been based on the assumption that the gains thereof are sufficiently large to compensate the losers of increasingly globalized economies. Especially the foreign activities of multinational enterprises (MNEs) have raised the concern that, at the end of the day, home countries lose, owing to a shift of production and employment abroad. A recent contribution to the literature on the consequences of MNE expansion abroad on home activity is that of Desai et al. (2009). Their study concludes that foreign operations of US firms between 1982 and 2004 have, on average, led to greater domestic investment and employee compensation. In contrast to this, other studies come to the opposite conclusion by providing evidence for a negative effect of foreign investment on home activities of MNEs.[1]

Our paper contributes to the literature on the relationship between foreign and domestic investment of MNEs in three ways. First, we use a unique dataset that allows us to observe home and foreign investment activity of German MNEs, in addition to yearly balance-sheet information.[2] Second, our econometric approach is based on propensity score methods and exploits variation at the extensive as well as intensive margin of foreign activity. Note that the *extensive margin* of foreign activity in our paper refers to the decision of setting up a new foreign entity. Hence, an extensive-margin estimate quantifies the treatment effect of foreign activity on investment activity at home. The *intensive margin* refers to the volume of foreign activity (measured in terms of fixed assets or in equity capital invested abroad). Hence, an intensive-margin estimate quantifies the effect of 1 percent more foreign activity on investment activity at home. One central advantage of our empirical approach is that it allows us to provide reliable estimates on intensive margin elasticities by explicitly modeling and conditioning

[1] We provide a brief survey on this literature in Section 5.2.

[2] Our data, which is provided by the German Central Bank (Deutsche Bundesbank), includes firm-level information on investment activity over time and we do not rely on changes in the stock of fixed assets. The latter is used to proxy for investment activity in most studies. Note as well that we also observe employment in our data. We provide additional results for alternative outcomes in Section 5.5.6, but mainly focus on investment.

on the extensive margin. The latter point, i.e., modeling the extensive margin, appears to be crucial as it determines observability and timing of foreign activity and the correlation thereof with endogenous firm characteristics. In numerous tests, we show that our estimation approach appropriately accounts for the simultaneous nature of foreign and domestic operations and other endogeneity issues. Third, and most importantly, we can identify the channels through which foreign activity affects domestic investment. In particular, we focus on three potential sources: technology, tax savings and profit shifting, and internal capital markets.

Our results presented in Section 5.5 of this paper indicate that establishing a new foreign affiliate is associated with more domestic investment activity. The effect is substantial, as our estimates imply a change in real investment activity at home of about EUR 460,000. As for the intensive margin, we estimate elasticities which lie in the range of 0.13 to 0.23, depending on the measure of foreign investment activity. The effect is smaller than the one found by Desai et al. (2009), who estimate that 1 percent greater foreign investment is associated with 0.26 percent greater domestic investment. Using our data, unconditional estimates suggest significantly higher elasticities in the range of 0.38 to 0.44.

Furthermore, we show that the basic effect of foreign activity on home investment is robust against a large number of sensitivity tests. These tests include (i) alternative measures of the outcome variable, (ii) tests for prior trends and lagged effects, (iii) alternative specifications of propensity score estimates, (iv) variations in treatment-control comparisons, and (v) the calculation of placebo effects.

Our findings indicate that the main channel through which the positive relationship can be explained is first and foremost related to issues of tax planning and profit shifting, as well as improved access to financing capital. The former allows firms to reduce their cost of capital by avoiding tax payments. The latter finding suggests that newly established foreign affiliates facilitate access to financial capital, which is then provided via an internal capital market to the home location. It is difficult, however, to clearly distinguish these two channels – profit shifting and internal financing –, as they harness the same vehicle: internal debt. Quantifications show that the effect of establishing a new affiliate abroad becomes about twice as large if the tax differential between Germany and the foreign country is 10.5 percentage points higher than the average tax differential. A surprising new result is that foreign activity does not boost total factor productivity (TFP) or similar measures of productivity at home. Additional tests indicate that the effect is also not related to vertical foreign direct investment (FDI), which is usually associated with production substitution, outsourcing, and productivity gains from technology upgrading through vertical integration (Grossman and Rossi-Hansberg, 2008; Navaretti et al., 2010). While we cannot clearly distinguish between horizontal and vertical FDI, many of our results seem to be consistent with the notion of horizontal FDI as a provider of intra-firm services (including financing and tax planning).

The remainder of the paper is structured as follows. The next section provides an overview of the related literature. Section 5.3 contains a concise introduction to the econometric methodology. Thereafter, we provide information on the panel dataset used for the empirical investigation and present descriptive statistics. The basic results from our empirical analysis are discussed in Section 5.5, including a comprehensive assessment of their robustness. In the subsequent section, we present three channels through which the observed effects might be explained. The last section serves as a conclusion: it summarizes the major findings and discusses some policy implications.

## 5.2 Related literature

Previous contributions to the literature do not provide clear evidence on whether domestic investment and FDI are substitutes or complements.[3] The majority of empirical studies rely on country-level or sectoral data. Macroeconomic contributions predominantly point to a positive relationship (Desai et al., 2005), although Herzer and Schrooten (2008) suggest a substitution effect for German MNEs in the long run. Hejazi and Pauly (2003) as well as Arndt et al. (2010) use sectoral

[3] A different strand of the literature deals with the impact of FDI on the labor market in home countries. Even though the results vary substantially across studies, the majority of contributions suggest that FDI has negative employment effects in home countries (Becker et al., 2005; Federico and Minerva, 2008; Buch and Lipponer, 2010; Debaere et al., 2010; Jäckle and Wamser, 2010). In contrast to this, Kovak et al. (2018) find that greater offshore activity modestly increases net employment.

panel data to provide a more nuanced picture on the relationship between FDI and the domestic capital stock: Hejazi and Pauly (2003) argue that the destination country of FDI is crucial when analyzing domestic effects, while Arndt et al. (2010) highlight that the effect varies with the production structure of industries. To the best of our knowledge, aside from Desai et al. (2009), only few studies are based on firm-level data. Monarch et al. (2017) use US microdata to analyze the short- and long-run effects of offshoring on several key indicators of domestic activity: employment, wages, output, and productivity. They find a substantial decline in domestic employment and output, yet no significant impact of offshoring events on productivity and wages.[4]

The literature on the channels through which FDI may affect domestic investment can be broadly grouped into domestic capital market imperfections on the one hand, and the organization of production within the MNE on the other hand. Stevens and Lipsey (1992) argue that, in the presence of financial frictions, an increase of investment in a foreign location, ceteris paribus, raises the cost of capital for domestic investment. In accordance with the theoretical model in Stevens and Lipsey (1992), empirical contributions such as Feldstein (1995) find a substitution effect for home-market and foreign investment. In contrast, Desai et al. (2005) and Desai et al. (2009) argue that MNEs mainly finance investment projects via world and internal capital markets so that financial resources at home are not necessarily a major constraint.

Predictions from models on the organization of production are similarly ambiguous. While horizontal FDI may affect domestic investment, the net effect depends on whether FDI displaces exports or not (Hejazi and Pauly, 2003; Desai et al., 2005). In general, the extent to which cross-border production sharing occurs – as vertical FDI or outside the boundaries of the firm – is determined by the characteristics of the various locations, such as relative factor prices and economies of scale (Helpman, 1984, 1985; Markusen, 2002). The resulting efficiency gains suggest a positive effect on an MNE's productivity (Grossman and Rossi-Hansberg, 2008; Navaretti et al., 2010), with possibly positive consequences

[4]A recent study by Bösenberg et al. (2018) examines the interdependence of firms' investments in fixed and intangible assets within MNEs' networks of foreign affiliates using a spatial econometrics approach. In contrast to this paper, it focuses on marginal investment decisions and the foreign affiliate network, while the effects on home activity are not analyzed.

for domestic investment activity (Desai et al., 2005; Arndt et al., 2010). Alternatively, other authors have emphasized the negative effect on home-market investment resulting from the shift of domestic activities to foreign countries (Hejazi and Pauly, 2003).

A rarely discussed perspective on the domestic effects of FDI relates to corporate taxation and profit shifting.[5] The link between corporate taxation and profit-shifting incentives has been extensively discussed in the literature. Previous studies provide evidence that MNEs' tax-planning strategies exploit international tax rate differentials to shift corporate profits from high-tax to low-tax countries (Huizinga and Laeven, 2008; Weichenrieder, 2009; Heckemeyer and Overesch, 2017). To the best of our knowledge, only Overesch (2009) has directly investigated the implications of profit-shifting opportunities for MNEs' investment decisions. Using a firm-level panel of German inbound FDI, Overesch (2009) analyzes the investment behavior of MNEs in a high-tax country (Germany) as a function of the tax rate applicable to the parent firm. Empirical results confirm the hypothesis that German inbound FDI increases in the tax differential between Germany and the investor's home country. Overesch (2009) explains this result arguing that profit shifting by MNEs from one location to another can reduce the MNEs' cost of capital. This, in turn, facilitates investment in high-tax countries like Germany.[6] Thus, profit shifting can be interpreted as a competitive advantage for a firm because comparatively high tax rates do not affect investment to the same extent as they would in the absence of profit-shifting opportunities (we explain the mechanisms at play in more detail in Section 5.6.2).[7]

[5]For an overview of profit-shifting channels and techniques, see Huizinga and Laeven (2008) and Dharmapala (2014).

[6]From a very general perspective, this argument relates to the literature on the theory of investment (Jorgenson, 1963; Jorgenson and Hall, 1967; Jorgenson, 1971; Chirinko, 1993).

[7]Egger et al. (2014b) provide evidence that MNEs vastly differ with respect to their ability to shift profits and, thus, their potential to avoid taxes. Using a panel of German MNEs, they find that investments of successful tax avoiders do not respond to taxation in high-tax countries, while investments of non-tax avoiding firms do.

## 5.3 Methodology

Let us define the indicator variable $NA_{i,t}$, which equals 1 if we observe in our data that firm $i$ has established a foreign entity in period $t$. If this is not the case, $NA_{i,t}$ equals 0. The central objective of our paper is to estimate the treatment effect of $NA_{i,t}$ on outcome $y_{i,t}$. We are particularly interested in the outcome $\Delta INV_{i,t}$, the first difference of gross investment, but we also analyze a number of alternative outcomes.

A naive comparison of $y_{i,t}$ between the groups of treated firms, where $NA_{i,t} = 1$, and untreated firms, where $NA_{i,t} = 0$, may lead to biased estimates, as selection into foreign activity is not random. Another source of endogeneity is the simultaneous nature of home and foreign investment. To account for variables that determine selection into foreign activity, we first estimate propensity scores, for which we specify the following linear index:

$$NA_{i,t} = \boldsymbol{\alpha}\mathbf{X}_{i,t-1} + \boldsymbol{\beta}\mathbf{C}_{k,t-1} + \boldsymbol{\gamma}\mathbf{M}_{\ell,t-1} + \boldsymbol{\delta}\mathbf{I}_{s,t-1} + \phi_t + \psi_s + \varepsilon_{i,t}. \tag{5.3.1}$$

Equation (5.3.1) may be estimated by way of a standard probability model, such as probit. The specification suggests that $NA_{i,t}$ depends on variables measured at the level of firm $i$, variables measured at the level of counties $k$ and municipalities $\ell$, as well as variables measured at the industry-level $s$;[8] $\phi_t$ and $\psi_s$ denote time- and sector-specific effects. Note that in our preferred specification, we apply a Mundlak-Chamberlain-type approach (see Mundlak, 1978; Chamberlain, 1982)[9] and additionally condition on averages of the time-varying explanatory variables (which we may denote by $\overline{\boldsymbol{X}}_i$, $\overline{\boldsymbol{C}}_k$, $\overline{\boldsymbol{M}}_\ell$, and $\overline{\boldsymbol{I}}_s$).

As a first and central effect, we estimate an average treatment effect on the treated (ATT), i.e. the impact of $NA_{i,t} = 1$ on outcome $y_{i,t}$, by matching on the propensity score. The latter is obtained from estimating (5.3.1) by way of

[8] Section 5.4 provides more details on the variables used.

[9] Mundlak (1978) and Chamberlain (1982) show that if firm-specific unobserved effects are correlated with the observed explanatory variables in one period, then this correlation also persists in all other periods. Hence, in order to consistently estimate the coefficients in Equation (5.3.1), one should include firm-specific fixed effects. Chamberlain (1982) includes a full set of leads and lags of all explanatory variables to explicitly allow for correlation between the latter and the unobserved effects. We follow Mundlak (1978), who suggests a more parsimonious approach employing the time means of all explanatory variables as additional regressors.

a probit model. Denoting the sets of treatment and control units by $N$ and $J$, respectively, we calculate

$$\widehat{ATT}|_{NA=1} = \frac{1}{\mathcal{N}} \sum_{i \in N} \left( y_i - \frac{1}{\mathcal{J}_i} \sum_{j \in J_i} \omega_j y_j \right), \tag{5.3.2}$$

where $\mathcal{N}$ and $\mathcal{J}_i$ denote the numbers of treated and non-treated units, respectively, and $\omega_j$ denotes the weight attached to the respective control unit.[10] Thus, expression (5.3.2) implies that matching is basically a weighting scheme, as from the set of comparison units (non-treated units) $J_i$, we match observations to the treated unit $i$ using specific weights (Dehejia and Wahba, 2002).

We usually determine $\frac{1}{\mathcal{J}_i} \sum_{j \in J_i} \omega_j y_j$ based on caliper or radius matching, where comparison units within a given propensity-score radius are matched.[11] $\mathcal{J}_i$ is therefore associated with all matched units, where each unit receives a weight $\omega_j$ equal to 1. It is important to notice that the propensity score matching approach relies on two fundamental assumptions. First, unconfoundedness needs to hold. This requires that, conditional on observable characteristics, the outcome is independent of treatment. For this purpose, we aim at conditioning on a set of covariates as outlined in (5.3.1). Second, given that assignment to treatment is random, if two firms have the same propensity score, the distribution of variables used in the estimation of the propensity score should also be the same for these two firms. This second feature is referred to as the balancing property of the propensity score and can be tested. Results in this regard are presented in Table 5.A.6 in the Appendix.

## 5.4 Data and descriptive statistics

### 5.4.1 Data

To analyze the relationship between domestic investment and FDI, we mainly use two datasets, both provided by the German Central Bank (Deutsche Bun-

[10] Note that we drop the time index $t$ as we always enforce exact year matching.

[11] Apart from some robustness checks, where we apply nearest neighbor and kernel matching techniques.

desbank). The micro data is confidential and only accessible in anonymized form at the headquarters of the Bundesbank in Frankfurt, Germany. Information on the foreign activity of German firms is obtained from *MiDi* (Microdatabase Direct Investment; for detailed information, see Lipponer, 2011), a comprehensive annual database of German FDI positions. *MiDi* provides information on each foreign affiliate's balance sheet, ownership structure and additional information such as an industry classification. A particular advantage of *MiDi* is that reporting by firms is mandatory by German Federal Law.[12] We use parent-affiliate-year observations in order to identify whether a new foreign affiliate was established by the parent company in a given year.[13] In addition, we supplement affiliate-level variables with information on the country where the newly established affiliate is located.[14] Information on domestic investment and other parent-level variables is taken from the Bundesbank's corporate balance sheet database for Germany, *Ustan* (Unternehmensbilanzstatistik). The data are primarily extracted from annual accounts (balance sheet, profit and loss accounts) and financial statements. Most notably for our purpose, the database includes information on firms' domestic investment. This feature is unique, as most studies define investment as the change in fixed assets reported in the balance sheet, which is a proxy for net

[12]German Federal Law (Foreign Trade and Payments Regulation) states that a parent company is obliged to report its FDI to Deutsche Bundesbank if both of the following criteria are fulfilled: (i) the parent company controls at least 10 percent directly or 50 percent indirectly of a foreign company's voting rights; (ii) the balance-sheet total of the foreign affiliate exceeds EUR 3 million. Indirect ownership of 50 percent or more means that the parent company together with at least another company in the multinational group holds at least 50 percent of the affiliate's shares. The dataset features a structural break in 2002 when the thresholds for the voting shares and the foreign affiliate's balance sheet total were adjusted. Observations prior to 2002 that do not satisfy these requirements are excluded from the analysis. Moreover, we do not consider associated branches in order to ensure that only independent affiliates are part of our sample.

