Research School of International Taxation

# Are Consumers Paying the Bill? How International Tax Competition Affects Consumption Taxation

Georg u. Thunecke

Working Paper
03/2022

Eberhard Karls
Universität Tübingen

School of Business and Economics

# Are Consumers Paying The Bill? How International Tax Competition Affects Consumption Taxation*

Georg U. Thunecke†

Version of September 8, 2022

**Abstract**

This paper empirically investigates whether governments are substituting from corporate to consumption taxation due to tax competition using a novel self-collected data set of corporate and consumption tax regime information. I estimate the slope of the tax policy reaction function between corporate and consumption tax rates exploiting the cross-sectional interdependence of corporate tax rates for an instrumental variable approach. Additionally, I analyze the rate-revenue relationship of both tax instruments to evaluate the overall revenue implications of corporate tax competition. I find that, on average, a one percentage point decrease in the corporate tax rate leads to a 0.35 percentage point increase in the consumption tax rate. The rate-revenue relationship of both corporate and consumption tax rates follows an inverted U-shape. Furthermore, governments can fully compensate for revenue losses from tax competition by substituting to consumption taxation. These results indicate that the debate on corporate tax competition may overstate efficiency considerations and underestimate equity concerns.

**Keywords: Corporate Taxation, Consumption Taxation, Tax Competition, Fiscal Externality, Revenue Effects**

**JEL classification: H20; H21; H25; F68**

## 1 Introduction

Recent corporate tax policy developments like the US Tax Cuts and Jobs Act of 2017 or the G7 proposal for the introduction of a global minimum corporate tax rate are the result of inter-governmental competition for increasingly mobile capital. Greater capital mobility and, thus, an increasing intensity in tax competition are caused by globalization which has also fueled distributional inequality and subsequently the demand for public spending (see Hines Jr and Summers, 2009). It has long been argued that tax competition results in an underprovision of public goods as governments set inefficiently low corporate tax rates and are, therefore,

*I am grateful to Johannes Becker, Ronald Davies, Michael Devereux, Wilhelm Kohler, Simon Loretz, Horst Raff, Frank Stähler, Nora Strecker, Maximilian Todtenhaupt, Georg Wamser and participants at the Public Economics Research Seminar at the ifo Institute Munich, the $8^{th}$ Annual Mannheim Taxation Conference, the Oxford University Center for Business Taxation Doctoral Conference, and the 2022 Annual Congress of the IIPF for comments and suggestions. The author gratefully acknowledges financial support received from the German Research Foundation through the Research Unit FOR 2738 Ünderstanding the Behaviour of Multinational Corporations in the Context of International Tax Institutions". The author

†University of Tübingen, School of Business and Economics and Research School of International Taxation (RSIT). Nauklerstr. 47, 72070 Tübingen, Germany. Email: georgthunecke@gmail.com. ORCID-ID: 0000-0003-1668-0912.

unable to raise sufficient revenues.[1] Figure 1 indicates that corporate tax rate-cutting has been prevalent throughout the past two decades. Average STRs decreased by roughly 21% (5.68 percentage points) from 2003 to 2020.[2] Meanwhile, base-broadening did not take place as depreciation allowances exhibit very little within-country variation over time. Thus, the tax burden on corporate profits has decreased substantially throughout the past two decades. Given this development, the concerns about an underprovision of public goods appear to be justified. However, government spending has not only remained stable, but even increased in the wake of recent economic crises, including the global financial crisis in 2008, the European debt crisis, and the ongoing Covid-19 pandemic. Given the increase in public expenditures and the simultaneous decrease in STRs, governments must raise the necessary funds from other tax bases.

Consumption is an apparent option to raise the necessary revenues from, due to its widespread availability, broad base, and low administrative cost. Figure 1 documents a substantial increase in consumption taxation. Average consumption tax rates (CTRs) have increased by roughly 16.9% (2.17 percentage points). Judging from this descriptive evidence, governments raise the revenue needed to consolidate public budgets from (less mobile) consumption. As a result, the burden of decreasing STRs appears to fall on consumption, potentially leaving consumers to pay the bill for corporate tax competition. While taxing consumption may be economically efficient, due to the limited mobility of the tax base, it raises concerns about equity, as consumption taxes tend to fall disproportionately on low-income individuals (see Metcalf, 1997; Hines Jr and Summers, 2009). Subsequently, the main consequence of tax competition may not be an underprovision of public goods, but rather a shift in the composition of the overall tax revenue away from corporate taxation to other potentially less mobile tax bases.

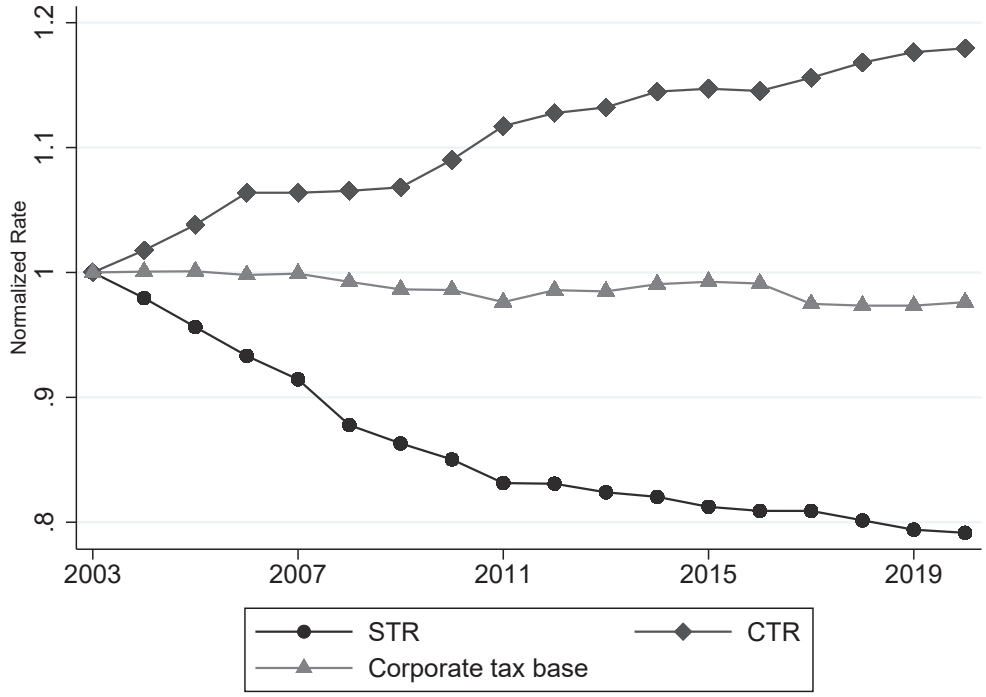
While the downward pressure on STRs and the adverse revenue effects from corporate tax competition are well studied and widely acknowledged[3], the potential spillovers to other non-corporate tax instruments are often neglected. Disregarding the fact that governments can raise revenues from other potentially less elastic tax bases might lead to false conclusions. Consequently, the debate on corporate tax competition might overestimate the threat of underprovision of public goods, while underestimating equity concerns. There is a surprisingly small empirical literature looking at the interaction between national tax policy instruments across different tax bases in general and at the interdependence of corporate and consumption tax policy in particular. This paper addresses this research gap by investigating the research question: Are governments shifting the burden of corporate tax competition to consumption? This question will be answered within three sub-questions: Are consumption tax rates substitutes for corporate tax rates? How is tax revenue

[1] See for example the seminal contributions of Oates (1972), Wilson (1986) and, Zodrow and Mieszkowski (1986).

[2] Note STRs exhibit a sharp downward trend over the past half century (see Devereux, Griffith, and Klemm, 2002; Loretz, 2008; Steinmüller, Thunecke, and Wamser, 2019).

[3] For a survey of the empirical literature see Gordon and Hines Jr (2002), Brueckner (2003), and Leibrecht and Hochgatterer (2012).