[13]Note that a new entry in the *MiDi* database can be due to greenfield investments or mergers and acquisitions. In addition, a new observation may also indicate that an existing affiliate exceeded the voting rights limit or the balance-sheet threshold for the first time. In order to make sure that the latter group of affiliates does not severely distort the clear distinction between firms with and without new affiliates, we have produced additional results excluding observations prior to 2002 (the year of the change in the threshold level; see above). The results remain fully robust, indicating that the uniform threshold assumption we make throughout the empirical analysis in this paper does not bias our estimates.

[14]In case more than one new affiliate was established in a given year, we compute sums or weighted averages across newly established affiliates using fixed-asset weights.

investment.[15] In addition, we make use of firm-specific information on total assets, fixed assets, value added and employment at the domestic parent company's location.

We match *Ustan* with *MiDi* and keep matched observations as well as unmatched observations from *Ustan*.[16] These unmatched units serve as additional control units in the subsequent analysis. Finally, we complement the two firm-level datasets with regional information. These data are merged using a correspondence between firms' German postal codes and a municipality identifier. Most of the variables vary at the county level, while municipality information is used if available.[17] All in all, we end up with an unbalanced panel for the time period between 2000 and 2013, with 2,234 MNEs, 37,299 purely domestic companies, and 197,761 firm-year observations (Table 5.A.2 in the Appendix).

### 5.4.2 Descriptive statistics

Table 5.4.1 provides summary statistics of all explanatory variables used to estimate the probability of establishing a new foreign affiliate (as suggested by Equation (5.3.1)). These can be categorized into variables at the firm level, denoted by $i$ (log of total assets, $TA_{i,t-1}$, value added per employee, $VA_{i,t-1}/EMP_{i,t-1}$, fixed assets per employee, $FA_{i,t-1}/EMP_{i,t-1}$, log of total assets of an MNE's affiliates, $TA_{i,t-1}(Affiliates)$, an MNE dummy indicating whether firm $i$ was an MNE in the year before entry, $MNE_{i,t-1}$),[18] sector-level variables denoted by $s$ ($Sectoral\ Sales\ Growth_{s,t-1}$), and regional-level variables denoted by $k$ or $\ell$ ($CountyGDP_{k,t-1}$, $CountyGDPperWorker_{k,t-1}$, $CountyIncomeperCapita_{k,t-1}$, all measured in logs, $CountyShareHighSkilled_{k,t-1}$, $MunicipalityPopulation_{\ell,t-1}$

[15]Using gross investment avoids problems related to the reporting of book values of fixed assets and depreciations, which may in part be related to tax considerations.

[16]For more details regarding the matching methodology and the quality of the match, see Schild et al. (2017).

[17]While the match between *MiDi* and *Ustan* datasets has been used in two previous studies – Becker and Muendler (2010) and Jäckle and Wamser (2010)–, many of the outcomes employed in this paper (e.g., investment, corporate financial variables, effective tax measures) have never been considered before. Moreover, we add three additional datasets to this data, and all parts of the matched datasets are crucial for our analysis. Therefore, our dataset can be considered novel.

[18]Note that $TA_{i,t-1}(Affiliates)$ and $MNE_{i,t-1}$ are set equal to zero in case no such activity is observed, which is naturally the case when firm $i$ is a domestic one.

measured in logs, $Municipality\ Business\ Tax_{\ell,t-1}$). For a comprehensive list of definitions and data sources, see Table 5.A.1 in the Appendix.

Table 5.4.1: *Determinants of establishing a new foreign affiliate*

| | All Firms | | Treatment Group ($NA = 1$) | | Control Group ($NA = 0$) | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| $TA_{i,t-1}$ | 9.441 | 1.946 | 12.355 | 1.879 | 9.387 | 1.906 |
| $VA_{i,t-1}/EMP_{i,t-1}$ | 4.616 | 0.754 | 5.047 | 0.918 | 4.608 | 0.748 |
| $FA_{i,t-1}/EMP_{i,t-1}$ | 3.246 | 1.864 | 3.468 | 1.494 | 3.242 | 1.870 |
| $TA_{i,t-1}$ (*Affiliates*) | 0.648 | 2.568 | 9.608 | 5.103 | 0.483 | 2.175 |
| $MNE_{i,t-1}$ | 0.062 | 0.241 | 0.809 | 0.393 | 0.048 | 0.214 |
| $Sectoral\ Sales\ Growth_{s,t-1}$ | -0.425 | 20.042 | -0.720 | 21.266 | -0.420 | 20.018 |
| $County\ GDP_{k,t-1}$ | 8.857 | 0.943 | 9.222 | 1.075 | 8.850 | 0.939 |
| $County\ GDP\ per\ Worker_{k,t-1}$ | 4.056 | 0.192 | 4.143 | 0.210 | 4.055 | 0.192 |
| $County\ Income\ per\ Capita_{k,t-1}$ | 3.062 | 0.197 | 3.133 | 0.196 | 3.060 | 0.197 |
| $County\ Share\ High\ Skilled_{k,t-1}$ | 0.087 | 0.042 | 0.103 | 0.051 | 0.086 | 0.042 |
| $Municipality\ Population_{\ell,t-1}$ | 10.578 | 1.793 | 11.165 | 1.889 | 10.567 | 1.789 |
| $Municipality\ Business\ Tax_{\ell,t-1}$ | 0.134 | 0.019 | 0.138 | 0.020 | 0.134 | 0.019 |

Figure 5.4.1 suggests that including regional variables might be important. It documents the number of parent companies per county with at least one foreign affiliate established in the time period between 2000 and 2013.[19] The figure clearly shows that agglomeration effects play a role as most firms establishing foreign affiliates are located in large metropolitan areas such as Munich city, Munich county, Frankfurt, Cologne, Dusseldorf, Berlin and Hamburg (from south to north). Another salient feature is the obvious east-west divide. In short, the geographic distribution of the extensive margin of FDI (setting up a new foreign entity) reflects differences in economic fundamentals at home which we aim at capturing by including a range of regional variables.

[19] Note that for illustration purposes we use all information (not just the matched data) from *MiDi* in Figure 5.4.1, but for reasons of confidentiality, regions with fewer than three parent companies cannot be displayed.

Figure 5.4.1: *Geographic distribution of German firms establishing new foreign affiliates*

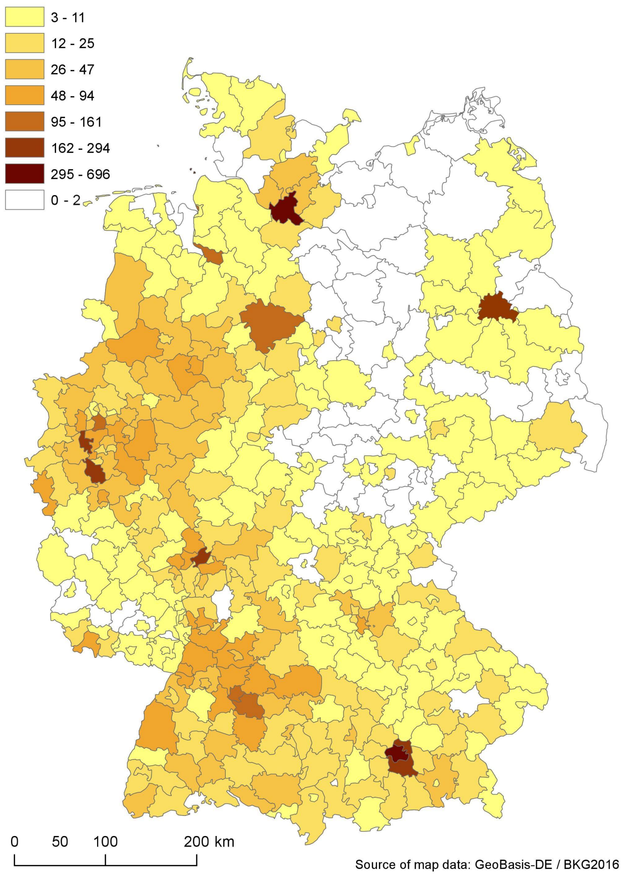



Table 5.4.2 provides an overview of the main outcome variables used. It presents statistics on the whole sample, distinguishing between treatment ($NA_{i,t} = 1$) and control group ($NA_{i,t} = 0$). A simple comparison between both groups without controlling for other variables shows that, on average, gross investment seems to be substantially larger for firms with new affiliates. This holds for the level, $INV_{i,t}$, and the change in gross investment, $\Delta INV_{i,t}$. Both variables are measured in 1,000 EUR. For net investment, $NINV_{i,t}$,[20] we cannot confirm the clear pattern, which could be due to differences in the application of depreciation rules or the composition of fixed assets.

Table 5.4.3 provides information on the characteristics of the new foreign affiliates and their host countries. In total, 9,844 new foreign affiliates were

[20]Changes in fixed assets equal fixed assets in the previous period plus investment expenditures and other additions, less depreciations and other withdrawals.

established between 2000 and 2013.[21] The majority of new affiliates were set up in Western Europe, followed by Eastern Europe, Asia and North America. For each region, we provide average values of the foreign affiliates' (denoted by $a$) sales, $SALES_{a,t}$, employment, $EMP_{a,t}$, fixed tangible and intangible assets, $FA_{a,t}$, and total assets, $TA_{a,t}$ (all these variables are measured in levels, in 1,000 EUR). There is substantial variation in the characteristics of host countries (denoted by $c$) such as GDP per capita ($GDPPC_{c,t}$), the statutory tax rate ($STR_{c,t}$), and a variable measuring the depth of the local capital market, domestic credit provided to the private sector relative to country $c$'s GDP ($DCP_{c,t}$). The variables are potentially correlated with the motives of the parent company for investing abroad, and we exploit variation therein when studying the channels of the effect on domestic investment in Section 5.6.

Table 5.4.2: *Descriptive statistics (outcome variables)*

| | All Firms | | | Treatment Group ($NA = 1$) | | | Control Group ($NA = 0$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | N | Mean | SD | N | Mean | SD | N |
| $INV_{i,t}$ | 3333.748 | 10599.811 | 195784 | 12878.203 | 21687.560 | 3352 | 3167.492 | 10222.915 | 192432 |
| $\Delta INV_{i,t}$ | 10.077 | 3308.505 | 193808 | 337.972 | 6529.722 | 3202 | 4.569 | 3226.796 | 190606 |
| $INV_{i,t}/FA_{i,t-1}$ | 0.384 | 0.529 | 193808 | 0.369 | 0.464 | 3520 | 0.384 | 0.530 | 190288 |
| $NINV_{i,t}$ | -489.983 | 4190.902 | 192857 | -1657.708 | 8476.977 | 3156 | -470.556 | 4078.930 | 189701 |
| $\Delta NINV_{i,t}$ | -42.608 | 4879.730 | 191954 | -1.697 | 10144.162 | 3168 | -43.295 | 4741.838 | 188786 |
| $NINV_{i,t}/FA_{i,t-1}$ | -0.072 | 0.431 | 192857 | -0.071 | 0.449 | 3502 | -0.072 | 0.431 | 189355 |

Table 5.4.3: *Characteristics of new foreign affiliates and their host countries*

| | Number of new foreign affiliates | $SALES_{a,t}$ Mean | $EMP_{a,t}$ Mean | $FA_{a,t}$ Mean | $TA_{a,t}$ Mean | $GDPPC_{c,t}$ Mean | $STR_{c,t}$ Mean | $DCP_{c,t}$ Mean |
|---|---|---|---|---|---|---|---|---|
| Western Europe | 4168 | 49515.595 | 116.883 | 16081.102 | 115159.827 | 10.587 | 0.305 | 133.788 |
| Eastern Europe | 1738 | 27173.188 | 155.930 | 11546.246 | 26655.468 | 9.832 | 0.218 | 38.905 |
| Africa | 203 | 23024.631 | 187.729 | 5047.212 | 20626.823 | 9.009 | 0.301 | 95.425 |
| Middle East | 178 | 12735.955 | 70.376 | 4132.506 | 16559.247 | 10.485 | 0.144 | 54.641 |
| North America | 1390 | 113551.079 | 193.509 | 52216.710 | 221143.018 | 10.649 | 0.363 | 161.159 |
| Caribbean | 30 | 10833.333 | 108.233 | 9855.800 | 31762.033 | 9.477 | 0.101 | 35.377 |
| Central/South America | 408 | 28620.098 | 148.868 | 11826.199 | 39108.284 | 9.447 | 0.317 | 42.399 |
| Asia | 1558 | 55212.452 | 173.497 | 20563.657 | 59620.666 | 9.444 | 0.292 | 115.832 |
| Oceania | 171 | 26497.076 | 80.667 | 11303.877 | 39233.561 | 10.506 | 0.313 | 109.725 |

[21] The number of MNEs is lower since some parent companies establish more than one new foreign affiliate in a given year. The data in Table 5.4.3 correspond to the respective years in which the new foreign affiliates were established.

## 5.5 Basic results

This section presents the findings of our empirical analysis using the propensity score matching method as outlined above. The structure follows the steps of the practical implementation. First, we present the results from estimating the probabilities of establishing a new affiliate. Thereafter, we estimate an ATT associated with establishing a new foreign affiliate on domestic investment. We make sure that neither prior trends nor (potentially negative) longer-term effects on the change in investment exist, which could bias our results. Following these extensive margin considerations, we also present intensive margin elasticities. Then, we provide a thorough sensitivity analysis of our main results, estimate ATTs for alternative outcomes and consider potential heterogeneity in treatment effects with respect to characteristics specific to firms or destination countries.

### 5.5.1 The probability of establishing a new foreign affiliate

We estimate the probability of establishing a new foreign affiliate based on Equation (5.3.1), including Mundlak-Chamberlain means of the time-varying explanatory variables as well as time and sector effects. All subsequent estimates of the domestic investment effects are based on this specification.[22] Table 5.5.1 presents the results of the probit estimate for all time-varying explanatory variables.[23] We employ lagged variables (i.e., in the year before foreign market entry) as regressors, and observe a high level of significance for most factors. The positive coefficients for total assets and fixed assets per employee indicate that large and capital-intensive firms are more likely to expand abroad, which is consistent with previous findings (Tomiura, 2007). We do not find an additional effect of labor productivity on the probability of establishing a new foreign affiliate after controlling for size and capital intensity. This is in line with the theoretical predictions

[22]Tables 5.A.3 and 5.A.4 in the Appendix provide estimation results for alternative probit specifications.

[23]An F-test indicates joint significance of the Mundlak-Chamberlain means, which are included as regressors to control for unobserved firm heterogeneity.

in Melitz (2003), Helpman et al. (2004), and Helpman (2006).[24] Furthermore, the results reveal that greater foreign activity in the preceding year (measured by the sum of total assets of existing affiliates) is associated with a higher probability of setting up another foreign affiliate. If the firm is already an MNE with foreign affiliates, it is less likely that we observe further foreign activity after controlling for the size of existing affiliates. While the latter finding is conditional on many covariates, it indicates that our data include both existing MNEs expanding their foreign affiliates networks and domestic firms becoming new MNEs.

Turning the focus to potential determinants on a regional level, we find that most variables are insignificant in the probability model, although there is substantial variation across the approximately 400 counties and 12,000 municipalities. Only for (i) GDP and (ii) the share of high-skilled labor in the (German) county where the firm is located, we observe a negative (and significant) effect. In contrast to this, there is no evidence that per capita measures of economic wealth such as county GDP per worker and county income per capita have a distinct impact on the propensity to expand abroad. Moreover, variables measured at the municipality level are not found to be significant either. The lack of significant evidence for factors at the county and municipality level is surprising, as these characteristics are usually expected to affect an MNE's decision of whether to expand or not (and also exhibit substantial time variation). Overall, our results suggest that firm-specific characteristics are the driving force behind the investment decision in question.

[24] However, note that our results are not directly comparable to these models, since they focus on selection into foreign activity, while we consider the extensive margin of FDI in a somewhat broader sense.

Table 5.5.1: *Probability of establishing a new foreign affiliate*

| | (1) |
|---|---|
| $TA_{i,t-1}$ | 0.361*** |
| | (0.056) |
| $VA_{i,t-1}/EMP_{i,t-1}$ | -0.056 |
| | (0.041) |
| $FA_{i,t-1}/EMP_{i,t-1}$ | 0.064** |
| | (0.027) |
| $TA_{i,t-1}$ *(Affiliates)* | 0.069** |
| | (0.034) |
| $MNE_{i,t-1}$ | -1.216*** |
| | (0.321) |
| *Sectoral Sales Growth*$_{s,t-1}$ | 0.083 |
| | (0.106) |
| *County GDP*$_{k,t-1}$ | -1.339** |
| | (0.591) |
| *County GDP per Worker*$_{k,t-1}$ | 0.976 |
| | (0.635) |
| *County Income per Capita*$_{k,t-1}$ | 0.557 |
| | (0.463) |
| *County Share High Skilled*$_{k,t-1}$ | -3.748* |
| | (2.262) |
| *Municipality Population*$_{\ell,t-1}$ | -0.004 |
| | (0.084) |
| *Municipality Business Tax*$_{\ell,t-1}$ | -0.372 |
| | (2.732) |

Standard errors clustered at the firm-level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively. A Wald test indicates joint significance of the Mundlak-Chamberlain means, which are included, but not reported here.

### 5.5.2 The effects of investing abroad

Using the propensity scores obtained from above, we estimate an average treatment effect on the treated (ATT), as in Equation (5.3.2), associated with establishing a new foreign affiliate on domestic investment. We employ radius matching with a caliper of 0.01 and match observations exactly by year in order to ensure that we only compare firm-year observations of the same year.[25] We then apply weighted regressions (with weights obtained from the propensity score matching) to estimate ATTs. In these regressions, we additionally condition on year-specific effects and imbalanced covariates, in case conditioning on the propensity score

[25] The choice of the caliper is consistent with the rule of thumb suggested by Austin (2011). According to the latter paper, a caliper width of about 20% of the standard deviation of the propensity score is optimal. This would suggest a caliper of 0.014 for the estimated propensity scores. In any case, our results prove to be very robust to the use of different calipers (see Table 5.A.5 in the Appendix).

does not fully remove significant differences in the means of pre-treatment characteristics.[26]

Table 5.5.2: *ATT of establishing a new foreign affiliate*

| | ATT | SE | No. treated ($NA = 1$) | No. untreated ($NA = 0$) |
|---|---|---|---|---|
| $INV_{i,t}$ | 1274.485** | 521.994 | 2998 | 188429 |
| $\Delta INV_{i,t}$ | 458.126*** | 145.101 | 3021 | 188740 |
| $INV_{i,t}/FA_{i,t-1}$ | 0.044*** | 0.010 | 2979 | 185053 |
| $NINV_{i,t}$ | 669.878*** | 205.790 | 2880 | 186413 |
| $\Delta NINV_{i,t}$ | -72.639 | 203.181 | 2900 | 185796 |
| $NINV_{i,t}/FA_{i,t-1}$ | 0.030*** | 0.010 | 2955 | 184112 |

Estimates are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. Standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Table 5.5.2 presents the results of the ATT estimates for six different measures of domestic investment.[27] We find that establishing a new affiliate in a foreign country has a highly significant and positive effect on domestic investment of the parent company. Our preferred estimate is the ATT for $\Delta INV_{i,t}$, since (i) gross investment is unaffected by the application of depreciation rules as argued above, and (ii) focusing on changes in outcome variables effectively combines propensity score matching with a difference-in-differences approach (Heckman et al., 1998; Blundell et al., 2004). The results suggest that a newly established foreign affiliate is associated with an increase in domestic investment activity of EUR 458,126. This is a substantial effect, given that the average firm in the treatment group invests EUR 12,878,000 per year. Similarly, domestic investment relative to fixed assets in the previous period is 4.4 percentage points higher as a result of increased foreign activity. For the level of domestic investment we obtain a larger ATT of EUR 1,275,000. The results for net investment, defined as changes in fixed assets, with the exception of the ATT for changes in net investment, $\Delta NINV_{i,t}$, are similar to those of gross investment. The level of

[26] The common support condition is guaranteed to hold for treated and non-treated firms in each year. Moreover, as shown in Table 5.A.6 in the Appendix, all variables except *County Income per Capita*$_{k,t-1}$ are well balanced between the treatment and control group in our main specification. Hence, we usually condition only on the latter variable.

[27] We should highlight that all estimates shown here have to be interpreted as short-run effects. Producing long-run estimates on the consequences of foreign activity requires additional years of data. Some results in this regard are presented in Section 5.5.3, yet only relying on a substantially lower number of observations.

net investment is EUR 670,000 larger and the growth rate of the capital stock ($NINV_{i,t}/FA_{i,t-1}$) 3 percentage points higher as a consequence of establishing a new foreign affiliate. Altogether, we can draw the preliminary conclusion that the impact of FDI on domestic investment is positive and substantial, irrespective of the particular measure of domestic investment under consideration.[28]

### 5.5.3 Timing of effects

An important issue which is rather difficult to address with our data is the question of whether investing abroad leads to long-run effects on home investment. What we observe is whether an existing MNE is establishing a new foreign affiliate in year $t$ or whether a domestic firm (yet to become an MNE) is investing in a foreign country for the first time. In the following, we make sure that MNEs are not setting up new foreign affiliates twice within a window of five years around the treatment (i.e., in periods $t-2$ to $t+2$, we allow for only one treatment). However, it might be that MNEs invest several times over the whole sample period. In any case, including leads and lags of the indicator variable $NA_{i,t}$ to capture long-run as well as anticipation effects relative to the treatment year will lead to a substantial loss of observations. The latter relates to the fact that (i) our firm-year panel is unbalanced and (ii) we observe many firms setting up foreign affiliates at the beginning or the end of the 13-year panel period. Moreover, as mentioned above, we need to impose the restriction that firms are not investing multiple times as this would blur our estimates.

Table 5.5.3 provides estimates where the indicator variable $NA_{i,t}$ is included in leads ($t+1$ and $t+2$) as well as in lags ($t-1$ and $t-2$). In column 1, compared to our benchmark estimate, we lose 2,645 treated observations.[29] The results suggest that there is a one-time increase in investment activity. The two indicators measuring long-run responses are obviously insignificant.

[28] We provide additional tests concerned with two issues. First, we account for outliers (Table 5.A.7 in the Appendix), where we remove the most extreme values of the dependent variable as these might drive our estimates. The tests show that the findings are very robust, and outliers do not seem to be an issue. Second, we check whether the effects are more pronounced if an MNE does not yet maintain affiliates in the country where the new affiliate is set up (this is the case for 80% of the investing firms). We provide the results in Table 5.A.8 in the Appendix.

[29] Note that we keep the weights from the propensity score constant. The latter is required to ensure consistency in making the comparison between treated and non-treated firms.

Table 5.5.3: *Timing of effects*

| | new affiliate | new MNE |
|---|---|---|
| $NA_{i,t+2}$ | -43.617 | -12.311 |
| | (555.011) | (563.654) |
| $NA_{i,t+1}$ | 59.748 | 52.342 |
| | (180.940) | (180.665) |
| $NA_{i,t}$ | 532.116*** | 466.692* |
| | (199.693) | (264.369) |
| $NA_{i,t-1}$ | -220.587 | 81.306 |
| | (234.919) | (363.332) |
| $NA_{i,t-2}$ | -550.315 | 199.539 |
| | (522.924) | (384.223) |
| No. treated | 376 | 239 |

Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

This is exactly what we would expect as an ever increasing effect on the outcome $\Delta INV_{i,t}$ would not lead to an equilibrium. The coefficients on the lagged variables indicate that there are no anticipation effects. This suggests that there is no differential prior trend which could bias our difference-in-differences results. Column 2 focuses on new MNEs which helps us to make sure that multiple foreign (previously established) affiliates are not an issue. This leads to an additional loss of observations. However, the only significant effect is the one estimated for $NA_{i,t}$.[30]

In an additional specification, we check whether there is a long-term effect by using the difference between $INV_{t+3}$ and $INV_{i,t-1}$ as outcome. This effect is positive and quantitatively very similar to the baseline effect on $\Delta INV_{i,t}$, but insignificant. This indicates that there is only a one-time positive effect in period t, and even if the impact on $\Delta INV_{i,t+3}$ is positive, too much noise (post treatment) renders the coefficient insignificant.

In summary, we do not find any long-term effect on $\Delta INV_{i,t}$, which is what

[30]Note that we provide additional tests using alternative outcomes in the Appendix (Tables 5.A.9 and 5.A.10). See also Section 5.5.6, where we introduce these alternative outcomes and provide estimates for them.

we would expect. We can also refute the hypothesis of prior trends and any kind of anticipation effects.[31]

### 5.5.4 Intensive margin elasticities

While our basic results mainly focus on the effects at the extensive margin of FDI, we are also interested in comparing our estimates to the ones of previous studies. To a large extent, existing research has provided estimates on elasticities at the intensive margin. As in Section 5.5.2, we run a weighted regression of outcome $y_{i,t}$ on $NA_{i,t}$, based on the weights obtained from the matched sample. To this parsimonious regression, we now add an interaction term between $NA_{i,t}$ and $\overline{FDI}_{a,t}$. The latter variable denotes demeaned measures of foreign activity. To be precise, we define $\overline{FDI}_{a,t} = FDI_{a,t} - MFDI$, where $MFDI$ denotes the sample mean of $FDI_{a,t}$. By doing so, we guarantee that the coefficient on the uninteracted new-affiliate-indicator still provides an estimate of the ATT (Wooldridge, 2010; Egger et al., 2015). The index $a$ indicates that we measure the latter at the level of the foreign affiliate. We use three variables to capture foreign activity: fixed tangible and intangible assets ($FA_{a,t}$), equity capital of FDI ($EFDI_{a,t}$), and the consolidated sum (equity capital plus internal debt) of FDI ($CFDI_{a,t}$). The estimated coefficient on $NA_{i,t} \times \overline{FDI}_{a,t}$ provides an estimate of the intensive margin effect of investing abroad. For the sake of comparability, in Table 5.5.4, we report elasticities rather than the coefficients on $NA_{i,t} \times \overline{FDI}_{a,t}$. The respective elasticities are defined as $\varepsilon^{\overline{FDI}} = \frac{\Delta INV}{INV} / \frac{\Delta \overline{FDI}}{\overline{FDI}}$, for $\overline{FDI} = \{\overline{FA}, \overline{EFDI}, \overline{CFDI}\}$.[32] The findings suggest that 1 percent more foreign activity (measured by fixed and intangible assets) leads to about 0.13 percent more investment at home. The elasticities for

[31] Another approach to address the concern of prior trends is to condition on firm-specific trends in the outcome equation. Estimates including such a trend on $\Delta INV_{i,t}$ suggest a significant treatment effect of 459.328 (224.302), which is very close to the benchmark estimates. Note that we guarantee in this additional test that treated firms are observed in the data for at least 5 years, as this firm-specific approach relies on sufficient variation over time.

[32] Note that the elasticities reported are based on specifications in which we define the outcome in levels and the volume of FDI in logs. We have chosen this specification to ensure comparability with our benchmark results on the ATT. Slightly different specifications where the outcome is defined in logs as well, or where FDI is defined as $log(FDI + 1)$ (as $FA_{a,t}$ is equal to zero in some cases, while $EFDI_{a,t}$ and $CFDI_{a,t}$ can also be negative), yield very similar results. Note also that $\varepsilon^{\overline{FA}}$ is our preferred estimate as taking logs of $FA_{a,t}$ implies the smallest loss of observations.

equity capital of FDI and the consolidated sum of FDI are somewhat bigger but go in the same direction. Since investment at home is measured in fixed assets, our preferred estimate is the one on $\varepsilon^{\overline{FA}}$.

Table 5.5.4: *Intensive margin elasticities*

| | (1) | (2) | (3) |
|---|---|---|---|
| | $INV_{i,t}$ | $INV_{i,t}$ | $INV_{i,t}$ |
| $\varepsilon^{\overline{FA}}$ | 0.127*** | | |
| | (0.025) | | |
| $\varepsilon^{\overline{EFDI}}$ | | 0.183*** | |
| | | (0.040) | |
| $\varepsilon^{\overline{CFDI}}$ | | | 0.228*** |
| | | | (0.039) |

Estimates are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Compared to previous studies, the estimated elasticities presented in Table 5.5.4 are lower. For example, Desai et al. (2009) find an elasticity of about 0.26.[33] We believe, however, that our approach has some advantages compared to previous work. First, we specifically account for selection into foreign activity. We do this not only by conditioning on the vector of observables as shown in Equation (5.3.1), but also by explicitly modeling selection into treatment. This also allows us to separate the extensive effect from the intensive one and provide estimates for both. Second, the robustness tests in Section 5.5.5 show that firm, regional, industry, and time effects fully capture that specific types of firms invest in a given period for specific reasons (selection into treatment). Then, the estimates on FDI should also be consistent under the same assumptions (which are fairly weak compared to a linear regression model) as imposed above (see Section 5.3). Third, and related to the first point, the approach generally solves the problem of not observing foreign activity in $t-1$, i.e. before treatment, neither for

[33]Note, however, that these values cannot be compared directly, as we are only considering intensive margin elasticities for newly established affiliates. We provide additional results in Table 5.A.11 in the Appendix, which replicate the approach of Desai et al. (2009).

the treated, nor for the untreated. This leads to bias in a linear regression model – as the extensive margin is not modeled explicitly and a linear relationship is assumed.

### 5.5.5 Sensitivity analysis

#### 5.5.5.1 Propensity score estimation and matching algorithm

We assess the robustness of our main result by using a range of different specifications for estimating the propensity score and by varying the matching algorithm. The goal of estimating Equation (5.3.1) is to obtain the best estimate for the selection into treatment. In principle, propensity score models including higher-order terms of the covariates can be used, although over-parameterization remains a concern (Augurzky and Schmidt, 2001; Bryson, 2002). Hence, as a robustness test, we include quadratic and cubic terms of all the explanatory variables in the estimation of the propensity score model in order to account for potential nonlinear relationships (Table 5.5.5, (1) and (2)). Moreover, the results in Table 5.5.5, (3), indicate robustness to the inclusion of second order lags in the propensity score estimation. Our baseline estimate captures the influence of changes in time-varying covariates on treatment assignment, while controlling for time-invariant characteristics of the firm by employing the Chamberlain-Mundlak device. Alternatively, we could ignore the panel dimension of our data and directly estimate a pooled probit for selection into treatment (Table 5.5.5, (4)). Similarly, propensity scores can be estimated on a yearly basis, which implies that estimated scores are based on smaller samples, in which unobserved heterogeneity as in our benchmark specification cannot be accounted for (Table 5.5.5, (5)).

In order to test the sensitivity of the results with regard to our choice of the matching algorithm, we also apply nearest neighbor matching with replacement, allowing for a maximum of 100 neighbors and using a caliper of 0.01 (Table 5.5.5, (6)). Moreover, we also apply kernel matching with a caliper of 0.01 (Table 5.5.5, (7)). In our baseline specification, we compare firms from different geographic locations in Germany as well as different sectors with each other. As far as there are systematic differences in the effect between these groups – for example, states at the border versus states in the interior, or manufacturing firms versus services firms – this could be a potential point of concern. To address this issue, we also exactly match firms by state and sector (Table 5.5.5, (8) and (9)). Hence, by insisting on an exact match, we only compare those firms with each other that are in the same state and sector (Heckman et al., 1997, 1998). Although the latter approach seems to be quite restrictive, the estimated ATTs remain almost unaffected.