Figure 1: Development of the Average STR and CTR 2003-2020




The figure is based on a balanced panel of 155 countries. All values are normalized to the 2003 value.

affected by the changes in corporate and consumption tax rates? Are governments able to compensate corporate tax revenue losses through consumption tax revenue? For the analysis, I am using a novel panel of corporate and consumption tax regime information covering more than 190 countries over the period from 2003 to 2020. The relationship between corporate and consumption tax rates is identified by estimating the slope of the tax policy reaction function using an instrumental variable (IV) approach. To resolve the simultaneity in setting different domestic tax instruments, I exploit the cross-sectional interdependence of corporate tax policies (i.e., tax competition) to instrument for domestic STRs. I find that corporate tax rates are substitutes for consumption tax rates. On average, a one percentage point decrease in the STR results in a 0.35 percentage point increase in the CTR. Based on this result, the downward trend in corporate tax rates rationalizes 91.6% of the increase in consumption tax rates throughout the past two decades. Furthermore, the rate-revenue relationship of both tax instruments follows an inverted U-shape (Laffer-Curve) pattern. Using these results, I conduct a back-of-the-envelope calculation to illustrate the importance of considering consumption taxation in the context of tax competition. Governments on average set corporate and consumption tax rates well below the revenue-maximizing policy. Consequently, decreases

in STRs result in net revenue losses which are more than offset by increases in the consumption tax. Thus, governments can deal with the revenue repercussions of corporate tax competition and maintain a stable level of public expenditure by substituting to other tax bases. As a result, the debate on tax competition appears to overemphasize efficiency concerns, while neglecting equity concerns.

This paper contributes to three strands of the literature. First, it adds to the literature that analyzes the effects of international corporate tax competition on other non-corporate tax policy instruments and the overall tax mix. The study by Loretz (2008) analyzes the co-development of various tax instruments in the OECD from 1982-2007. The author illustrates a diverging development of personal and corporate income taxes compared to depreciation allowances and consumption tax rates. While the former two experienced a stable and significant decrease over the observational period, the latter two exhibit the opposite pattern. The author concludes that this development is caused by corporate tax competition and that governments compensate for falling STRs by increasing consumption tax rates and broadening the corporate tax base. Hines Jr and Summers (2009) investigate the effect of globalization on the tax revenue mix. The authors demonstrate that small and more economically open countries rely increasingly on consumption rather than corporate or personal income tax revenue. They conclude that globalization leads to greater reliance on revenues from immobile tax bases. Similarly, Genschel and Schwarz (2012) analyze the consequences of corporate tax competition on the autonomy of OECD governments to independently set national tax instruments. The authors illustrate that countries of all sizes substitute from corporate to consumption taxation due to tax competition. The existing literature descriptively documents that EU and OECD governments are substituting from corporate to consumption taxation due to globalization and intensifying tax competition. The paper at hand is the first to directly estimates the tax reaction function between corporate and consumption tax rates. Furthermore, the analysis is based on a global panel allowing for a generalization of the results beyond the OECD/EU context.

Second, this paper contributes to the empirical literature analyzing the effects of corporate tax rate changes on tax revenue. Clausing (2007) uses a panel of OECD countries from 1979 to 2002 to estimate the relationship between corporate tax rates and revenues using an OLS regression. Her results indicate that this relationship follows an inverted U-shape with a revenue-maximizing STR of 33%. Devereux (2007) replicates these results using a panel of 20 OECD countries from 1986 to 2004. However, when using log revenues, he only finds weak evidence for any relationship between corporate tax rates and revenues. Kawano and Slemrod (2016) also analyze a panel of OECD countries for the years 1980 to 2004. In contrast to the previous literature, they additionally control for unobserved time invariant country characteristics. They also find evidence for an inverted U-shape relationship which is less pronounced, compared to previous findings, implying a higher revenue-maximizing tax rate. Steinmüller, Thunecke, and Wamser (2019) analyze

the relationship between STRs and corporate tax revenues for a panel of 142 countries from 2004 to 2016 controlling for time and panel fixed effects. They also find an inverted U-shape relationship. While the relationship between tax rates and revenues is well-studied for corporate taxation, evidence on this relationship for other non-corporate tax instruments remains scarce. This paper adds to this literature by expanding the analysis of the rate-revenue relationship to consumption taxation providing a more complete analysis of the overall revenue consequences of tax competition.

Third, this paper contributes to the empirical literature on corporate tax competition estimating direct policy reaction functions. Devereux, Lockwood, and Redoano (2008) estimate corporate tax reaction functions for a time series of 21 OECD countries from 1982-1999. They find that countries compete both in statutory and forward-looking effective tax rates. According to their analysis the downward trend of STRs can almost entirely be attributed to intensifying corporate tax competition. Overesch and Rincke (2011) derive similar results in a dynamic setting for a larger (1983-2006) and broader (32 countries) time series. They also find strong cross-sectional dependencies in STRs which can explain the downward trend in statutory tax rates. Egger and Raff (2015) investigate corporate tax competition in both tax rates and the tax base for 43 European countries between 1982 and 2005. They conclude that countries not only compete in STRs but also in the tax base. Crivelli, De Mooij, and Keen (2016) analyze corporate tax rate and base spillovers for 173 countries from 1980 to 2013. They find evidence for tax base and rate spillovers which appear to be especially relevant for developing countries. The key result of the empirical tax competition literature is that corporate tax rates are interdependent across countries. I built on this result by exploiting this cross-sectional interdependence for an unbiased identification using an IV approach. To resolve the simultaneity problem of corporate and consumption tax setting, I instrument for the domestic corporate tax rate using a weighted average of all other countries' corporate tax rates. This study adds to the literature by focusing on the interaction between different tax instruments within a country rather than across countries. To the best of my knowledge, no study has previously utilized an IV approach exploiting corporate tax competition as an instrument for domestic policy spillovers.

The remainder of the paper is structured as follows. Section 2 establishes the setting and outlines the key assumptions of the analysis. The estimation strategy and the data are discussed in Section 3. The empirical results are presented in Section 4. Section 5 analyzes the overall revenue consequences of tax competition. The last section concludes the analysis.

## 2 Setting

The goal of this paper is to explain the divergent development of STRs and CTRs in Figure 1. Following Hines Jr and Summers (2009), globalization leads to both higher public expenditure needs and capital mobility, resulting in an intensification of corporate tax competition. The paper extends this point by arguing that increased tax competition creates revenue losses which governments compensate by substituting to CTRs. For this mechanism to be plausible, some assumptions need to hold which are descriptively tested in this section. First, public good provision remains constant. One reason for this could be short-run budget rigidity. If governments could simply reduce the required budget at short notice, the need for additional public funds never arises. Looking at Figure 2, we observe that public spending between 2000 and 2020 exhibits a stable horizontal development with the exception of a discrete jump following the global financial crisis in 2008. Following this discrete jump, the spending level stabilized again. However, public spending is only an imperfect proxy for public good provision as it also captures administrative costs. Figure 4 depicts the development of the expenditures on public goods and services from 2000 to 2019. Most of these expenditures have remained stable throughout the observational period indicating that, on average, countries did not experience a significant reduction/underprovision of public goods and services. The only two exceptions are defense and general public services, which have both decreased by roughly 20 percent relative to the level of 2000. The development of the latter could indicate a reduction in public good provision. However, the development appears to depend on overall business cycles, as expenditures sharply increase following the global financial crisis in 2008 and start to decrease again with the ongoing economic recovery. Looking at governmental expenses in Figure 5, we observe that almost all types of expenses have remained stable throughout the past two decades. The only two expenses that exhibit substantial changes are interest payments and social benefit expenses. While the decrease of the former is most likely driven by the low central bank discount rates, the latter increased substantially due to economic repercussions from the financial crisis in 2008. Taking these results together, we do not observe underprovision of public goods. In fact, government spending increased as a result of several global economic crises.

Second, governments are not able to debt-finance a public deficit indefinitely. Looking at Figure 2, public revenues also exhibit a stable trend but have remained below public spending for the majority of the observed sample period implying that, on average, governments run a public deficit. Judging from the development of gross debt, also depicted in Figure 2, governments on average debt-financed this fiscal deficit, at least in the short-run. If governments were able to debt-finance public deficits for a prolonged period of time, the need for raising additional revenue disappears. Theoretically, some governments might be able to run such a deficit. As long as they can credibly signal their ability and willingness to repay public debt,

interest rates will remain reasonably low and government default is very unlikely (see Breen and McMenamin, 2013).[4] However, the majority of countries will eventually need to increase taxes in the future to prevent excessive debt and rising interest rates. Additionally, countries may also wish to increase tax rates and raise additional tax revenue to emphasize a commitment to solvency, thus, keeping interest rates low. All in all, it is impossible to conclusively test whether governments are able to debt-finance public deficits infinitely. However, it appears plausible to assume that most governments will need to repay their debt eventually and subsequently raise taxes.

Third, corporate tax revenues decline. Turning to Figure 3, we observe that the largest share of the overall tax revenue comes from consumption taxes, while personal income and corporate taxation play a smaller yet relevant role. In line with Hines Jr and Summers (2009), revenue from corporate income has decreased by 1.7 percent over the past two decades, while consumption tax revenues have risen by 4.7 percent. Overall, personal income tax revenue has remained almost constant. The decline in the revenue share of corporate income taxation appears to moderate given the substantial decrease in STRs. However, Fuest, Hugger, and Wildgruber (2020) document a substantial increase in pre-tax corporate profits which is only to a small extent driven by increases in operating profits. This precludes the possibility of a self-financing corporate tax cut.[5] Given the increase in public spending and these revenue developments, governments appear to have increasingly relied on revenues from consumption taxation to finance public goods. This argument is supported by the findings of Hines Jr and Summers (2009) and Arezki, Dama, and Rota-Graziosi (2021), who find that increasing trade openness, generally associated with more intense tax competition, results in a shift of the tax mix towards consumption taxation. Additionally, Egger, Nigai, and Strecker (2019) document that a similar development occurred within personal income tax revenue as the tax burden has been shifted from top income earners to the middle class, explaining the stability in the share of personal income tax revenues.

Fourth, governments do not substitute to other non-consumption tax bases. While the evidence so far illustrates the need to raise additional revenue, governments could also tab into other potential tax bases including personal income, property or capital gains taxes instead of consumption. However, several arguments can be made in favor of taxing consumption. First, consumption is comparatively inelastic allowing for revenue to be raised more efficiently (see Ramsey, 1927). Furthermore, consumption taxes are less sensitive to business cycles resulting in a more stable revenue flow due to the immobility of thetax

[4]Lierse and Seelkopf (2016) analyze the fiscal responses of debt-constrained European countries during the 2008 financial crisis. They find that countries facing high bond yields refinance themselves predominantly by increasing taxes on consumption and other less mobile tax bases.

[5]Figure A.1 in the Appendix illustrates that corporate tax revenues follow an inverted U-Shape, technically allowing for the possibility of self-financing corporate tax cuts. However, the average corporate tax rate is well below the revenue-maximizing one, thus, revenue increases must be driven by other non-tax policy related developments.

base. Second, personal income tax rates (PITs) show the same downward trend as STRs over the past two decades.[6] Using the data of Egger, Nigai, and Strecker (2019), Figure A.3 illustrates the development of the effective average PITs based on the average country-year-specific wage. STRs and PITs exhibit an almost identical development. Furthermore, the analysis in Appendix A.4 indicates that the PIT development is not self-financing and results in revenue losses.[7] These results are in line with expectations, the taxation of personal income suffers from similar problems as capital gains and corporate taxation. Additionally, personal income taxation generally serves as a backstop to corporate taxation. Large differentials between corporate and personal income taxation would create (dis-)incentives for incorporation and, thus, additional frictions and inefficiencies. Third, consumption taxes are set on the national level and flow predominantly into the national budgets, which allows for an easier adaptation to revenue requirements of the national government.[8] While the property tax base is substantially less elastic compared to consumption, it is generally administered at the sub-national level (see Bird and Slack, 2004). As a result, property taxation is out of reach for national parliaments and, thus, not adequate to consolidate national budgets. Looking at the overall size of the revenue generated (Table 1), it is apparent that property taxes only make up a small portion of the overall tax revenue raised (see also Hines Jr and Summers, 2009). Therefore, only a disproportionate increase of property tax rates could compensate for falling STRs, which bears the substantial risk of political repercussions by voters. Consequently, consumption taxes are the most feasible instrument to raise additional revenue.

# 3 Empirical Model and Working Hypotheses

## 3.1 Working Hypothesis

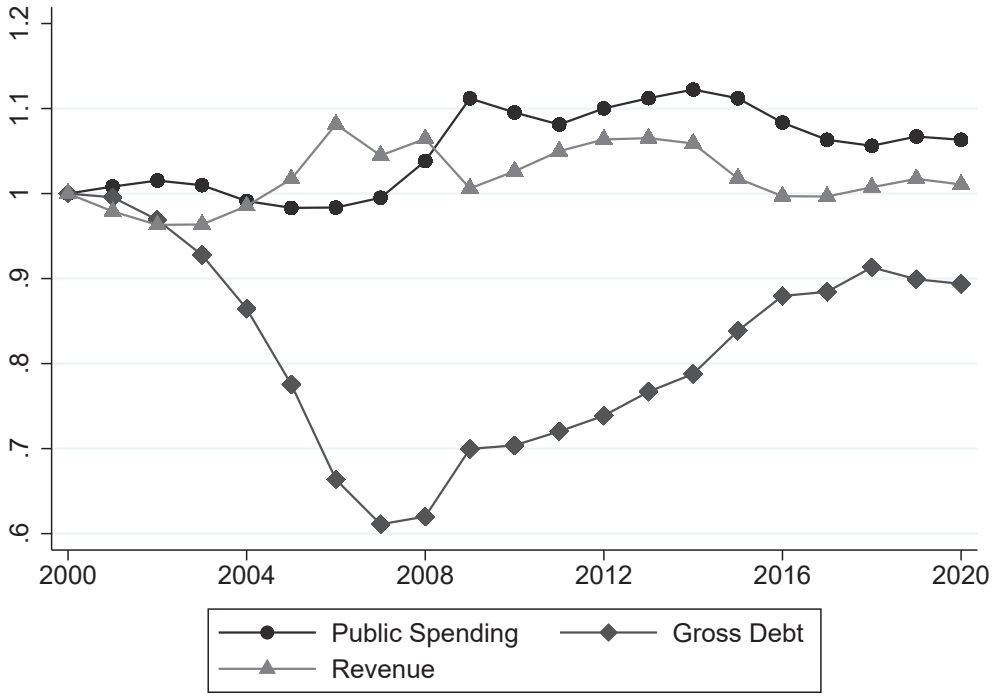
Based on the research question and the descriptive evidence presented in Section 2, I derive several testable hypotheses for the empirical analysis. The first hypothesis concerns the relationship between corporate and consumption tax rates. Due to budget rigidity, revenue losses stemming from falling (effective) corporate tax rates are compensated through raising additional revenue from consumption. Accordingly, I derive the following hypothesis:

**Hypothesis 1:** The corporate and consumption tax rates are substitutes.

The next set of hypotheses is related to the revenue effects caused by changes in the consumption and corporate tax rate. Given the relatively mobile corporate tax base, it is reasonable to expect that the rela-

[6] See for example Egger, Nigai, and Strecker (2019) and Loretz (2008).
[7] See Appendix A.4 for more details.
[8] There are some notable exceptions to this rule, including the United States of America and Brazil.