While the balancing property of the propensity score holds for all variables with the exception of county income per capita, we also provide estimates where we control for all explanatory variables used in the first stage when calculating the ATT (Table 5.5.5, (10)). We finally provide estimates where we additionally condition on four firm-specific variables (Table 5.A.12 in the Appendix). This leaves the baseline effect of setting up a new foreign affiliate virtually unaffected, and it seems that, once we condition on the variables in the propensity score estimation, these variables are almost orthogonal to $NA_{i,t}$.

Table 5.5.5: *Additional sensitivity checks (outcome: $\Delta INV_{i,t}$)*

| | ATT | SE | No. treated ($NA = 1$) | No. untreated ($NA = 0$) |
|---|---|---|---|---|
| (1) Probit: 2nd order polynomial | 453.453*** | 143.897 | 3005 | 188764 |
| (2) Probit: 3rd order polynomial | 465.018*** | 135.042 | 2966 | 188737 |
| (3) Probit: 2nd order lags | 438.259*** | 165.621 | 2406 | 143470 |
| (4) Probit: Pooled estimation | 468.465*** | 146.928 | 3010 | 188585 |
| (5) Probit: Estimated year-by-year | 312.118** | 157.720 | 2987 | 166817 |
| (6) Nearest neighbor matching | 466.693*** | 145.198 | 3021 | 28769 |
| (7) Kernel matching | 390.086*** | 122.534 | 3189 | 188806 |
| (8) Exact matching by state | 495.628*** | 153.445 | 2443 | 144022 |
| (9) Exact matching by sector | 366.926** | 153.493 | 2687 | 160842 |
| (10) Condition on all first stage variables | 459.837*** | 147.665 | 3021 | 188740 |

Estimates are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. Standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Table 5.5.5 illustrates that all alternative specifications leave the ATT by and large unchanged in terms of significance and sign. Hence, this indicates that we maintain a highly significant and positive effect of FDI on domestic investment.

#### 5.5.5.2 Placebo and permutation tests

In the following, we present further results using placebo treatments and a permutation test. A placebo test can shed light on the question of whether changes in domestic activity in the treatment year can actually be interpreted as the effect of establishing a new affiliate abroad. Similar tests are also frequently used in the treatment literature to evaluate the common trends assumption in difference-in-differences models. In our case, the common trends assumption requires that treated and control firms would have evolved similarly in the absence of treatment. We address both points by (i) considering changes in domestic investment in the year before establishing a new *foreign* affiliate and (ii) analyzing the effects of new *domestic* affiliates as placebo treatments.

Table 5.5.6 reports estimates of the ATT for the year prior to treatment as well as the ATT for the actual treatment year for the same sample of firms.[34] The ATT in the year of treatment is estimated to be positive and strongly significant, which is consistent with Table 5.5.2. The placebo ATT in the year prior to treatment clearly suggests the absence of a placebo effect, indicating that the increase in investment coincides precisely with the establishment of a new affiliate abroad.

Table 5.5.6: *Placebo treatments in year t-1*

| | ATT | SE | No. treated ($NA = 1$) | No. untreated ($NA = 0$) |
|---|---|---|---|---|
| $\Delta INV_{i,t-1}$ | 86.764 | 177.940 | 1704 | 155799 |
| $\Delta INV_{i,t}$ | 501.834*** | 133.348 | 1704 | 155799 |

Standard errors clustered at the firm level are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

A second endogeneity concern could be that some foreign and some domestic investments are undertaken simultaneously, making it difficult to establish a causal link between FDI and domestic investment. We use the establishment of a new *domestic*, German affiliate as a placebo treatment and find that there is

[34] This is done for the sake of comparability of placebo and actual-year-of-treatment effects. The sample of firms considered in the placebo test is smaller than for the baseline ATT due to the requirement of three consecutive observations and the absence of successive treatments.

no significant effect on domestic investment (Table 5.A.13 in the Appendix).[35] If we contrast this finding to the substantial and highly significant effect of establishing a new *foreign* affiliate, this is strong evidence that there is a fundamental difference between a new domestic and a new foreign affiliate.[36]

A further concern pertains to the calculation of standard errors for our difference-in-differences estimates, which may be biased downward in the presence of serial correlation (Bertrand et al., 2004). We address this issue by implementing two nonparametric permutation tests for the ATT (Fisher, 1922; Chetty et al., 2009). That is, we simulate an empirical distribution of placebo estimates to which our actual ATT can be compared. There are several possible ways of re-shuffling treatment across firms. First, we randomly select 3,021 firm-year observations[37] from the subset of MNEs in our dataset.[38] Second, we keep the structure of treatment timing and randomly select 332 firm-year observations for the year 2000, 314 for 2001, and so on (cf. Table 5.A.2). We then reestimate selection into treatment as well as the ATT, and we repeat this procedure 1,000 times. Figure 5.5.1 provides the empirical distribution of the placebo ATTs for $\Delta INV_{i,t}$ and both permutation alternatives. The vertical lines indicate the treatment effect as reported in Table 5.5.2. In both cases they are clearly located to the right of the 1,000 simulated ATTs and suggest significance at the 1% level.

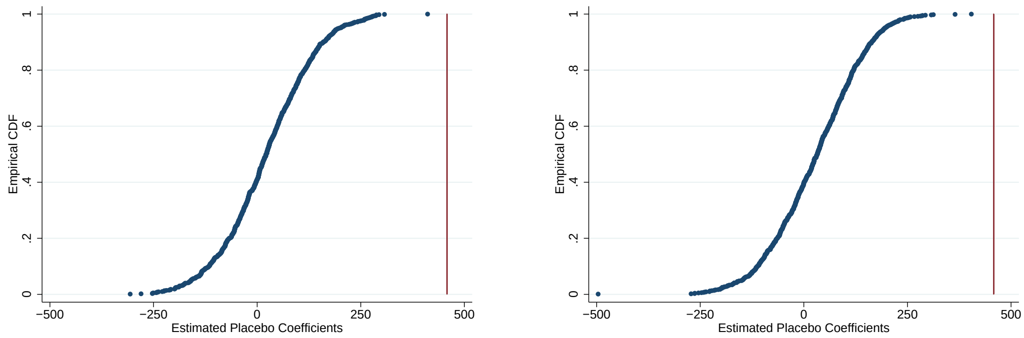
[35] Unfortunately, the original dataset used for our analysis does not allow us to check whether there is a significant effect of opening a German affiliate on investment in the rest of the firm. However, to overcome this, we have matched our data with *Orbis*, a commercial dataset including, inter alia, firm-level balance-sheet data, ownership information and location details. Admittedly, this leads to a substantial loss of treated observations (140-150 treated firms compared to 3,021 in the original estimation), as the *Orbis* data is only available for the period 2006 to 2013.

[36] In addition to the latter results, we also examine whether establishing a new *domestic* affiliate affects other outcomes such as the tax bill, which is one of the alternative outcomes we analyze below. The results suggest that no significant impact on the tax bill is observed when a new domestic affiliate is set up (see Table 5.A.13 in the Appendix). This is not surprising, as then, there is no tax differential between the home location and the new affiliate's destination to be exploited. In the spirit of Simon (2016), we moreover check whether some other lump-sum German investment has a significant effect on (i) investment and (ii) the tax bill (Table 5.A.14 in the Appendix). In this approach, a firm is considered to be 'treated' if the growth of (domestic) fixed assets is above the median in a given year (rows 1 and 2) or in the top decile (rows 3 and 4). The results indicate that also these lump-sum German investments do not have a significant effect on neither investment nor the tax bill.

[37] This corresponds to the number of firm-year observations with newly established foreign affiliates (Table 5.5.2).

[38] MNEs are more likely to establish new foreign affiliates than purely domestic firms. Repeating both permutation tests for the full dataset yields qualitatively similar results.

Figure 5.5.1: *Distribution of placebo estimates*




(a) *Same number of treatments* (b) *Same years & number of treatments*

Thus, the permutation tests confirm that the establishment of new foreign affiliates treatment is related to a significant increase in domestic investment.

### 5.5.6 Alternative outcomes

Our identification strategy also allows us to shed light on the effect that the establishment of new foreign affiliates has on other domestic activities. We therefore provide estimates for three different measures of firm size, as well as compensation per employee. To be consistent with the preferred outcome from above, $\Delta INV_{i,t}$, we use the first differences in total assets ($\Delta TA_{i,t}$), total sales ($\Delta SALES_{i,t}$), employees ($\Delta EMP_{i,t}$) and wages ($\Delta WAGES_{i,t}$).[39] Table 5.5.7 shows that total assets (EUR 4.8 million), and labor demand (6 employees) both become greater in response to an increase in foreign activity. Our results are broadly in line with Desai et al. (2009) who find that foreign and domestic asset, sales and employment growth are complementary. We do not find evidence that firms establishing new foreign affiliates pay higher wages. This, however, is perfectly consistent with the results below, where we show that an additional foreign investment does not lead to an increase in productivity. Note that the focus of our paper is mainly on investment in real capital, and therefore we do not provide a more detailed discussion and tests on the alternative outcomes.

[39] In particular, with respect to employment effects, one could think of firms taking time to react, hence firm responses may be delayed. However, results in this regard, analogously to those presented in Section 5.5.3, show that this is not the case here (see Table 5.A.9 in the Appendix).

Table 5.5.7: *Alternative outcomes*

| | ATT | SE | No. treated ($NA = 1$) | No. untreated ($NA = 0$) |
|---|---|---|---|---|
| $\Delta TA_{i,t}$ | 4752.288*** | 927.211 | 2721 | 186834 |
| $\Delta SALES_{i,t}$ | 1638.517 | 1057.054 | 2814 | 186554 |
| $\Delta EMP_{i,t}$ | 6.247*** | 1.907 | 2817 | 183956 |
| $\Delta WAGE_{i,t}$ | 0.221 | 0.176 | 2797 | 182510 |

Estimates are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. Standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

### 5.5.7 Heterogeneity in treatment effects

In Table 5.5.8 we test whether the domestic effect varies in variables usually employed in gravity-type models of trade. In particular, we interact the treatment indicator $NA_{i,t}$ with the following three variables: $\overline{DIST}_c$, $\overline{GDP}_{c,t}$, and $\overline{GDPPC}_{c,t}$, where the bar indicates that all variables are demeaned in the same manner as described in Section 5.5.4.

$DIST_c$ measures the log distance between Germany and host country $c$, $GDP_{c,t}$ is the log of the host country's GDP, and $GDPPC_{c,t}$ the log of the host country's GDP per capita. In separate specifications, including these interaction terms one by one, only $NA_{i,t} \times \overline{GDPPC}_{c,t}$ turns out to be statistically significant. The positive coefficient implies that the treatment effect becomes larger in the per capita income of the host country. This could be interpreted as evidence against the hypothesis that the positive treatment effect is in any form related to firms' outsourcing to low-wage or low-productivity countries. We come back to this issue below, as this finding is consistent with the interpretations concerning the potential drivers behind the positive effect of $NA_{i,t}$. In the last column, where we include all interaction terms, also $NA_{i,t} \times \overline{DIST}_c$ is significant. This means that the longer the distance between Germany and the host country, the more pronounced is the positive effect on domestic investment.

Table 5.5.8: *Heterogeneity in treatment effects*

| | $\Delta INV_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta INV_{i,t}$ |
|---|---|---|---|---|
| $NA_{i,t}$ | 444.467*** | 447.368*** | 447.547*** | 448.960*** |
| | (143.806) | (144.364) | (144.123) | (144.033) |
| $NA_{i,t} \times \overline{DIST}_c$ | 86.652 | | | 249.687** |
| | (88.251) | | | (102.817) |
| $NA_{i,t} \times \overline{GDP}_{c,t}$ | | -20.801 | | -96.175 |
| | | (80.919) | | (88.097) |
| $NA_{i,t} \times \overline{GDPPC}_{c,t}$ | | | 364.814** | 517.579*** |
| | | | (164.074) | (176.879) |

Standard errors are obtained from running weighted regressions including year effects, and conditioning on imbalanced covariates. Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

## 5.6 What explains the positive relationship between foreign and domestic investment?

So far, our empirical analysis has mainly been concerned with estimating ATTs associated with setting up a new foreign affiliate. In the following sections, we complement these basic results by identifying the potential channels that may explain the finding of a positive domestic investment effect. First, we examine productivity gains linked to the re-organization of production. Second, we analyze tax savings and profit-shifting opportunities. Finally, we shed light on financing aspects and internal capital markets.

We present empirical results with respect to these three channels in a condensed way in Table 5.6.1, which is structured as follows: in addition to the baseline effect of establishing a new foreign affiliate, we include (i) a series of interactions of $NA_{i,t}$ with variables concerned with the three channels, and (ii) estimate the effects of a new foreign affiliate not only on investment, but also on other outcome variables (total factor productivity, tax payments, and internal debt). Moreover, in all specifications, we control for the country characteristics ($\overline{DIST}_c$, $\overline{GDP}_{c,t}$, $\overline{GDPPC}_{c,t}$) discussed above to rule out omitted variable bias.[40]

[40]Table 5.A.15 in the Appendix provides estimation results in which standard errors are clustered at the level of host countries instead of the firm level.

The interactions specific to each channel as well as the additional outcome variables are discussed in the next sections (5.6.1, 5.6.2, and 5.6.3).

Table 5.6.1: *Three channels to explain the domestic effects of FDI*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | $\Delta INV_{i,t}$ | $\Delta TFP_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta TAX_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta TAX_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta ID_{i,t}$ | $\Delta INV_{i,t}$ |
| $NA_{i,t}$ | 450.647$^{***}$ | -0.257 | 433.917$^{***}$ | -109.110$^{**}$ | 432.573$^{***}$ | -109.556$^{**}$ | 414.216$^{***}$ | 469.819$^{**}$ | 384.147$^{**}$ |
| | (144.208) | (0.158) | (143.846) | (53.882) | (143.205) | (53.816) | (152.265) | (192.855) | (151.389) |
| $NA_{i,t} \times \overline{VERT}_{a,t}$ | -187.787 | 0.108 | | | | | | | 59.835 |
| | (227.227) | (0.279) | | | | | | | (245.970) |
| $NA_{i,t} \times \overline{IGCA}_{a,t}$ | -421.864 | -0.805 | | | | | | | -731.254 |
| | (834.751) | (1.380) | | | | | | | (926.344) |
| $NA_{i,t} \times \overline{CESEE}_{a,t}$ | 19.833 | -0.003 | | | | | | | -204.894 |
| | (307.721) | (0.384) | | | | | | | (483.182) |
| $NA_{i,t} \times \overline{DSTR}_{c,t}$ | | | 4142.748$^{***}$ | -367.522 | 4159.319$^{**}$ | -359.932 | | | 6321.722$^{***}$ |
| | | | (1602.983) | (670.881) | (1617.915) | (675.531) | | | (2120.986) |
| $NA_{i,t} \times \overline{DCE}_{c,t}$ | | | | | -8.490 | -13.454 | | | 67.526 |
| | | | | | (239.132) | (100.771) | | | (286.963) |
| $NA_{i,t} \times \overline{IGL}_{a,t}$ | | | | | -1801.543 | -1754.405$^{**}$ | | | -2040.559 |
| | | | | | (1914.829) | (826.131) | | | (2030.040) |
| $NA_{i,t} \times \overline{DCP}_{c,t}$ | | | | | | | 768.156 | 1147.915 | 307.229 |
| | | | | | | | (702.595) | (806.375) | (797.560) |
| $NA_{i,t} \times \overline{DCPB}_{c,t}$ | | | | | | | -725.415 | -875.282 | -91.445 |
| | | | | | | | (667.421) | (783.019) | (825.145) |
| $NA_{i,t} \times \overline{SMC}_{c,t}$ | | | | | | | 90.589 | -116.748 | 0.105 |
| | | | | | | | (270.879) | (320.954) | (305.099) |
| $NA_{i,t} \times \overline{DIST}_{c}$ | 255.859$^{**}$ | 0.327$^{**}$ | 238.267$^{**}$ | 12.715 | 236.869$^{**}$ | 12.214 | 243.637$^{*}$ | 266.937 | 238.021$^{*}$ |
| | (105.791) | (0.141) | (102.054) | (43.983) | (102.096) | (43.926) | (124.416) | (164.037) | (127.117) |
| $NA_{i,t} \times \overline{GDP}_{c,t}$ | -95.395 | 0.019 | 38.656 | -60.504 | 39.623 | -59.739 | -126.687 | -171.285 | 23.322 |
| | (93.114) | (0.128) | (103.258) | (42.076) | (104.224) | (42.230) | (111.900) | (131.318) | (127.006) |
| $NA_{i,t} \times \overline{GDPPC}_{c,t}$ | 549.051$^{***}$ | 0.074 | 569.602$^{***}$ | -55.437 | 574.393$^{***}$ | -49.157 | 360.621 | 533.992$^{*}$ | 488.510$^{*}$ |
| | (189.744) | (0.230) | (179.018) | (80.068) | (181.132) | (80.035) | (265.497) | (305.277) | (293.744) |

Estimates are obtained from running weighted regressions including year effects, and conditioning on imbalanced covariates. Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

### 5.6.1 Production and technology channel

We start by examining whether the positive relationship between FDI and domestic investment can be explained by changes in the organization of production of the MNE. In particular, the existing literature has emphasized potential differences in the home market effects of FDI, depending on the specific type of FDI.