Figure 2: Average Fiscal Development 2000-2020 (Normalized to the Base Year 2000)



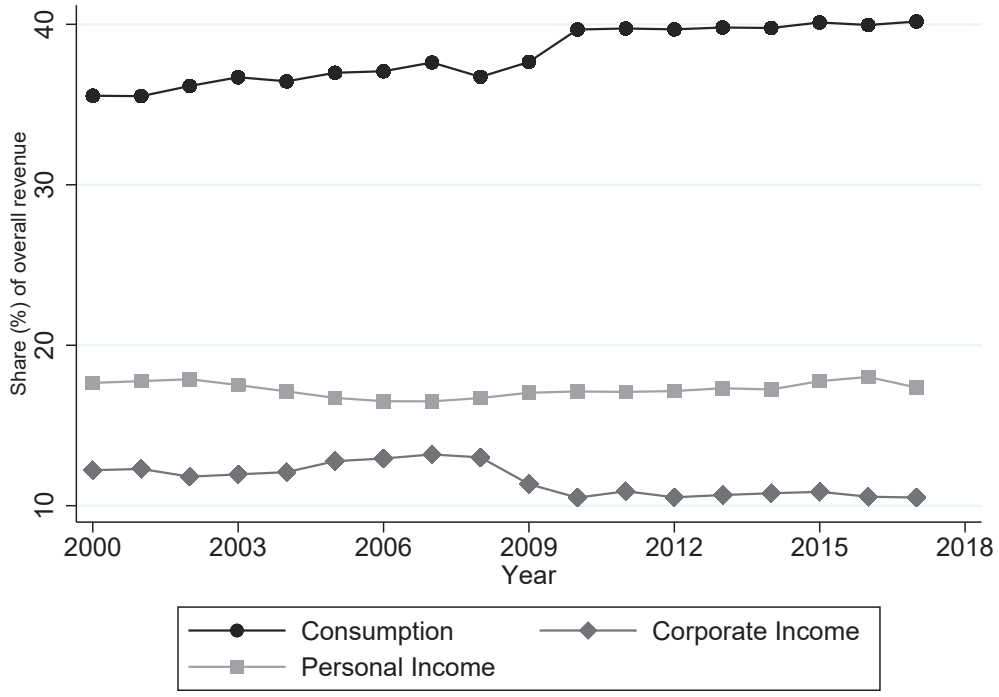

The calculations are based on an unbalanced panel of 113 countries taken from the IMF Fiscal monitor. The values are normalized by the respective value in the year 2000. The variable values are expressed in % of GDP.

tionship between corporate tax rates and revenue follows an inverted U-shape (Laffer-Curve) pattern. This pattern is produced by the opposing mechanical and behavioral effect. The mechanical effect is linear in the tax rate, as an increase (decrease) in the tax rate leads to more (less) revenue raised from the existing tax base. The behavioral effect is quadratic in the tax rate and captures the tax base mobility, thus, an increase (decrease) in the tax rate causes the tax base and, therefore, revenue to decrease (increase) as capital is relocated. Since consumption is a less mobile base compared to corporate profits, one would expect to see a strong mechanical effect but only a weak behavioral effect.[9] Given these differences in base mobility, I derive the following two hypotheses:

**Hypothesis 2:** The corporate tax rate-revenue relationship exhibits a positive mechanical effect and a negative behavioral effect.

[9]For descriptive evidence on tax base mobility refer to Appendix A.3. Local polynomial regression of tax revenue on tax rates reinforce the presumed differences in tax base mobility.

Figure 3: Average Development of Revenue Shares Relative to Overall Tax Revenue



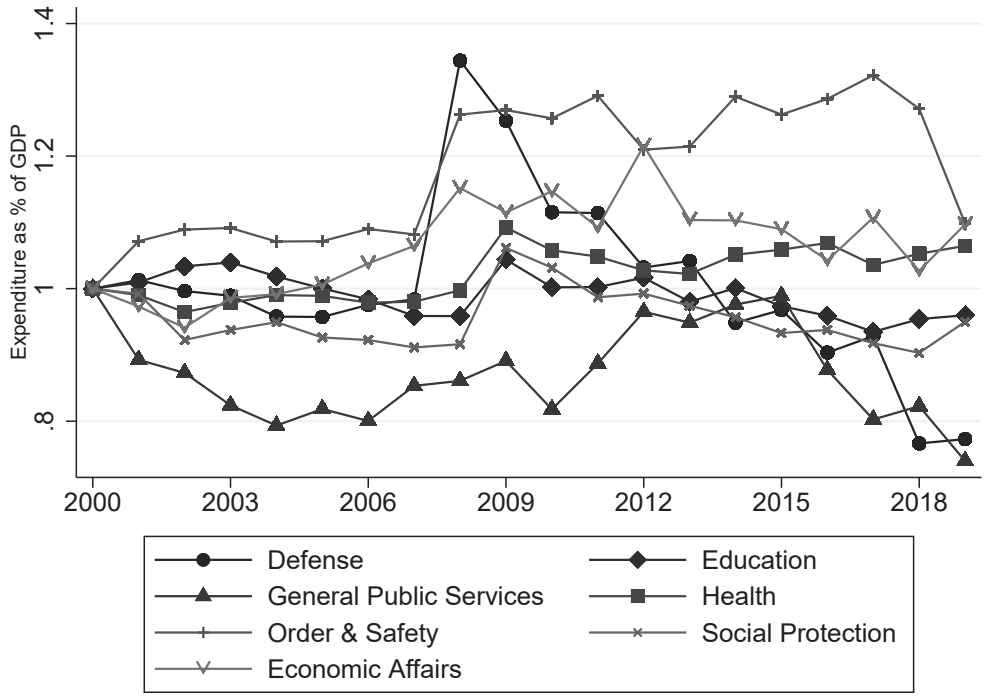

The calculations are based on an unbalanced panel of 164 countries taken from the UN Government Revenue Dataset. The variable values are expressed as share of total tax revenue.

**Hypothesis 3:** The consumption tax rate-revenue relationship exhibits a positive mechanical effect and a weak negative behavioral effect.

Given the argument on budget rigidity, the question remains, whether the revenue effects of consumption taxation are sufficient to match the revenue changes from corporate taxation. In order to investigate this relationship, I test the following hypothesis:

**Hypothesis 4:** Governments fully compensate revenue losses from STR decreases through substitution to consumption taxation.

Figure 4: Average Development of Different Expenditures




The calculations are based on an unbalanced panel of 73 countries taken from the IMF Expenditure by function of Government Database. The values are normalized by the respective value in the year 2000. The variable values are expressed in % of GDP.

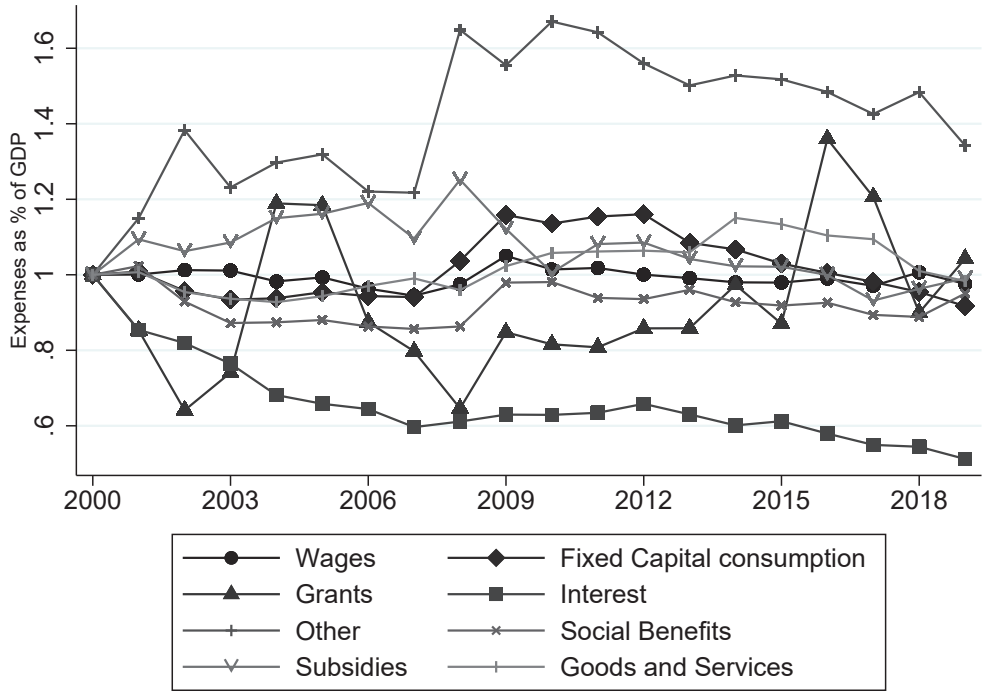
## 3.2 Empirical specification

Hypothesis 1 to 3 are examined using a panel data set covering $T$ time periods and $N$ countries. To test hypothesis 1, I estimate the tax reaction function of the CTR with respect to the STR, following:

$$\theta_t = \beta_\theta \tau_t + \mathbf{X}_t \gamma_\theta + \epsilon_t, \tag{1}$$

where $\theta_t$ and $\tau_t$ are $N \times 1$ vectors of consumption and corporate tax rates in year $t$. $\mathbf{X}_t$ is a $N \times (3+N)$ matrix containing control variables for country size, production and trade cost as well as country fixed effects. Year fixed effects are purposefully excluded in Equation (1) due to the IV approach outlined in Section 3.3. The IV approach exploits the (weighted) average global change in corporate tax rates for identification which would be almost entirely controlled for by year fixed effects. $\epsilon_t$ is the disturbance term of the model. The coefficient of interest is $\beta_\theta$, returning the type and strength of the interaction between STRs and CTRs. In line with hypothesis 1, substitutability implies that $\beta_\theta$ is expected to be negative.

Figure 5: Development of Normalized Mean Expenses from Different Categories




The calculations are based on an unbalanced panel of 181 countries taken from the IMF Government Finance Statistics Database. The values are normalized by the respective value in the year 2000. The variable values are expressed in % of GDP.

Hypothesis 2 and 3 are tested separately for consumption and corporate taxation. The revenue consequences of corporate/consumption tax rate changes are estimated according to:

$$\mathbf{REV}_{\tau t} = \alpha_0 + \alpha_\tau \tau_t + \delta_\tau \tau_t^2 + \mathbf{X}_{\tau t}\eta_\tau + \epsilon_{\tau t}, \tag{2}$$

$$\mathbf{REV}_{\theta t} = \alpha_0 + \alpha_\theta \theta_t + \delta_\theta \theta_t^2 + \mathbf{X}_{\theta t}\eta_\theta + \epsilon_{\theta t}. \tag{3}$$

$\mathbf{REV}_{\tau t}$ and $\mathbf{REV}_{\theta t}$ are $N \times 1$ vectors denoting the corporate and consumption tax revenues in period $t$ respectively. $\mathbf{X}_t$ is a $N \times (1 + N + T)$ matrix containing control variables for economic growth, country and year fixed effects. $\epsilon_{\tau t}$ and $\epsilon_{\theta t}$ represent the disturbance terms of the respective model. Both equation 2 and 3 estimate a Laffer-Curve relationship, with $\alpha_\tau$ and $\alpha_\theta$ capturing the strength and direction of the mechanical effect and $\delta_\tau$ and $\delta_\theta$ picking up the behavioral effect. In line with hypothesis 2, the expected coefficients are $\alpha_\tau > 0$ and $\delta_\tau < 0$. Regarding hypothesis 3, $\alpha_\theta$ is expected to be positive. Due to the relative immobility of consumption, I expect $\delta_\theta$ to be smaller than $\delta_\tau$. Hypothesis 4 is addressed in Section 5 by combining the estimation results of $\beta_\theta$, $\alpha_\tau$, $\alpha_\theta$, $\delta_\tau$ and $\delta_\theta$ to analyze the effects of a change in the STR on the overall tax

revenue.

### 3.3 IV Approach

There are two econometric issues that need to be addressed to obtain consistent and unbiased results for equation 1. First, naively estimating equation 1 using OLS will produce biased results, as corporate and consumption tax rates are likely to be jointly determined rendering $\tau_t$ endogenous. Second, the estimated standard errors need to be corrected to be heteroskedasticity, spatial and serial autocorrelation-consistent (SHAC) following Driscoll and Kraay (1998).

To obtain an unbiased estimate of the coefficient of interest $\beta_\theta$, I estimate equation 1 by using an IV approach instrumenting for $\tau_t$ using:

$$\bar{\tau_t} \equiv \mathbf{W}\tau_t. \tag{4}$$

$\bar{\tau_t}$ is the weighted average corporate tax rate of country $i$'s neighbors (competitors). $\mathbf{W}$ is an exogenous, time-constant $N \times N$ weighting matrix with zero diagonal elements. $w_{ij}$ is the weight assigned to country $j$ from the perspective of country $i$. For the analysis, I will use two different weighting schemes; inverse distance (geographical neighbors) and 'natural' trade flows (economic neighbors).[10] All elements of W are row-sum normalized implying that $\sum_{j=1}^{N} w_{ij} = 1$. The identifying assumption behind this IV strategy is that STRs across countries are cross-sectionally interdependent due to tax competition, while CTRs are only indirectly affected. Put differently, the STRs of $i's$ neighbors affect the STR in $i$, but have no direct effect on the CTR in $i$. Consequently, the endogeneity is resolved by exploiting the variation in $i's$ STR, caused by changes in the corporate tax policy of $i's$ neighbors, which lie beyond the control of $i$. For the IV strategy to yield unbiased estimates, both relevance and exclusion restriction need to hold. The relevance assumption in this case requires that the STRs of $i's$ neighbors do have an economically and statistically significant impact on the STR in $i$; countries strategically interact in their tax setting behavior due to corporate tax competition. To test the relevance assumption, I replicate the estimation conducted by Egger and Raff (2015) in Appendix A.2 to test for strategic interaction in corporate tax instruments. I find that STRs are strong strategic complements. These results imply that the chosen instrument is relevant and not weak.[11] These findings are in line with the results derived by Devereux, Lockwood, and Redoano (2008), Overesch and Rincke (2011) and Egger and Raff (2015) who provide strong evidence for corporate tax competition in the OECD/EU context. Apart from the relevance assumption, the results in Appendix A.2 imply that

[10] For a more detailed description of the different weighting schemes applied see Appendix A.1.
[11] For a more detailed description of the estimation strategy and the results see Appendix A.2.

the findings of the empirical tax competition literature are not confined to the OECD/EU context but also generalize to the panel analyzed in this essay. Thus, tax competition appears to be not only an EU/OECD phenomenon but takes place globally.

The exclusion restriction demands that $\mathbb{E}(\epsilon_t|\bar{\tau}_t) = 0$; STRs of $i's$ neighbors have no direct effect on the choice of the CTR in country $i$. This assumption would be violated if countries were to compete not only in corporate but also consumption tax rates, since this would imply that CTRs in $i$ are simultaneously determined with the corporate and consumption tax rates of $i's$ neighbors. I test for consumption tax competition in Appendix A.3, using a similar empirical approach as for corporate tax competition.[12] Following the results presented in Table A.3, I do not find evidence for consumption tax competition, thus, the exclusion restriction holds. The weighted average of CTRs has no direct statistically significant impact on the CTR in $i$.[13] This result is intuitive, given that mobility of consumption is limited, countries have little incentive to strategically set CTRs to attract foreign consumption.

## 3.4 Data

The analysis in this paper builds on two self-collected data sets containing information on corporate and consumption tax regimes. The corporate tax data are a substantial extension of the data set presented in Steinmüller, Thunecke, and Wamser (2019). It contains information on corporate tax rates, depreciation allowances, and methods for an unbalanced panel of 224 countries for the years 2001-2020.[14] Following Devereux, Pearson, and Sørensen (1991) as well as Devereux and Griffith (1998), I combine STRs and depreciation allowances to calculate forward-looking effective marginal (EMTR) and effective average tax rates (EATR) for a balanced panel of 166 countries. Both the EMTR and EATR are composite measures encompassing rate and base effects of corporate tax policy. They capture the tax incentives a firm faces for marginal (EMTR) and discrete investment projects (EATR) respectively.[15] The consumption tax data set contains variables on standard and reduced consumption tax rates, the type of consumption tax, as well as the number of different consumption tax rates for an unbalanced panel of 203 countries covering the time period from 2003 to 2020. This data were primarily collected using the *EY Worldwide VAT, GST and Sales Tax Guides*, *Deloitte Guides to Fiscal Information*, *PwC Worldwide Tax Summaries* and the *IBFD Tax Research Database*. From these two novel data sets, I construct a balanced corporate and consumption tax rate panel for 173 countries from 2003 to 2020. The number of countries drops to 154 countries when also

[12] Note that ideally I would also run a Sargan-Hansen-test to validate the exclusion restriction. Unfortunately, I am unable to so as this as more than one instrument is required.