Efficiency-seeking or vertical FDI is expected to have positive effects if efficiency gains prevail over the direct losses from offshoring parts of the production process (Hejazi and Pauly, 2003; Desai et al., 2005; Arndt et al., 2010). The net effect of market-seeking or horizontal FDI is assumed to depend on whether FDI displaces exports or not (Desai et al., 2005; Hejazi and Pauly, 2003). In the following, we focus on potential productivity gains from vertical FDI. We use the approach proposed by Levinsohn and Petrin (2003) to obtain value-added-based estimates of total factor productivity, $TFP_{i,t}$. Based on these estimates, we estimate ATTs on TFP.[41] In addition, we interact three proxies of vertical/horizontal FDI with the treatment indicator. First, we construct a proxy for vertical FDI, $VERT_{a,t}$, which equals one if the parent company operates in a different sector than the new foreign affiliate, and is zero otherwise (Arndt et al., 2010). Second, we interact the treatment indicator with the share of current claims on affiliated enterprises relative to total assets of the newly established affiliate, $IGCA_{a,t}$, which is expected to be larger in the presence of intermediates trade with an affiliate $a$. Third, we use a dummy for new foreign affiliates in Central, Eastern and Southeastern Europe (CESEE), $CESEE_{a,t}$, which has been a popular offshoring destination for German MNEs. All proxies for vertical FDI are demeaned, as above.

Column (1) in Table 5.6.1 presents regressions where $\Delta INV_{i,t}$ is the outcome and the interactions between the proxies for vertical FDI and $NA_{i,t}$ are included. The interactions of the vertical FDI proxies with $NA_{i,t}$ are all insignificant. Column (2) suggests that the ATT for $\Delta TFP_{i,t}$ is highly insignificant. The absence of a productivity effect is consistent with the observation that establishing a new foreign affiliate does not make MNEs pay higher wages (c.f. Section 5.5.6). From this relatively clear picture, we conclude that the re-organization of production, in particular regarding productivity gains from vertical FDI, does not seem to be a relevant channel for explaining the positive link between FDI and domestic investment.

[41] Using revenue-based measures of TFP (Levinsohn and Petrin, 2003) or labor productivity (value added per employee) yields similar results.

### 5.6.2 Tax savings and profit shifting channel

In this subsection, we provide evidence that the domestic investment effects of foreign investment are heterogeneous in corporate tax differentials. Moreover, we analyze changes in tax payments as an additional outcome. The findings leave scope for a profit-shifting interpretation, which we discuss in the following.

A substantial literature has argued that international investment decisions of MNEs are not only related to production, trade and the opening up of new markets, but moreover represent a strategic location choice crucially influenced by tax-planning and profit-shifting opportunities (Huizinga and Laeven, 2008; Büttner and Wamser, 2013; Dharmapala, 2014). Common practices in this regard include the manipulation of intra-firm transfer pricing schemes (Davies et al., 2018) and the use of internal capital markets (Heckemeyer and Overesch, 2017). While transfer pricing is hard to detect and is not discussed in more detail here, we are able to establish an empirical link between MNEs' foreign and domestic activities, intra-company loans and tax savings.

To better understand the mechanisms at work, let us assume a simple investment model and a distortive tax $\tau_i$ on business profits implemented at the location of the MNE (Germany). Thus, we start from a setting in which the tax on corporate profits drives a wedge between marginal product of capital and marginal return.

Our argument is based on a very simple model of a profit-maximizing firm. From the maximization problem, we obtain the following marginal condition:[42]

$$F'(K_i) = \frac{r}{1 - \tau_i(1 - \varphi_i)} \tag{5.6.1}$$

In this expression, $F'(K_i)$ denotes the marginal product of capital $K_i$, $r$ is the opportunity cost of capital, and $\varphi_i$ denotes the share of profits that can be shifted to other countries by MNE $i$, with $\varphi_i \in [0, 1]$. The tax $\tau_i$ drives a wedge between the opportunity cost $r$ and the marginal product of capital and

[42] The simple maximization problem may be formulated as in Egger et al. (2014b). Firms maximize profits $\pi_i = F_i(K_i) - \tau_i K_i(1-\varphi_i) - rK_i$ by optimally choosing capital input $K_i$, with $K_i(1 - \varphi_i)$ denoting the tax base and $r$ the normal (benchmark) rate of return. The model makes standard assumptions about the production technology, with $F'(K_i) > 0, F''(K_i) < 0$.

thereby increases the required rate of return on investment. At the margin, in order to account for the increase in the required rate of return, the firm reduces investment. If, however, the firm can fully avoid the tax, the user cost of capital remains undistorted as under a cash-flow or allowance for corporate equity (ACE) tax. More generally, in the above marginal condition, if $\varphi_i = 1$, the first-order condition equals $F'(K_i) = r$. The term $(1 - \varphi_i)$ denotes the extent to which the tax base can be reduced and $\tau_i(1 - \varphi_i)$ can be understood as the effective tax burden of firm $i$. If the latter is equal to zero, there is no distortion.

When denoting those MNEs setting up a new foreign affiliate by superscript $NA = 1$ and those not setting up a new affiliate by $NA = 0$, the key argument we make is that $\varphi_i^{NA=1} > \varphi_i^{NA=0}$, i.e., there is a discrete jump in the opportunities to avoid taxes for those MNEs setting up a new affiliate, compared to the counterfactual of not setting up a new affiliate. This argument is particularly relevant if the new foreign entity is located in a low-tax or tax haven country (relative to the German parent). Thus, we allow the basic effect of setting up a foreign affiliate to be heterogeneous (by using interactions) in the tax differentials between Germany and the host countries where new foreign affiliates are established. Thus, additional profit-shifting opportunities are associated with a vanishing role of the tax, a reduction in the cost of capital, and more investment. By the same token, we may argue that restrictions on $\varphi_i$ (many countries have implemented restrictions on profit shifting such as transfer-pricing rules) lead to adverse investment consequences.[43]

Columns (3) to (6) in Table 5.6.1 present evidence on treatment effects being heterogeneous with respect to corporate tax differentials.[44] In the specifications in columns (3) and (5), we estimate ATTs on $\Delta INV_{i,t}$, explicitly controlling for corporate tax rate differentials ($\overline{DSTR}_{c,t}$), transfer pricing documentation requirements ($\overline{DCE}_{c,t}$), and intra-group loans ($\overline{IGL}_{a,t}$) provided by the newly established affiliate $a$. $\overline{DSTR}_{c,t}$ is defined as the German statutory tax rate plus the business tax rate at the municipality level minus the statutory tax rate of the country where the newly established foreign affiliate is located.[45]

[43]This argument is presented in Büttner et al. (2017), for example.

[44]In addition to the data utilized so far, we employ corporate taxes taken from Steinmüller et al. (2019). For a detailed overview of all data sources, see Table 5.A.1 in the Appendix.

[45]Note that Germany follows a territorial tax system.

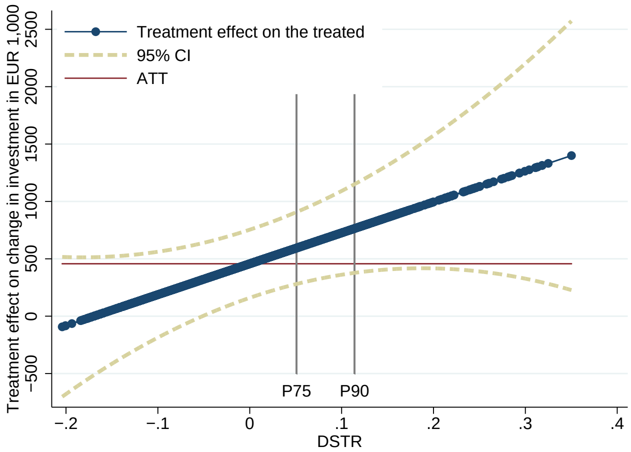
We would expect that $\Delta INV$ is positively related to low taxes abroad. The firm may particularly use the newly established entity to shift profits and save taxes, which gives rise to the positive domestic investment effect via a reduction in the cost of capital at home. For the interaction term with the transfer pricing indicator, which is equal to 1 if the host country has implemented transfer pricing documentation requirements, and zero otherwise, we expect a negative estimate as countries use documentation requirements to prevent abusive use of transfer pricing for the purpose of profit shifting. The intra-group loans variable is defined as the balance-sheet position 'lending to affiliated entities' relative to the total assets of affiliate $a$ at time $t$. If internal loans are used to shift profits, rather than the manipulation of transfer pricing or other means of profit shifting, we would expect the positive treatment effect to be positively related to $\overline{IGL}_{a,t}$.

All specifications have in common that the main effect of setting up a foreign affiliate on domestic investments remains very stable in terms of size and significance. Moreover, our results suggest that the treatment effect is in fact heterogeneous with respect to the corporate tax rate. The larger the tax differential between Germany and the destination country, the larger is the positive and significant impact of foreign activity on domestic investments as measured by $\Delta INV_{i,t}$. In contrast to these significant factors, the existence of transfer pricing documentation requirements as well as a higher share of intra-group loans do not seem to be associated with a significant deviation from the ATT.[46]

In order to get more detailed insights into the interplay of MNEs' investment behavior and tax incentives, we depict the heterogeneity of the treatment effect in Figure 5.6.1. Displaying the treatment effect on $\Delta INV_{i,t}$ on the vertical axis as a function of the demeaned tax differential confirms our findings from Table 5.6.1. The solid horizontal line illustrates the ATT. The positively sloped solid line shows the treatment effect on the treated as increasing in the tax differential. The two solid lines cross at a treatment effect value of EUR 434,000 and a demeaned

[46]Note that we include three further refinements in the Appendix (Tables 5.A.16, 5.A.17 and 5.A.18): (i) we use effective average tax rates (EATRs) instead of STR (results remain qualitatively the same), (ii) we exclude tax haven countries as destination countries (results remain robust in this case as well), (iii) we produce separate results for manufacturing and services affiliates. Also in this regard, we do not observe any differences, and all core results prevail.

Figure 5.6.1: *Heterogeneous tax effects*




tax differential of zero. This is of course no coincidence, but merely follows from the definition of the ATT and the demeaned tax differential. The treatment effect of EUR 434,000 is the same as the ATT measured in Table 5.6.1, which is associated with an average tax differential, hence a value of zero on the horizontal axis. To the right of this intersection, the tax differential between Germany and the respective destination country is larger than the average. This is associated with an effect on domestic investment which is larger than the ATT. Vice versa, to the left of the intersection, the effect is comparatively smaller. For a tax differential only slightly below average, the ATT is still positive and significant; however, for demeaned tax differentials smaller than around -0.05, the effect on investments becomes insignificant. On the one hand, this finding is consistent with the tax incentives suggested above. On the other hand, we see that in both tails of the tax differential distribution, the confidence bands as depicted by the dotted lines in Figure 5.6.1 are broadening. Particularly for high values of the demeaned tax differential, this can be explained by a lower support of observations. As a consequence, the larger the deviation from the average tax differential, the more difficult it is to precisely estimate the heterogeneous effect of taxes.

The findings in this section so far have shown that domestic investment behavior is sensitive towards tax incentives through the establishment of new foreign affiliates. An obvious goal of choosing affiliate locations for tax optimization reasons is to reduce the overall tax burden of the firm. Hence, an additional way to analyze how tax incentives affect investment behavior is to take a closer look at how FDI affects domestic tax payments. To this end, we estimate ATTs on $\Delta TAX_{i,t}$, which is the change in taxes paid by the German parent company. The results are shown in columns (4) and (6) in Table 5.6.1. All explanatory variables and the way they are defined are the same as above.[47]

In both specifications, we observe a robust, negative ATT on $\Delta TAX_{i,t}$, significant at the 5% level. According to our estimation results, setting up a new foreign affiliate is associated with a decrease in domestic tax payments of EUR 109,000. Analogous to above, we include interaction terms with ($\overline{DSTR}_{c,t}$), ($\overline{DCE}_{c,t}$) and ($\overline{IGL}_{i,t}$). The empirical findings suggest that the treatment effect neither varies significantly with the demeaned tax rate differential, nor do documentation requirements alter the treatment effect.

In contrast to this, the absolute magnitude of the negative treatment effect strongly increases in the share of intra-group loans to total assets of the newly established affiliate. The estimated coefficient in column (6) of Table 5.6.1 indicates that if the new affiliate's intra-group loans increase by 10 percentage points relative to total assets, the decline in $\Delta TAX_{i,t}$ amounts to EUR 175,000.

To sum up, our empirical analysis has shown that MNEs' investment activities are strongly influenced by tax incentives.[48] A common vehicle to exploit tax differentials is internal borrowing and lending. The next subsection discusses the characteristics of internal capital markets, tests whether the prospect of better access to financial capital is a driver of the treatment effect and highlights the interdependencies between this 'financing channel' and the 'profit shifting and tax savings channel'.

[47] In addition to the ATTs on $\Delta TAX_{i,t}$, we also estimate the effect of a new foreign affiliate on domestic profits. These results are presented in Table 5.A.19 in the Appendix and show that profits do indeed decline when a new foreign affiliate is established, reinforcing the hypothesis that parts of domestic profits are shifted abroad.

[48] In order to reinforce the previous results, we estimate the ATT on domestic investments and the tax bill with a refined definition of the treatment group: we only include MNEs with affiliates in countries for which the demeaned tax differential exceeds the 75th and 90th percentile, respectively. Table 5.A.20 in the Appendix presents the estimated ATTs in this regard, suggesting that the ATTs are larger if new affiliates are set up in low-tax countries. We should note, however, that for reasons of data availability (taxes paid), the number of treated units becomes relatively small.

### 5.6.3 Financing channel

One of the distinguishing features of large firms in general and MNEs in particular is that they can borrow and lend on an internal capital market (Gertner et al., 1994; Stein, 1997; Bolton and Scharfstein, 1998; Scharfstein and Stein, 2000). Egger et al. (2014a) argue that internal capital markets are established for reasons which can be broadly grouped into two categories: (i) profit shifting via debt shifting and tax savings; (ii) frictions in economic fundamentals and efficient resource allocation. Their model suggests that differences in economic fundamentals – such as weak institutional quality, underdeveloped financial markets, or high productivity – produce different levels of excess returns at host locations. Capital should be allocated to those entities where this excess return is highest. In our context, establishing a new foreign entity may facilitate access to financial capital (at host locations). Through a firm's internal capital market, internal financing then becomes available for operations at home and more investment projects may be realized there. Thus, we hypothesize that the positive domestic investment effect found in the basic results may reflect better access to financial capital.