[13] See Appendix A.2 for a more detailed description.

[14] Note that these also include unincorporated territories with tax autonomy like Puerto Rico, the Kosovo, or South Sudan.

[15] For a thorough discussion of the data set and the calculation of the EMTRs and EATRs see Steinmüller, Thunecke, and Wamser (2019).

considering the forward-looking effective tax rates.

For the empirical analysis, I use country size, production and trade cost, as well as GDP growth as control variables. Furthermore, I require revenue data as the dependent variable for the estimation of equations 2 and 3. Country size and labor cost are approximated through log GDP and log GDP per capita in constant USD. Both variables as well as annual GDP growth in % are taken from the World Bank's *World Development Indicators Database*. Trade cost is approximated using the log value of cost, insurance and fright (CIF) data from the *CEPII Trade Unit Values database*. The expenditure, debt and revenue data presented in Figure 2 are taken from the IMF *Fiscal Monitor*. The data on different types of tax revenue illustrated in Figure 3 and used for testing hypotheses 2-4 were retrieved from the UN *Government Revenue Dataset*. The public expenditure and expenses data represented in Figures 4 and 5 were taken from the IMF *Government Finance Statistics Database*. All the variables taken from the IMF are measured in % of GDP. The inverse distance weighting matrix is calculated using geo-spatial information from the CEPII *GeoDist* database. "Natural" Trade flow weights are estimated using structural gravity estimation building on the same geo-spatial information as well as bilateral export volume data from the CEPII *BACI* database and data on regional trade agreements from Egger and Larch (2008). After combining the tax regime data with several control variables, I am left with a balanced panel of 133 countries covering the years 2003 to 2018 for the empirical analysis. For the analysis in Appendix A.4 I use data from Egger, Nigai, and Strecker (2019) on effective average personal income tax rates calculated for the mean income in each country and year. This data was provided to me by the authors and covers 162 countries from 2003 to 2012. Table 1 contains the summary statistics.

Table 1: Summary Statistics

| Variable | Mean | SD | Min | Max | N.Obs |
|---|---|---|---|---|---|
| Corporate income tax rate | 0.24 | 0.10 | 0.00 | 0.57 | 2,772 |
| Standard consumption tax rate | 0.14 | 0.07 | 0.00 | 0.27 | 2,772 |
| NPV of depr. allowances | 0.52 | 0.14 | 0.00 | 0.88 | 2,772 |
| Effective marginal tax rate | 0.13 | 0.06 | 0.00 | 0.37 | 2,772 |
| Effective average tax rate | 0.21 | 0.08 | 0.00 | 0.49 | 2,772 |
| Effective Average PIT rate | 0.13 | 0.13 | 0.00 | 0.80 | 1,530 |
| Public expenditure (% of GDP) | 32.25 | 11.63 | 3.79 | 65.05 | 1,742 |
| Gross public debt (% of GDP) | 51.70 | 34.98 | 0.00 | 237.69 | 1,736 |
| Public revenue (% of GDP) | 30.69 | 12.32 | 1.98 | 72.34 | 1,742 |
| Corporate Income Tax Revenue (% of GDP) | 3.09 | 2.12 | 0.00 | 20.78 | 1,831 |
| VAT Revenue (% of GDP) | 6.15 | 2.61 | 0.00 | 18.89 | 1,702 |
| Goods and Services Tax Revenue (% of GDP) | 9.06 | 4.43 | 0.03 | 36.04 | 1,945 |
| Property Tax Revenue (% of GDP) | 0.92 | 1.07 | 0.00 | 17.37 | 1,732 |
| Income Tax Revenue (% of GDP) | 7.30 | 4.56 | 0.08 | 31.67 | 1,923 |
| GDP growth (annual %) | 3.77 | 4.44 | -46.08 | 34.47 | 2,365 |
| log GDP per capita (constant 2010 US$) | 8.83 | 1.43 | 5.27 | 11.86 | 2,344 |
| log GDP (constant 2010 US$) | 24.67 | 2.17 | 18.82 | 30.51 | 2,344 |
| log mean trade cost (CIF) | 11.93697 | 1.194189 | 7.824515 | 18.06337 | 2,394 |

# 4 Results

In the following, I will present the estimation results for the tax reaction function of CTRs with respect to STRs and their respective revenue effects. Table 2 summarizes the estimation results for equation 1, instrumenting for $\tau_t$ using equation 4. Columns (1)-(3) depict the results based on the inverse distance weighting scheme, while the results in Columns (4)-(6) are based on the 'natural' trade flow weighting. The dependent variable in all models is the standard CTR. $TAX$ represents the STR, the EMTR or EATR, as denoted by the column label. The coefficient of interest is negative and statistically significant across all models.[16] This result is in line with hypothesis 1, implying that corporate and consumption tax rates are, in fact, substitutes. A decrease in the EMTR and/or EATR implies that not only statutory rates are decreasing but also the base to which this rate is applied becomes narrower. Thus, it is not surprising that the estimated slope of the tax reaction function is steeper for the EMTR or EATR. Governments respond stronger to changes in the effective tax rates, since they need to compensate for rate and base decreases, requiring a larger increase in the CTR. Employing different weighting schemes only changes the results quantitatively but not qualitatively. Interpreting the results of Column (1) as a baseline, a one percentage point decrease in the STR is on average compensated by a 0.35 percentage point increase in the standard CTR. Quantitatively, this tax reaction function implies that consumption taxes change less than proportionately as a response to changes in the STR. This result captures the fact that the consumption tax base is much larger than the corporate tax base (see Table 1). To compensate for falling STRs, a less than proportionate increase in consumption taxes is sufficient to balance out the respective revenue effects. Given these results, 91.6% of the average CTR increase between 2003 and 2020 can be attributed to the decrease in average STRs by 5.68 percentage points. Looking at the F-values, I can confidently conclude that the chosen instrument is relevant as also indicated by the analysis in Appendix A.2.

Table 3 presents the results for the estimation of equations 2 and 3. Columns (1)-(3) use the corporate income tax revenue and Column (4) the consumption tax revenue as dependent variable. $TAX$ denotes the different tax rates as described by the column label. Looking at the coefficients of $TAX$ and $TAX^2$ for Columns (1) to (3), an inverted U-shape pattern emerges for corporate tax revenue. As expected and in line with hypothesis 2, the mechanical effect is positive throughout all three specifications, while the behavioral effects are negative. Similar to the tax reaction function, the revenue responses with respect to changes in the effective tax measures are stronger. This result is intuitive, as jointly decreasing or increasing the STRs and the tax base should trigger a more pronounced revenue response. The rate-revenue patterns for the STRs also emerge even when no functional form is ex-ante assumed as documented by Figure A.1. Turning

[16] Note that this result is robust to using $\tau_{t-1}$ as an instrument.