To understand why we cannot really distinguish between the profit-shifting argument and the financial development argument, it is important to recognize that MNEs often use internal capital markets for tax reasons (Büttner and Wamser, 2013). There, the entity in a tax haven provides internal debt to affiliates or the parent located in a high-tax country (Germany). In the optimality condition in (5.6.1), this is equivalent to an increase in $\varphi_i$ as interest payments are tax deductible at the parent $i$ and interest income is not taxed in the new foreign affiliate (in the tax haven). There are many cases of MNEs where exactly this tax-planning strategy has been applied. Hines (1999) highlights the consequences of restricting interest deduction, stating that countries which limit the deductibility of interest payments (lower $\varphi_i$) might reduce domestic investment and encourage MNEs to raise funds through foreign affiliates. However, internal debt is often provided from countries where not only taxes are low but also where capital market access and financing is facilitated (Egger et al., 2014a). To summarize, the new affiliate allows the German firm to increase $\varphi_i$, which means that additional investment projects can be realized in Germany.

Our tests of the financing channel hypothesis focus on two aspects. First, we use variables on the development of the local capital market and interact these measures with $NA_{i,t}$. That is, we allow the effect of $NA_{i,t}$ on $\Delta INV_{i,t}$ to vary with the quality of the capital market at host country $c$. The variables we use are all taken from the World Bank's World Development Indicators (WDI) and the Global Financial Development Database (GFDD), and are often used in the literature to measure financial market depth.[49] The results are presented in column (7) in Table 5.6.1. They show that neither stock market capitalization nor the variables measuring credit to the private sector are statistically significant at conventional levels.

A second way to test the financing channel hypothesis is to look at alternative outcomes. We do so by using information on (internal) loans from affiliated enterprises, i.e. internal debt $ID_{i,t}$. If newly established affiliates increase the scope for intra-group borrowing of the parent company, this should be reflected in $ID_{i,t}$. We find that $\Delta ID_{i,t}$ is positively related to $NA_{i,t}$, as expected.[50] Using the same interactions with the variables measuring the quality of the local capital market, we do not find any positive and statistically significant coefficients.

All findings together support the hypothesis that the financing channel is important and contributes to the positive treatment effect for domestic investment. In particular, the estimates on the alternative outcomes suggest that foreign activity allows firms to allocate capital more efficiently on their internal capital markets. Hence, in view of the contribution by Egger et al. (2014a), it seems that firms are able to make use of potential excess returns at home. However, these

[49]The three variables are (a) Domestic Credit to the Private Sector ($DCP_{c,t}$), (b) Domestic Credit to the Private Sector by Banks ($DCPB_{c,t}$), and (c) Stock Market Capitalization ($SMC_{c,t}$). The first two are taken from the World Bank's WDI database, while the latter comes from the GFDD; (a) and (b) measure domestic credit provided to the private sector (in % of GDP), where (b) accounts only for credit provided by banks; (c) measures the total value of all listed shares in the stock market (in % of GDP). Larger values of all three variables are associated with a higher degree of financial depth and a more favorable (local) capital market.

[50]As an additional outcome, we use $\Delta ID_{i,t}/TA_{i,t}$, which measures the change in the share of internal borrowing in total assets, i.e., the internal-debt-to-asset ratio. Note that the total assets in this case refer to total capital (as the sum of nominal capital, capital reserves, profit reserves and total debt), such that the internal-debt-to-capital ratio, the external-debt-to-capital ratio and the equity-to-capital ratio add up to one. The alternative definition, using the total assets in the denominator, does not change the results (Table 5.A.21 in the Appendix).

empirical findings and the interaction terms should only be interpreted together with the findings of the tax and profit-shifting channel (Section 5.6.2), as internal debt is the vehicle through which (i) profits are shifted (ii) and capital is allocated more efficiently.

## 5.7 Conclusions

This paper has provided new empirical results on the relationship between foreign and domestic activity of MNEs. While previous contributions have presented ambiguous evidence on whether home-market investment and FDI can be seen as substitutes or complements, our basic results suggest that FDI complements domestic investment at the firm level. The distinct contribution of our paper can be subdivided into three aspects. First, we employ a unique dataset enabling us to observe domestic and foreign investment of German MNEs. Second, we cope with the simultaneous nature of these two investment activities and associated endogeneity concerns by estimating ATTs based on propensity scores. This allows us to control for variables that determine the selection into foreign acticvity. Third, we present three specific channels through which foreign activity may affect domestic investment.

As a baseline result, we have estimated an average treatment effect on the treated which suggests that setting up a new foreign affiliate is associated with about EUR 460,000 additional investment in fixed assets. In addition to this extensive margin estimate, we also exploit variation at the intensive margin of foreign activity and estimate an elasticity between foreign and domestic investment in the range of 0.13 and 0.23, depending on the measure of foreign investment activity. The basic effect of foreign activity on home investment proves to be robust against a large number of sensitivity tests. The latter include (i) alternative measures of outcome, (ii) tests for prior trends and lagged effects, (iii) alternative specifications of propensity score estimates, (iv) variations in treatment-control comparisons, and (v) the calculation of placebo effects.

Trying to explain the observed outcomes, we investigate three channels through which domestic activity might be affected by foreign investment: first, technology and productivity gains; second, tax savings and profit shifting; and third, financing and internal capital markets. To the best of our knowledge, we are the first to relate empirical findings from firm-level data in this field to such comprehensive explanatory approaches.

In contrast to previous studies both in theoretical and empirical economics, our empirical results suggest that foreign activity does not enhance total factor productivity at home. Thus, while productivity gains are commonly named as a driver of the positive link between foreign and home activity, this is not reflected in our data.

Instead, our empirical results suggest that the crucial channel determining the positive relation between domestic and foreign investment is mainly associated with MNEs' tax planning and profit-shifting opportunities, as well as improved access to financing capital. On the one hand, MNEs strategically locate affiliates as a response to tax incentives. The larger the tax differential between Germany and the destination country of FDI, the more pronounced is the domestic effect of a new foreign affiliate. On the other hand, we find evidence that newly established affiliates are lending to firm entities in the home countries. Hence, expanding abroad is associated with improved access to financing capital and allows MNEs to allocate capital more efficiently via an internal capital market. These two channels are closely linked to each other as internal debt is the common vehicle for both profit shifting and a more efficient allocation of capital.

Turning the focus to the policy implications of our findings, we can argue that investing abroad allows MNEs to avoid financial imperfections and hence implies an efficiency gain. In addition to that, however, public policy should recognize as well that tax savings and profit shifting account for some portion of the positive effect associated with investing abroad. If MNEs can exploit differences in taxes across countries, this provides an advantage of MNEs against their domestic competitors. Thus, thoroughly designed policies against profit shifting are needed to guarantee a level playing field. In the end, policymakers face a trade-off between preventing profit shifting and tax avoidance on the one hand and the risk of distorting the optimal allocation of investment capital on the other hand.

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# 5.A Appendix

## Description of variables and data sources

Table 5.A.1: *Description of variables and data sources*

| Variable | Definition and source | Variable level |
|---|---|---|
| $TA_{i,t}$ | Log of total assets of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $FA_{i,t}/EMP_{i,t}$ | Log of fixed assets over number of employees of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $VA_{i,t}/EMP_{i,t}$ | Log of value added over number of employees of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $EMP_{i,t}$ | Number of employees of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $INV_{i,t}$ | Gross investment in 1,000 EUR of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $NINV_{i,t}$ | Net investment in 1,000 EUR of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $SALES_{i,t}$ | Total sales in 1,000 EUR of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $WAGE_{i,t}$ | Labor costs in 1,000 EUR over number of employees of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $CF_{i,t}$ | Cash flow relative to total assets of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $Q_{i,t}$ | Lagged sales growth of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $INTANG_{i,t}$ | Intangible assets relative to total assets of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $LEV_{i,t}$ | Debt-to-equity-ratio of domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $TFP_{i,t}$ | Total factor productivity of domestic firm $i$, based on value added in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $TAX_{i,t}$ | Taxes in 1,000 EUR paid by domestic firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $ID_{i,t}$ | Internal debt in 1,000 EUR provided by affiliated entities to parent (domestic) firm $i$ in period $t$; Source: *Ustan* | Domestic firm $i$ |
| $MNE_{i,t}$ | Dummy variable equal to 1 if the domestic firm $i$ has been an MNE in period $t-1$, and 0 otherwise; Source: *MiDi* | Domestic firm $i$ |
| $TA_{i,t}$(*Affiliates*) | Log of the sum of total assets across all affiliates in period $t$; Source: *MiDi* | Domestic firm $i$ |
| $SALES_{a,t}$ | Sales in 1,000 EUR of affiliate $a$ in period $t$; Source: *MiDi* | Foreign affiliate $a$ |
| $EMP_{a,t}$ | Number of employees of affiliate $a$ in period $t$; Source: *MiDi* | Foreign affiliate $a$ |
| $FA_{a,t}$ | Fixed and intangible assets in 1,000 EUR of affiliate $a$ in period $t$; Source: *MiDi* | Foreign affiliate $a$ |
| $TA_{a,t}$ | Total assets in 1,000 EUR at affiliate $a$ in period $t$; Source: *MiDi* | Foreign affiliate $a$ |
| $EFDI_{a,t}$ | Equity capital of FDI in 1,000 EUR at affiliate $a$ in period $t$; Source: *MiDi* | Foreign affiliate $a$ |
| $CFDI_{a,t}$ | Consolidated sum (equity capital plus internal debt) of FDI in 1,000 EUR at affiliate $a$ in period $t$; Source: *MiDi* | Foreign affiliate $a$ |
| $VERT_{a,t}$ | Dummy equal to 1 if the parent firm operates in a different sector than the new foreign affiliate in period $t$, and 0 otherwise; Source: *MiDi* | Foreign affiliate $a$ |
| $CESEE_{a,t}$ | Dummy equal to 1 if new affiliate in period $t$ is located in Central, Eastern or Southeastern Europe, and 0 otherwise; Source: *MiDi* | Foreign affiliate $a$ |
| $IGL_{a,t}$ | Intra-group loans over total assets of affiliate $a$ in period $t$ ; Source: *MiDi* | Foreign affiliate $a$ |
| $IGCA_{a,t}$ | Intra-group current claims over total assets of affiliate $a$ in period $t$ ; Source: *MiDi* | Foreign affiliate $a$ |
| $Sectoral\ Sales\ Growth_{s,t}$ | Sales growth in sector $s$ in period $t$; Source: *MiDi* | Sectoral or regional level |
| $County\ GDP_{k,t}$ | Log of GDP in county $k$ in period $t$; Source: *Regional Database, German Statistical Office* | Sectoral or regional level |
| $County\ GDP\ per\ Worker_{k,t}$ | Log of GDP per worker in county $k$ in period $t$; Source: *Regional Database, German Statistical Office* | Sectoral or regional level |
| $County\ Income\ per\ Capita_{k,t}$ | Log of income per capita in county $k$ in period $t$; Source: *Regional Database, German Statistical Office* | Sectoral or regional level |
| $County\ Share\ High\ Skilled_{k,t}$ | Share of high-skilled workers in county $k$ in period $t$ ; Source: *Federal Employment Agency* | Sectoral or regional level |
| $Municipality\ Population_{\ell,t}$ | Log of population in municipality $\ell$ in period $t$; Source: *German Statistical Office* | Sectoral or regional level |
| $Municipality\ Trade\ Tax_{\ell,t}$ | Trade tax applicable in municipality $\ell$ in period $t$; Source: *German Statistical Office* | Sectoral or regional level |
| $GDP_{c,t}$ | Log of GDP at purchasing power parity (PPP) (constant 2011 international \$) of country $c$ in period $t$; Source: *World Bank, WDI database* | Host Country $c$ |
| $GDPPC_{c,t}$ | Log of GDP at PPP (constant 2011 international \$) per capita of country $c$ in period $t$; Source: *World Bank, WDI database* | Host Country $c$ |
| $DIST_c$ | Log of the geodesic distance between Germany and country $c$; Source: *CEPII, GeoDist Database* | Host Country $c$ |
| $DCP_{c,t}$ | Log of domestic credit provided to the private sector in % of GDP of country $c$ in period $t$; Source: *World Bank, WDI database* | Host Country $c$ |
| $DCPB_{c,t}$ | Log of domestic credit provided to the private sector by banks in % of GDP of country $c$ in period $t$; Source: *World Bank, WDI database* | Host Country $c$ |
| $SMC_{c,t}$ | Log of the total value of all listed shares in the stock market in % of GDP of country $c$ in period $t$; Source: *World Bank, GFDD* | Host Country $c$ |
| $DCE_{c,t}$ | Dummy indicating whether transfer pricing documentation requirements exist; if not, the dummy equals 0; Source: Lohse and Riedel (2013) | Host Country $c$ |
| $STR_{c,t}$ | Statutory corporate tax rate in country $c$ in period $t$; Source: Steinmüller et al. (2019) | Host Country $c$ |
| $DSTR_{c,t}$ | German statutory tax rate plus the business tax rate at the municipality level minus the statutory tax rate in country $c$ in period $t$; Source: *German Statistical Office*; Steinmüller et al. (2019) | Host Country $c$ |

## Additional descriptive statistics

Table 5.A.2: *Number of observations in different datasets*

| | Ustan | MiDi | Ext. Margin | Match | Ext. Margin |
|---|---|---|---|---|---|
| 2000 | 15564 | 5732 | 2196 | 803 | 332 |
| 2001 | 14661 | 5966 | 1977 | 852 | 314 |
| 2002 | 12954 | 5632 | 1512 | 789 | 199 |
| 2003 | 12065 | 5433 | 1293 | 761 | 170 |
| 2004 | 12086 | 5337 | 1239 | 771 | 197 |
| 2005 | 12038 | 5381 | 1358 | 754 | 230 |
| 2006 | 12693 | 5503 | 1590 | 792 | 249 |
| 2007 | 13519 | 5682 | 1648 | 872 | 274 |
| 2008 | 14607 | 5805 | 1537 | 941 | 292 |
| 2009 | 15718 | 5897 | 1388 | 975 | 230 |
| 2010 | 16586 | 6097 | 1526 | 1058 | 297 |
| 2011 | 16664 | 6286 | 1523 | 1093 | 310 |
| 2012 | 16799 | 6475 | 1501 | 1110 | 286 |
| 2013 | 11807 | 6467 | 1120 | 884 | 204 |
| Firm | 39533 | 12636 | 10022 | 2234 | 1496 |
| Firm-Year | 197761 | 86946 | 21408 | 12455 | 3584 |

## Additional results

### The probability of establishing a new foreign affiliate

Table 5.A.3: *Probit specification with second-order lags*

| | (1) |
|---|---|
| $TA_{i,t-2}$ | 0.219*** |
| | (0.063) |
| $VA_{i,t-2}/EMP_{i,t-2}$ | -0.016 |
| | (0.044) |
| $FA_{i,t-2}/EMP_{i,t-2}$ | 0.047 |
| | (0.032) |
| $TA_{i,t-2}$ (*Affiliates*) | 0.035 |
| | (0.036) |
| $MNE_{i,t-2}$ | -0.897*** |
| | (0.341) |
| *Sectoral Sales Growth*$_{s,t-2}$ | -0.205* |
| | (0.117) |
| *County GDP*$_{k,t-2}$ | -1.156* |
| | (0.657) |
| *County GDP per Worker*$_{k,t-2}$ | 0.491 |
| | (0.702) |
| *County Income per Capita*$_{k,t-2}$ | 0.639 |
| | (0.497) |
| *County Share High Skilled*$_{k,t-2}$ | -2.964 |
| | (3.059) |
| *Municipality Population*$_{\ell,t-2}$ | -0.009 |
| | (0.104) |
| *Municipality Business Tax*$_{\ell,t-2}$ | 2.335 |
| | (3.288) |

Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively. A Wald test indicates joint significance of the Mundlak-Chamberlain means, which are not shown.

Table 5.A.4: *Alternative probit specifications*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $TA_{i,t-1}$ | 0.155*** | | 0.157*** | 1.583*** | 2.612*** |
| | (0.007) | | (0.008) | (0.122) | (0.634) |
| $VA_{i,t-1}/EMP_{i,t-1}$ | 0.053** | | 0.052** | 0.111 | 0.598** |
| | (0.024) | | (0.024) | (0.076) | (0.247) |
| $FA_{i,t-1}/EMP_{i,t-1}$ | -0.036*** | | -0.036*** | 0.028 | 0.060 |
| | (0.010) | | (0.010) | (0.032) | (0.041) |
| $TA_{i,t-1}$ (*Affiliates*) | 0.214*** | | 0.215*** | -0.620*** | -0.284 |
| | (0.013) | | (0.013) | (0.125) | (0.361) |
| $MNE_{i,t-1}$ | -0.734*** | | -0.744*** | 2.307*** | 1.046 |
| | (0.132) | | (0.133) | (0.718) | (1.342) |
| *Sectoral Sales Growth*$_{s,t-1}$ | -0.084 | | -0.086 | 0.238* | 0.152 |
| | (0.086) | | (0.087) | (0.134) | (0.172) |
| *County GDP*$_{k,t-1}$ | | -0.029 | -0.008 | -1.286** | -0.676 |
| | | (0.032) | (0.025) | (0.655) | (2.905) |
| *County GDP per Worker*$_{k,t-1}$ | | 0.481*** | -0.031 | 3.842 | -42.081 |
| | | (0.130) | (0.133) | (2.765) | (40.725) |
| *County Income per Capita*$_{k,t-1}$ | | 0.264** | 0.129 | 0.246 | 20.189 |
| | | (0.107) | (0.102) | (2.100) | (23.206) |
| *County Share High Skilled*$_{k,t-1}$ | | 0.610 | -0.216 | -5.355* | 2.572 |
| | | (0.482) | (0.459) | (3.068) | (4.946) |
| *Municipality Population*$_{\ell,t-1}$ | | 0.068*** | 0.004 | -0.226* | -0.439 |
| | | (0.016) | (0.014) | (0.116) | (0.489) |
| *Municipality Business Tax*$_{\ell,t-1}$ | | -1.861 | -0.813 | 13.912 | 52.182 |
| | | (1.241) | (1.059) | (12.284) | (87.412) |
| $(TA_{i,t-1})^2$ | | | | -0.054*** | -0.142*** |
| | | | | (0.005) | (0.054) |
| $(VA_{i,t-1}/EMP_{i,t-1})^2$ | | | | -0.015** | -0.086** |
| | | | | (0.006) | (0.034) |
| $(FA_{i,t-1}/EMP_{i,t-1})^2$ | | | | 0.006* | -0.008 |
| | | | | (0.003) | (0.008) |
| $(TA_{i,t-1}$ (*Affiliates*)$)^2$ | | | | 0.033*** | 0.004 |
| | | | | (0.005) | (0.033) |
| (*Sectoral Sales Growth*$_{s,t-1})^2$ | | | | 0.609** | 1.044* |
| | | | | (0.287) | (0.628) |
| (*County GDP*$_{k,t-1})^2$ | | | | -0.003 | -0.077 |
| | | | | (0.016) | (0.314) |
| (*County GDP per Worker*$_{k,t-1})^2$ | | | | -0.340 | 10.397 |
| | | | | (0.327) | (9.692) |
| (*County Income per Capita*$_{k,t-1})^2$ | | | | 0.046 | -6.196 |
| | | | | (0.334) | (7.450) |
| (*County Share High Skilled*$_{k,t-1})^2$ | | | | 9.642 | -64.646* |
| | | | | (6.394) | (36.236) |
| (*Municipality Population*$_{\ell,t-1})^2$ | | | | 0.013** | 0.034 |
| | | | | (0.005) | (0.051) |
| (*Municipality Business Tax*$_{\ell,t-1})^2$ | | | | -49.515 | -351.836 |
| | | | | (43.245) | (662.901) |
| $(TA_{i,t-1})^3$ | | | | | 0.002 |
| | | | | | (0.002) |
| $(VA_{i,t-1}/EMP_{i,t-1})^3$ | | | | | 0.003** |
| | | | | | (0.001) |
| $(FA_{i,t-1}/EMP_{i,t-1})^3$ | | | | | 0.001** |
| | | | | | (0.001) |
| $(TA_{i,t-1}$ (*Affiliates*)$)^3$ | | | | | 0.001 |
| | | | | | (0.001) |
| (*Sectoral Sales Growth*$_{s,t-1})^3$ | | | | | 0.858 |
| | | | | | (1.120) |
| (*County GDP*$_{k,t-1})^3$ | | | | | 0.003 |
| | | | | | (0.011) |
| (*County GDP per Worker*$_{k,t-1})^3$ | | | | | -0.833 |
| | | | | | (0.766) |
| (*County Income per Capita*$_{k,t-1})^3$ | | | | | 0.649 |
| | | | | | (0.796) |
| (*County Share High Skilled*$_{k,t-1})^3$ | | | | | 188.557** |
| | | | | | (92.638) |
| (*Municipality Population*$_{\ell,t-1})^3$ | | | | | -0.001 |
| | | | | | (0.002) |
| (*Municipality Business Tax*$_{\ell,t-1})^3$ | | | | | 776.068 |
| | | | | | (1657.172) |

Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively. A Wald test indicates joint significance of the Mundlak-Chamberlain means in specification (4) and (5), which are not shown.

## The effects of investing abroad

Table 5.A.5: *Robustness to caliper choice (caliper width in brackets)*

| | ATT | SE | No. treated ($NA = 1$) | No. untreated ($NA = 0$) |
|---|---|---|---|---|
| $\Delta INV_{i,t}$ [0.01] | 458.126*** | 145.101 | 3021 | 188740 |
| $\Delta INV_{i,t}$ [0.005] | 427.675*** | 138.159 | 2917 | 188348 |
| $\Delta INV_{i,t}$ [0.001] | 544.439*** | 144.925 | 2392 | 101706 |
| $\Delta INV_{i,t}$ [0.0005] | 429.675*** | 151.191 | 1949 | 79009 |
| $\Delta INV_{i,t}$ [0.0001] | 533.060*** | 192.308 | 905 | 27762 |
| $\Delta INV_{i,t}$ [0.00005] | 629.884*** | 225.786 | 627 | 15630 |
| $\Delta INV_{i,t}$ [0.00001] | 1307.033*** | 334.026 | 327 | 3549 |

Estimates are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. Standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Table 5.A.6: *Balancing property* ($\Delta INV_{i,t}$)

| | Mean | | | t-test | | |
|---|---|---|---|---|---|---|
| | Treated ($NA = 1$) | Control ($NA = 0$) | %bias | t | p>\|t\| | V(T)/V(C) |
| $TA_{i,t-1}$ | 11.842 | 11.831 | 0.6 | 0.28 | 0.780 | 0.70* |
| $VA_{i,t-1}/EMP_{i,t-1}$ | 4.990 | 5.011 | -2.6 | -0.87 | 0.382 | 0.72* |
| $FA_{i,t-1}/EMP_{i,t-1}$ | 3.351 | 3.333 | 1.0 | 0.46 | 0.643 | 1.06 |
| $TA_{i,t-1}$ (*Affiliates*) | 8.789 | 8.652 | 3.5 | 1.11 | 0.268 | 1.05 |
| $MNE_{i,t-1}$ | 0.784 | 0.787 | -1.1 | -0.33 | 0.741 | . |
| *Sectoral Sales Growth*$_{s,t-1}$ | -0.009 | -0.013 | 2.0 | 0.73 | 0.467 | 0.99 |
| *County GDP*$_{k,t-1}$ | 9.142 | 9.131 | 1.1 | 0.42 | 0.676 | 1.07 |
| *County GDP per Worker*$_{k,t-1}$ | 4.122 | 4.118 | 2.1 | 0.79 | 0.427 | 1.00 |
| *County Income per Capita*$_{k,t-1}$ | 3.123 | 3.113 | 5.0 | 1.99 | 0.047 | 0.98 |
| *County Share High Skilled*$_{k,t-1}$ | 0.098 | 0.097 | 3.9 | 1.45 | 0.147 | 1.06 |
| *Municipality Population*$_{\ell,t-1}$ | 11.017 | 11.004 | 0.7 | 0.27 | 0.784 | 1.08* |
| *Municipality Business Tax*$_{\ell,t-1}$ | 0.137 | 0.137 | 0.8 | 0.30 | 0.768 | 1.02 |

Table 5.A.7: *Robustness to outlier treatment*

| | ATT | SE | No. treated ($NA = 1$) | No. untreated ($NA = 0$) |
|---|---|---|---|---|
| $\Delta INV_{i,t}$ [1%] | 458.126*** | 145.101 | 3021 | 188740 |
| $\Delta INV_{i,t}$ [2%] | 297.240*** | 80.473 | 2777 | 185101 |
| $\Delta INV_{i,t}$ [3%] | 127.474** | 61.751 | 2566 | 181478 |

Estimates are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. Standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Table 5.A.8: *MNEs establishing their first foreign affiliate in a country*

| | $\Delta INV_{i,t}$ | $\Delta TAX_{i,t}$ |
|---|---|---|
| $NA_{i,t}$ | 458.224*** | -108.906** |
| | (145.101) | (53.401) |
| $NA_{i,t} \times \overline{NEW}_{i,t}$ | -146.194 | -59.336 |
| | (380.380) | (130.133) |

Estimates are obtained from running weighted regressions including year effects, and conditioning on imbalanced covariates. Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively. $NEW_{i,t}$ is a dummy variable equal to 1 if the parent firm establishes its first foreign affiliate in a country in period $t$, and 0 otherwise.

## Timing of effects

Table 5.A.9: *Timing of effects: Alternative outcomes ($\Delta EMP$)*

| | new affiliate | new MNE |
|---|---|---|
| $NA_{i,t+2}$ | 6.025 | 12.640 |
| | (3.906) | (11.921) |
| $NA_{i,t+1}$ | 1.363 | 0.114 |
| | (2.879) | (3.105) |
| $NA_{i,t}$ | 2.206 | 2.280 |
| | (2.590) | (2.902) |
| $NA_{i,t-1}$ | 2.754 | 1.262 |
| | (2.782) | (2.844) |
| $NA_{i,t-2}$ | 3.281 | -1.206 |
| | (3.127) | (5.751) |
| No. treated | 369 | 230 |

Standard errors clustered at the firm level in parentheses.***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Table 5.A.10: *Timing of effects: Alternative outcomes ($\Delta TFP$)*

| | new affiliate | new MNE |
|---|---|---|
| $NA_{i,t+2}$ | 0.427 | -0.661 |
| | (0.571) | (1.933) |
| $NA_{i,t+1}$ | 0.445 | 0.275 |
| | (0.366) | (0.388) |
| $NA_{i,t}$ | 0.046 | 0.078 |
| | (0.324) | (0.412) |
| $NA_{i,t-1}$ | -0.144 | -0.488 |
| | (0.340) | (0.464) |
| $NA_{i,t-2}$ | 0.122 | 0.043 |
| | (0.726) | (0.618) |
| No. treated | 346 | 223 |

Standard errors clustered at the firm level in parentheses.***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

### Intensive margin elasticities

Table 5.A.11: *Comparison to Desai, Foley and Hines (2009)*

| | 1% | 1% | 5% | 5% | 10% | 10% |
|---|---|---|---|---|---|---|
| *FA Growth*$_{a,t}$ | 0.021*** | 0.021*** | 0.042*** | 0.042*** | 0.062*** | 0.061*** |
| | (0.004) | (0.004) | (0.006) | (0.006) | (0.007) | (0.008) |
| $TA_{i,t-1}$ (*Affiliates*) | | 0.000 | | 0.000** | | 0.000 |
| | | (0.000) | | (0.000) | | (0.000) |
| $TA_{i,t-1}$ | | 0.000 | | 0.003** | | 0.005*** |
| | | (0.003) | | (0.001) | | (0.001) |
| $VA_{i,t-1}/EMP_{i,t-1}$ | | 0.023*** | | -0.004 | | -0.006** |
| | | (0.006) | | (0.003) | | (0.002) |
| $FA_{i,t-1}/EMP_{i,t-1}$ | | -0.023*** | | 0.004** | | 0.006*** |
| | | (0.004) | | (0.002) | | (0.001) |
| *Sectoral Sales Growth*$_{s,t-1}$ | | 0.054 | | 0.042** | | 0.022* |
| | | (0.033) | | (0.018) | | (0.013) |
| *County GDP*$_{k,t-1}$ | | 0.010 | | 0.010*** | | 0.006** |
| | | (0.006) | | (0.004) | | (0.003) |
| *County GDP per Worker*$_{k,t-1}$ | | -0.020 | | -0.022 | | -0.017 |
| | | (0.033) | | (0.019) | | (0.014) |
| *County Income per Capita*$_{k,t-1}$ | | -0.018 | | 0.008 | | 0.016 |
| | | (0.028) | | (0.016) | | (0.013) |
| *County Share High Skilled*$_{k,t-1}$ | | 0.136 | | 0.002 | | -0.032 |
| | | (0.122) | | (0.071) | | (0.054) |
| *Municipality Population*$_{\ell,t-1}$ | | -0.008** | | -0.002 | | -0.002 |
| | | (0.003) | | (0.002) | | (0.002) |
| *Municipality Business Tax*$_{\ell,t-1}$ | | -0.307 | | -0.282* | | -0.124 |
| | | (0.285) | | (0.171) | | (0.136) |

Estimates are obtained from running regressions including sector and year effects. Standard errors clustered at the firm level in parentheses. Percentages refer to different outlier treatments. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

### Sensitivity analysis

We further evaluate the robustness of our main result by estimating a series of regressions with additional covariates. The literature suggests several firm-i-level characteristics that are considered important for domestic investment decisions. We use lagged sales growth, $Q_{i,t}$, which is a commonly used proxy for Tobin's Q of unlisted firms (Whited, 2006; Bloom et al., 2007). In addition, we include measures of financing constraints such as cash flow relative to total assets (Fazzari et al., 1988), $CF_{i,t}$, intangible assets relative to total assets (Almeida and Campello, 2007), $INTANG_{i,t}$, and firm leverage (Whited, 1992), $LEV_{i,t}$. Table 5.A.12 presents the results from a set of weighted regressions, additionally conditioning on these four variables. In all specifications, the ATT remains positive and highly significant. Column (1) indicates that a one percentage point increase in cash flow relative to total assets is associated with an increase in domestic investment of around EUR 30,000. Tobin's Q, the ratio of intangible to total assets and the debt-to-equity ratio have no significant effect on changes in domestic investment for the firms in our sample (columns (2) to (4)). Simultaneously including all variables in one regression leaves the ATT fully unaffected (see column (5)).