Table 2: Consumption Tax Reaction Function

| Weighting scheme | inverse distance | | | 'natural' trade flow | | |
|---|---|---|---|---|---|---|
| | (1) STR | (2) EMTR | (3) EATR | (4) STR | (5) EMTR | (6) EATR |
| $TAX$ | -0.352*** | -0.576*** | -0.411*** | -0.388*** | -0.644*** | -0.454*** |
| | (0.041) | (0.070) | (0.048) | (0.045) | (0.074) | (0.052) |
| Country size (log GDP) | -0.040*** | -0.047*** | -0.041*** | -0.045*** | -0.052*** | -0.046*** |
| | (0.009) | (0.009) | (0.009) | (0.010) | (0.011) | (0.010) |
| Costs (log GDP-per-capita) | 0.038*** | 0.047*** | 0.039*** | 0.041*** | 0.051*** | 0.042*** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.009) | (0.009) |
| Trade costs (log CIF) | 0.001** | 0.001** | 0.001** | 0.001* | 0.001** | 0.001** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Country FE | X | X | X | X | X | X |
| $N$ | 2128 | 2128 | 2128 | 2128 | 2128 | 2128 |
| F-Value | 234.06 | 198.28 | 223.83 | 307.59 | 282.01 | 305.31 |

The table presents IV estimates. Standard errors are reported in parentheses. Standard errors are heteroskedasticity, spatial and serial autocorrelation-consistent. *** denotes significance at the 1% level; ** denotes significance at the 5% level; * denotes significance at the 10% level.

to Column (4), the rate-revenue relationship of consumption taxation exhibits both a substantial mechanical and behavioral effect. In contrast to hypothesis 3, the consumption tax base appears to be fairly mobile. The linear relationship in Figure A.2 in Appendix A.3 is thus mostly driven by country size which is mostly accounted for using country fixed effects in Table 3; large countries setting higher tax rates and raising higher revenues.

Table 3: Revenue Effects of Rate Changes

| | (1) STR | (2) EMTR | (3) EATR | (4) CTR |
|---|---|---|---|---|
| $TAX$ | 14.504*** | 17.747*** | 17.499*** | 38.361*** |
| | (2.054) | (3.273) | (2.400) | (3.093) |
| $TAX^2$ | -22.953*** | -41.904*** | -32.465*** | -95.001*** |
| | (4.413) | (11.680) | (6.007) | (13.660) |
| GDP growth | 0.015** | 0.015** | 0.014** | 0.005 |
| | (0.006) | (0.006) | (0.006) | (0.007) |
| Constant | 0.269 | 0.800*** | 0.265 | 1.902*** |
| | (0.268) | (0.242) | (0.268) | (0.217) |
| Country FE | X | X | X | X |
| Year FE | X | X | X | X |
| $N$ | 1919 | 1845 | 1845 | 1901 |
| Within $R^2$ | 0.0859 | 0.0806 | 0.0835 | 0.0968 |

The table presents OLS estimates. Standard errors are reported in parentheses. *** denotes significance at the 1% level; ** denotes significance at the 5% level; * denotes significance at the 10% level.

# 5 Revenue Consequences

To test for the overall revenue effects of tax competition (hypothesis 4), I conduct a back-of-the-envelop calculation combining the results from the previous section to analyze the average countries' ability to compensate for falling STRs through increasing CTRs. I will focus primarily on the effects of corporate tax rate changes on the overall budget. So far, the empirical analysis suggests that STR reforms affect both CTRs (Table 2) and the corporate tax base (Table 3). Furthermore, the consumption tax base also responds to CTR changes (Table 3). The relationship between corporate and consumption tax rates is a linear function with the slope of -0.352 which is assumed to be time constant (see Table 2 Column (1)). Given the inverted U-shape rate-revenue relationship of both corporate and consumption taxation in Table 3, I am able calculate revenue-maximizing tax rates; the tax rate for which a marginal increase is just revenue neutral.[17] Using the results of Column (1) of Table 3, the average revenue-maximizing corporate tax rate ($\tau^*$) is equal to 31.59%. For any $\tau > \tau^*$ the behavioral dominates the mechanical effect and a STR reduction would lead to net revenue gains. For any $\tau < \tau^*$ the opposite holds true. In 2003, 38.6% of the countries in our dataset had a tax rate exceeding $\tau^*$, by 2018 this number dropped to 11.2%. Thus, by 2018, the vast majority of countries was in a position where the mechanical effect dominated the behavioral effect. Given that the average STR between 2003 and 2018 fell from 28.4% to 23.02%, the average country suffered corporate tax revenue losses from decreasing their STR. Similarly, the average revenue-maximizing consumption tax rate ($\theta^*$) is equal to 20.19%. In 2003, 91.5% of countries levied a consumption tax smaller than $\theta^*$. By 2018, this number dropped to 87.2%. Consequently, the overwhelming majority of countries imposed less than revenue-maximizing CTRs. Since the average CTR rose from 12.13% in 2003 to 14.6% in 2018, most countries generated additional consumption tax revenue. The question remains whether these revenue gains outweighed the corporate tax revenue losses.

Based on these results, I test hypothesis 4. First, I calculate the average tax revenue from each base by plugging the empirical results from Table 3 and the average STR and CTR level in 2003 into equations 2 and 3.[18] In 2003, governments raised an estimated 2.267% of GDP in corporate tax revenues and 3.255% of GDP in consumption tax revenues. Due to the decline in STRs between 2003 and 2018 by 5.38 percentage points, corporate tax revenues reduced by 6.4% to 2.122% of GDP. Similarly, the decrease in STRs resulted in an average increase of the CTR by 1.894 percentage points to an estimated 14.014%. Thus, the estimated consumption tax revenue in 2018 rose by 7.9% to 3.511% of GDP. Consequently, the revenue gains from substituting from corporate to consumption taxation more than outweighed the revenue losses from falling

[17] The calculation follows from the first order derivative of equation 2 and 3 with respect to the corporate and consumption tax rate respectively.

[18] For simplicity I will disregard the both GDP growth and the regression constant and focus only on $\alpha_{TAX}$ and $\delta_{TAX}$.

corporate tax rates. This result is in line with hypothesis 4, illustrating that most countries fully compensated for falling STRs. Thus, the threat of underprovision of public goods appears to be overemphasized as governments are able to maintain a stable overall level of tax revenues. However, tax competition appears to have resulted in an increasing share of the overall tax burden to fall on consumption, raising equity rather than efficiency concerns. The increases in CTRs are likely to be at least partially passed on to consumers, effectively leaving them to pay part of the bill of corporate tax competition.

# 6 Conclusion

This paper empirically investigates the spillovers from international tax competition to consumption taxation deriving three key findings. First, governments increase consumption tax rates as a result of falling (effective) corporate income tax rates. A one percentage point decrease in the STR is on average compensated by a 0.35 percentage point increase of the CTR explaining 91.6% of the average CTR increase between 2003 and 2020 decreasing average STRs. This result is derived by exploiting strategic interdependence in STRs across countries as an instrument for domestic STRs. Second, the corporate and consumption tax rate-revenue relationship follow an inverted U-shape (Laffer-Curve) with governments setting, on average, less than revenue-maximizing corporate and consumption tax rates. Third, the substantial reduction in STRs in the past two decades resulted in net revenue losses, which were more than compensated by substituting to consumption taxation. Thus, the ability to substitute to other tax bases has allowed governments to maintain a stable level of public expenditures and public good provision. All in all, these results illustrate that the fiscal repercussion of corporate tax competition on the overall public budget/expenditure are small, as long as governments are able to substitute to consumption taxation. Consequently, tax competition affects the tax mix but not the overall level of public expenditures. Thus, the discussion about corporate tax competition should be less concerned about underprovision of public goods and should focus more on the question who ends up paying for corporate tax competition. Judging from the analysis presented in this paper, consumption bears a substantial part of the cost of corporate tax competition. While this may be economically efficient, it raises concerns about equity, as consumption taxes affect low-income households disproportionately strong.

Given the recent G7's proposal for the introduction of a global minimum corporate tax, governments around the globe appear to be determined to curb corporate tax competition. According to Mathias Cormann, secretary general of the OECD, the introduction of a minimum tax would both "put a limit on the level of tax competition" and ensure that "governments [are] able to raise the necessary revenue to fund [public] services" (Bloomberg, 2021). However, based on the results of this paper, a global minimum cor-

porate tax might have unintended consequences for consumption taxation as it would allow governments to reduce the tax burden born by consumption, due to tax competition. Thus, apart from the beneficial impact on tax revenues, the minimum tax might also offer additional, so far unexpected, benefits to low income households and potentially curb income/wealth inequality.