Table 5.A.12: *Weighted regressions conditioning on firm-specific variables*

| Dependent variable: $\Delta INV_{i,t}$ | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $NA_{i,t}$ | 449.636*** | 451.922*** | 457.356*** | 481.402*** | 474.630*** |
| | (143.985) | (162.494) | (146.177) | (148.508) | (166.844) |
| $CF_{i,t}$ | 2980.256*** | | | | 3214.630*** |
| | (590.921) | | | | (725.199) |
| $Q_{i,t}$ | | -248.142 | | | -505.553 |
| | | (521.084) | | | (555.830) |
| $INTANG_{i,t}$ | | | -1755.949 | | -2472.489 |
| | | | (4421.941) | | (4665.499) |
| $LEV_{i,t}$ | | | | -6.166 | -8.524 |
| | | | | (8.250) | (9.728) |

Estimates are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Table 5.A.13: *Domestic investment as placebo: new affiliates*

| | ATT | SE | No. treated ($NA = 1$) | No. untreated ($NA = 0$) |
|---|---|---|---|---|
| $INV_{i,t}$ | 1678.980 | 1777.726 | 147 | 77785 |
| $\Delta INV_{i,t}$ | 381.396 | 549.183 | 151 | 77961 |
| $INV_{i,t}/FA_{i,t-1}$ | -0.013 | 0.039 | 149 | 76209 |
| $NINV_{i,t}$ | -560.413 | 831.804 | 140 | 76995 |
| $\Delta NINV_{i,t}$ | 256.676 | 763.440 | 139 | 76855 |
| $NINV_{i,t}/FA_{i,t-1}$ | -0.043 | 0.037 | 150 | 76257 |
| $\Delta TAX_{i,t}$ | -244.990 | 237.334 | 123 | 78401 |

Estimates are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. Standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Table 5.A.14: *Domestic investment as placebo: lump-sum investments*

| | ATT | SE | No. treated ($NA = 1$) | No. untreated ($NA = 0$) |
|---|---|---|---|---|
| (1) $\Delta INV_{i,t}$ (fixed assets growth of domestic affiliates > 50%) | 214.809 | 161.881 | 1105 | 98581 |
| (2) $\Delta TAX_{i,t}$ (fixed assets growth of domestic affiliates > 50%) | 50.034 | 65.769 | 979 | 97378 |
| (3) $\Delta INV_{i,t}$ (fixed assets growth of domestic affiliates > 90%) | 181.487 | 230.652 | 618 | 98875 |
| (4) $\Delta TAX_{i,t}$ (fixed assets growth of domestic affiliates > 90%) | 90.220 | 80.149 | 526 | 97669 |

Estimates are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. Standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

**What explains the positive relationship between foreign and domestic investment?**

Table 5.A.15: *Standard errors clustered at the country level*

| | $\Delta INV_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta INV_{i,t}$ |
|---|---|---|---|---|---|
| $NA_{i,t}$ | 450.647*** | 433.917*** | 432.573*** | 414.216*** | 384.147*** |
| | (109.796) | (99.424) | (100.857) | (119.546) | (109.037) |
| $NA_{i,t} \times \overline{VERT}_{a,t}$ | -187.787 | | | | 59.835 |
| | (223.132) | | | | (230.561) |
| $NA_{i,t} \times \overline{IGCA}_{a,t}$ | -421.864 | | | | -731.254 |
| | (846.264) | | | | (1069.162) |
| $NA_{i,t} \times \overline{CESEE}_{a,t}$ | 19.833 | | | | -204.894 |
| | (249.825) | | | | (435.834) |
| $NA_{i,t} \times \overline{DSTR}_{c,t}$ | | 4142.748*** | 4159.319*** | | 6321.722*** |
| | | (1308.025) | (1297.237) | | (1838.654) |
| $NA_{i,t} \times \overline{DCE}_{c,t}$ | | | -8.490 | | 67.526 |
| | | | (200.303) | | (259.129) |
| $NA_{i,t} \times \overline{IGL}_{a,t}$ | | | -1801.543 | | -2040.559 |
| | | | (2100.832) | | (2195.664) |
| $NA_{i,t} \times \overline{DCP}_{c,t}$ | | | | 768.156 | 307.229 |
| | | | | (814.596) | (820.876) |
| $NA_{i,t} \times \overline{DCPB}_{c,t}$ | | | | -725.415 | -91.445 |
| | | | | (685.823) | (818.441) |
| $NA_{i,t} \times \overline{SMC}_{c,t}$ | | | | 90.589 | 0.105 |
| | | | | (281.047) | (307.423) |
| $NA_{i,t} \times \overline{DIST}_{c}$ | 255.859** | 238.267** | 236.869** | 243.637** | 238.021** |
| | (113.437) | (104.499) | (103.842) | (121.561) | (114.075) |
| $NA_{i,t} \times \overline{GDP}_{c,t}$ | -95.395 | 38.656 | 39.623 | -126.687 | 23.322 |
| | (85.350) | (98.246) | (99.553) | (88.091) | (103.210) |
| $NA_{i,t} \times \overline{GDPPC}_{c,t}$ | 549.051** | 569.602*** | 574.393*** | 360.621 | 488.510* |
| | (244.117) | (186.100) | (186.107) | (299.292) | (289.538) |

Estimates are obtained from running weighted regressions including year effects, and conditioning on imbalanced covariates. Standard errors clustered at the country level in parentheses ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Table 5.A.16: *Tax savings and profit-shifting channel: Effective average tax rates*

| | $\Delta INV_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta TAX_{i,t}$ | $\Delta TAX_{i,t}$ |
|---|---|---|---|---|
| $NA_{i,t}$ | 437.672*** | 436.944*** | -111.346** | -112.065** |
| | (143.730) | (143.039) | (53.898) | (53.825) |
| $NA_{i,t} \times \overline{DEATR}_{c,t}$ | 3981.858* | 3962.123* | 377.726 | 384.587 |
| | (2225.811) | (2230.050) | (888.692) | (899.815) |
| $NA_{i,t} \times \overline{DCE}_{c,t}$ | | -26.459 | | -0.849 |
| | | (236.821) | | (100.986) |
| $NA_{i,t} \times \overline{IGL}_{a,t}$ | | -1733.316 | | -1762.796** |
| | | (1897.272) | | (826.695) |
| $NA_{i,t} \times \overline{DIST}_{c}$ | 243.377** | 242.777** | 11.222 | 10.241 |
| | (102.211) | (102.205) | (43.937) | (43.864) |
| $NA_{i,t} \times \overline{GDP}_{c,t}$ | 18.134 | 18.960 | -37.762 | -37.695 |
| | (107.758) | (108.662) | (44.803) | (44.946) |
| $NA_{i,t} \times \overline{GDPPC}_{c,t}$ | 573.641*** | 579.051*** | -44.837 | -39.405 |
| | (183.615) | (185.412) | (81.717) | (81.649) |

Estimates are obtained from running weighted regressions including year effects, and conditioning on imbalanced covariates. Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively. $DEATR_{c,t}$ is defined as the German effective average tax rate minus the effective average tax rate in country $c$ in period $t$.

Table 5.A.17: *Excluding tax haven countries*

| | $\Delta INV_{i,t}$ | $\Delta TFP_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta TAX_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta TAX_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta ID_{i,t}$ | $\Delta INV_{i,t}$ |
|---|---|---|---|---|---|---|---|---|---|
| $NA_{i,t}$ | 351.346** | -0.286* | 336.561** | -97.638* | 335.007** | -99.614* | 321.148** | 461.209** | 294.173* |
| | (143.141) | (0.161) | (142.416) | (55.639) | (141.857) | (55.749) | (154.521) | (180.434) | (155.255) |
| $NA_{i,t} \times \overline{VERT}_{a,t}$ | -167.286 | -0.099 | | | | | | | 37.461 |
| | (230.190) | (0.279) | | | | | | | (247.715) |
| $NA_{i,t} \times \overline{IGCA}_{a,t}$ | -408.694 | -1.397 | | | | | | | -710.341 |
| | (947.992) | (1.283) | | | | | | | (1077.017) |
| $NA_{i,t} \times \overline{CESEE}_{a,t}$ | -61.711 | -0.008 | | | | | | | -329.597 |
| | (311.246) | (0.383) | | | | | | | (505.079) |
| $NA_{i,t} \times \overline{DSTR}_{c,t}$ | | | 3968.042** | -298.615 | 3965.054** | -303.839 | | | 6330.806*** |
| | | | (1726.700) | (709.456) | (1731.676) | (715.536) | | | (2282.395) |
| $NA_{i,t} \times \overline{DCE}_{c,t}$ | | | | | 16.156 | 25.676 | | | 83.374 |
| | | | | | (251.547) | (102.938) | | | (301.125) |
| $NA_{i,t} \times \overline{IGL}_{a,t}$ | | | | | -1422.136 | -2245.903** | | | -1627.041 |
| | | | | | (2098.781) | (1012.142) | | | (2251.503) |
| $NA_{i,t} \times \overline{DCP}_{c,t}$ | | | | | | | 778.222 | 1705.432** | 413.315 |
| | | | | | | | (747.863) | (732.136) | (827.793) |
| $NA_{i,t} \times \overline{DCPB}_{c,t}$ | | | | | | | -601.176 | -1413.945** | -143.755 |
| | | | | | | | (709.760) | (649.218) | (853.628) |
| $NA_{i,t} \times \overline{SMC}_{c,t}$ | | | | | | | 74.078 | -88.146 | -13.506 |
| | | | | | | | (304.695) | (324.257) | (334.806) |
| $NA_{i,t} \times \overline{DIST}_{c}$ | 171.235 | 0.296** | 179.576 | 13.728 | 176.725 | 10.139 | 195.131 | 263.167 | 208.286 |
| | (119.273) | (0.145) | (116.707) | (48.994) | (117.910) | (49.139) | (146.380) | (188.714) | (153.548) |
| $NA_{i,t} \times \overline{GDP}_{c,t}$ | -71.683 | 0.055 | 56.571 | -60.262 | 56.541 | -60.735 | -151.957 | -117.391 | -7.500 |
| | (106.992) | (0.135) | (114.394) | (44.325) | (114.816) | (44.253) | (132.663) | (148.470) | (143.225) |
| $NA_{i,t} \times \overline{GDPPC}_{c,t}$ | 469.357** | 0.073 | 529.401*** | -8.869 | 530.365*** | -6.742 | 315.124 | 649.541** | 480.797 |
| | (199.664) | (0.239) | (189.847) | (87.483) | (192.064) | (87.632) | (276.647) | (313.649) | (307.774) |

Estimates are obtained from running weighted regressions including year effects, and conditioning on imbalanced covariates. Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Table 5.A.18: *New manufacturing vs. new services foreign affiliates*

| | $\Delta INV_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta TAX_{i,t}$ | $\Delta TAX_{i,t}$ | $\Delta TAX_{i,t}$ | $\Delta INV_{i,t}$ | $\Delta ID_{i,t}$ |
|---|---|---|---|---|---|---|---|---|
| $NA_{i,t}$ | 457.751*** | 442.226*** | 454.894*** | -108.864** | -111.458** | -112.776** | 437.512*** | 526.594*** |
| | (145.103) | (144.686) | (145.423) | (53.348) | (53.758) | (53.819) | (156.457) | (197.089) |
| $NA_{i,t} \times \overline{SERV}_{a,t}$ | -348.330 | -453.984** | -460.273** | 82.590 | 119.857 | 122.428 | -333.973 | -108.424 |
| | (220.468) | (228.106) | (228.719) | (87.095) | (94.755) | (95.167) | (248.694) | (308.478) |
| $NA_{i,t} \times \overline{DSTR}_{c,t}$ | | 4170.369*** | | | -351.428 | | | |
| | | (1610.620) | | | (668.074) | | | |
| $NA_{i,t} \times \overline{SERV}_{a,t} \times \overline{DSTR}_{c,t}$ | | -1634.554 | | | -174.028 | | | |
| | | (2564.462) | | | (980.446) | | | |
| $NA_{i,t} \times \overline{IGL}_{a,t}$ | | | -2028.416 | | | -1668.389* | | |
| | | | (2792.352) | | | (877.421) | | |
| $NA_{i,t} \times \overline{SERV}_{a,t} \times \overline{IGL}_{a,t}$ | | | 2209.776 | | | -610.935 | | |
| | | | (5793.180) | | | (1797.653) | | |
| $NA_{i,t} \times \overline{DCP}_{c,t}$ | | | | | | | 331.579 | 920.369 |
| | | | | | | | (694.808) | (828.191) |
| $NA_{i,t} \times \overline{SERV}_{a,t} \times \overline{DCP}_{c,t}$ | | | | | | | -3321.366** | -1513.424 |
| | | | | | | | (1330.388) | (1636.153) |
| $NA_{i,t} \times \overline{DCPB}_{c,t}$ | | | | | | | -292.438 | -676.317 |
| | | | | | | | (657.419) | (794.592) |
| $NA_{i,t} \times \overline{SERV}_{a,t} \times \overline{DCPB}_{c,t}$ | | | | | | | 2233.849* | 787.818 |
| | | | | | | | (1254.636) | (1588.124) |
| $NA_{i,t} \times \overline{SMC}_{c,t}$ | | | | | | | 136.057 | -83.807 |
| | | | | | | | (267.477) | (323.856) |
| $NA_{i,t} \times \overline{SERV}_{a,t} \times \overline{SMC}_{c,t}$ | | | | | | | 901.467* | -172.195 |
| | | | | | | | (509.468) | (618.573) |
| $NA_{i,t} \times \overline{DIST}_{c}$ | | 234.795** | 242.274** | | 15.403 | 12.823 | 223.838* | 257.317 |
| | | (102.013) | (102.853) | | (43.837) | (43.790) | (123.862) | (163.451) |
| $NA_{i,t} \times \overline{GDP}_{c,t}$ | | 36.083 | -98.319 | | -59.838 | -48.576 | -141.614 | -190.641 |
| | | (103.284) | (88.094) | | (41.966) | (33.479) | (111.963) | (131.339) |
| $NA_{i,t} \times \overline{GDPPC}_{c,t}$ | | 653.563*** | 601.480*** | | -77.454 | -68.115 | 435.530 | 551.033* |
| | | (190.381) | (188.847) | | (84.876) | (84.307) | (271.554) | (312.153) |

Estimates are obtained from running weighted regressions including year effects, and conditioning on imbalanced covariates. Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively. $SERV_{a,t}$ is a dummy variable equal to 1 if the new foreign affiliate $a$ operates primarily in the services sector in period $t$, and 0 otherwise.

Table 5.A.19: *Treatment effects on different profit measures*

| | ATT | SE | No. treated ($NA = 1$) | No. untreated ($NA = 0$) |
|---|---|---|---|---|
| $\Delta OI_{i,t}$ | -327.830 | 211.542 | 2736 | 186729 |
| $\Delta EBT_{i,t}$ | -656.713$^{**}$ | 297.891 | 2669 | 186683 |
| $\Delta NP_{i,t}$ | -408.359$^{*}$ | 214.796 | 2680 | 186653 |
| $\Delta OI_{i,t}/SALES_{i,t}$ | -0.002$^{*}$ | 0.001 | 2575 | 183055 |
| $\Delta EBT_{i,t}/SALES_{i,t}$ | 0.001 | 0.002 | 2515 | 183124 |
| $\Delta NP_{i,t}/SALES_{i,t}$ | 0.002 | 0.002 | 2525 | 183118 |

Estimates are obtained from running weighted regressions including year effects and conditioning on *County Income per Capita*$_{k,t-1}$. Standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively. $OI_{i,t}$ denotes operating income, $EBT_{i,t}$ denotes earnings before taxes, $NP_{i,t}$ denotes net profits, $OI_{i,t}/CF_{i,t}$ denotes operating income relative to cash flow in period $t$, $EBT_{i,t}/CF_{i,t}$ denotes earning before taxes relative to cash flow in period $t$, and $NP_{i,t}/CF_{i,t}$ denotes net profits relative to cash flow in period $t$.

Table 5.A.20: *Tax savings and profit-shifting channel - Top quartile/decile of the tax differential distribution*

| | ATT | SE | No. treated | No. untreated |
|---|---|---|---|---|
| $(DSTR > P75)\Delta INV_{i,t}$ | 668.052$^{***}$ | 246.808 | 756 | 185711 |
| $(DSTR > P90)\Delta INV_{i,t}$ | 754.181$^{**}$ | 359.096 | 303 | 134372 |

Estimates are obtained from running weighted regressions including year effects, and conditioning on imbalanced covariates. Standard errors are clustered at the firm level. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

Table 5.A.21: *Financing channel – internal-debt-to-total-assets-ratio*

| | $\Delta ID_{i,t}/TA_{i,t}$ |
|---|---|
| $NA_{i,t}$ | 0.003$^{***}$ |
| | (0.001) |
| $NA_{i,t} \times \overline{DCP}_{c,t}$ | -0.009 |
| | (0.006) |
| $NA_{i,t} \times \overline{DCPB}_{c,t}$ | 0.003 |
| | (0.005) |
| $NA_{i,t} \times \overline{SMC}_{c,t}$ | 0.007$^{***}$ |
| | (0.003) |
| $NA_{i,t} \times \overline{DIST}_{c,t}$ | 0.000 |
| | (0.001) |
| $NA_{i,t} \times \overline{GDP}_{c,t}$ | 0.000 |
| | (0.001) |
| $NA_{i,t} \times \overline{GDPPC}_{c,t}$ | 0.000 |
| | (0.002) |

Estimates are obtained from running weighted regressions including year effects and conditioning on imbalanced covariates. Standard errors clustered at the firm level in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.