The paper adds to the existing literature by providing estimates of the slope of the consumption tax reaction function with respect to STRs. To the best of my knowledge, this paper is the first to analyze and quantify the effects of corporate tax competition on consumption taxation. Additionally, it provides estimates of the revenue consequences of both corporate and consumption tax rate changes. I introduce tax competition as an innovative instrument to obtain unbiased reaction functions of simultaneously determined tax policy instruments. Furthermore, the estimations are based on a novel data set covering more than 190 countries around the globe. This allows for the results to be generalized beyond the EU/OECD context.

Building on these results, future research should focus on whether the increasing consumption taxation has contributed to the polarization of wealth and income distributions in the past decades. This analysis would crucially depend on the question whether the supply or demand side has been bearing the majority of the consumption tax burden. More thoroughly analyzing the relationship between STRs, CTRs, and PITs could also offer another interesting starting point for future research to further illuminate the effects of corporate tax competition on other national policy instruments. A more thorough analysis of the tax rate and revenue data would potentially yield interesting insights into the anatomy and development of public spending and revenues of the past decades. Results from these analyses could allow for a more comprehensive conclusion whether governments are generally moving away from direct taxation due to increasing tax base mobility. This could provide valuable evidence for a long-held debate in economics whether to tax consumption instead of income (see Fisher, 1942; Feldstein, 1978; Bradford, 1980; Kaldor, 2014).

## Statements and Declarations

The author declares that he has no relevant or material financial interests that relate to the research described in the paper entitled ≪Are Consumers Paying the Bill? How International Tax Competition Affects Consumption Taxation≫.

# References


Arezki, R., A. Dama, and G. Rota-Graziosi (2021): "Revisiting the relationship between trade liberalization and taxation," Working Paper Series no 349, African Development Bank Group.

Bird, R. M., and N. E. Slack (2004): *International handbook of land and property taxation*. Edward Elgar Publishing.

Bloomberg (2021): "OECD sees global minimum accord improving tax system: Cormann," .

Bradford, D. F. (1980): "The case for a personal consumption tax," *What should be taxed: Income or expenditure*, pp. 77–113.

Breen, M., and I. McMenamin (2013): "Political institutions, credible commitment, and sovereign debt in advanced economies," *International Studies Quarterly*, 57(4), 842–854.

Brueckner, J. K. (2003): "Strategic interaction among governments: An overview of empirical studies," *International Regional Science Review*, 26(2), 175–188.

Clausing, K. A. (2007): "Corporate tax revenues in OECD countries," *International Tax and Public Finance*, 14(2), 115–133.

Crivelli, E., R. De Mooij, and M. Keen (2016): "Base erosion, profit shifting and developing countries," *FinanzArchiv/Public Finance Analysis*, 72(3), 268–301.

Devereux, M. P. (2007): "Developments in the taxation of corporate profit in the OECD since 1965: Rates, bases and revenues," CBS Working Paper Series WP 7/4, Oxford University Centre for Business Taxation.

Devereux, M. P., and R. Griffith (1998): "The taxation of discrete investment choices," IFS Working Papers WP98/16, Institute for Fiscal Studies.

——— (2003): "Evaluating tax policy for location decisions," *International Tax and Public Finance*, 10(2), 107–126.

Devereux, M. P., R. Griffith, and A. Klemm (2002): "Corporate income tax reforms and international tax competition," *Economic Policy*, 17(35), 449–495.

Devereux, M. P., B. Lockwood, and M. Redoano (2008): "Do countries compete over corporate tax rates?," *Journal of Public Economics*, 92(5-6), 1210–1235.

Devereux, M. P., M. Pearson, and P. B. Sørensen (1991): *Taxing profits in a global economy: Domestic and international issues*. OECD Publishing.

Driscoll, J. C., and A. C. Kraay (1998): "Consistent covariance matrix estimation with spatially dependent panel data," *Review of Economics and Statistics*, 80(4), 549–560.

Egger, P., and M. Larch (2008): "Interdependent preferential trade agreement memberships: An empirical analysis," *Journal of International Economics*, 76(2), 384–399.

Egger, P., and H. Raff (2015): "Tax rate and tax base competition for foreign direct investment," *International Tax and Public Finance*, 22(5), 777–810.

Egger, P. H., S. Nigai, and N. M. Strecker (2019): "The taxing deed of globalization," *American Economic Review*, 109(2), 353–90.

Feldstein, M. (1978): "The welfare cost of capital income taxation," *Journal of Political Economy*, 86(2), 29–51.

Fisher, I. (1942): *Constructive income taxation*. New York: Harper Publishing Co.

Fuest, C., F. Hugger, and S. Wildgruber (2020): "Why is corporate tax revenue stable while tax rates fall? Evidence from firm-level data," Discussion paper, CESifo Working Paper.

Genschel, P., and P. Schwarz (2012): "Tax competition and fiscal democracy," Discussion paper, TranState working papers.

Gordon, R. H., and J. R. Hines Jr (2002): "International taxation," *Handbook of Public Economics*, 4, 1935–1995.

Hines Jr, J. R., and L. H. Summers (2009): "4 How globalization affects tax design," *Tax Policy and the Economy*, 23(1), 123–158.

Kaldor, N. (2014): *Expenditure tax*. Routledge.

Kawano, L., and J. Slemrod (2016): "How do corporate tax bases change when corporate tax rates change? With implications for the tax rate elasticity of corporate tax revenues," *International Tax and Public Finance*, 23(3), 401–433.

Kelejian, H. H., and I. R. Prucha (1999): "A generalized moments estimator for the autoregressive parameter in a spatial model," *International Economic Review*, 40(2), 509–533.

Kelejian, H. H., I. R. Prucha, and Y. Yuzefovich (2004): "Instrumental variable estimation of a spatial autoregressive model with autoregressive disturbances: large and small sample results," *Advances in Econometrics*, 18, 163–198.

Leibrecht, M., and C. Hochgatterer (2012): "Tax competition as a cause of falling corporate income tax rates: A survey of empirical literature," *Journal of Economic Surveys*, 26(4), 616–648.

Lierse, H., and L. Seelkopf (2016): "Capital markets and tax policy making: A comparative analysis of European tax reforms since the crisis," *Comparative European Politics*, 14(5), 686–716.

Loretz, S. (2008): "Corporate taxation in the OECD in a wider context," *Oxford Review of Economic Policy*, 24(4), 639–660.

Metcalf, G. E. (1997): *The national sales tax: Who bears the burden?* Cato Institute.

Oates, W. E. (1972): *Fiscal federalism*. Edward Elgar Publishing.

Overesch, M., and J. Rincke (2011): "What drives corporate tax rates down? A reassessment of globalization, tax competition, and dynamic adjustment to shocks," *The Scandinavian Journal of Economics*, 113(3), 579–602.

Ramsey, F. P. (1927): "A contribution to the theory of taxation," *The Economic Journal*, 37(145), 47–61.

Silva, J. S., and S. Tenreyro (2006): "The log of gravity," *Review of Economics and Statistics*, 88(4), 641–658.

Steinmüller, E., G. U. Thunecke, and G. Wamser (2019): "Corporate income taxes around the world: A survey on forward-looking tax measures and two applications," *International Tax and Public Finance*, 26(2), 418–456.

Wilson, J. D. (1986): "A theory of interregional tax competition," *Journal of Urban Economics*, 19(3), 296–315.

Wilson, J. D. (1999): "Theories of tax competition," *National Tax Journal*, 52(2), 269–304.

Zodrow, G. R., and P. Mieszkowski (1986): "Pigou, Tiebout, property taxation, and the underprovision of local public goods," *Journal of Urban Economics*, 19(3), 356–370.

# A Appendix

## A.1 Weighting Scheme

Following Egger and Raff (2015), I am employing two different weighting schemes for the analysis in Section 3 and for the estimations in Appendix A.2. The weighting matrix W is calculated based on inverse distance and on 'natural' trade flows. In the following, I will briefly outline the properties of these weighting schemes, how they are calculated, and what data are used for the calculation. To obtain unbiased and reliable results W needs to be exogenous, time-constant, exhibit bounded row-sums, and zero-diagonal elements. Exogeneity of W is necessary to obtain unbiased estimates and implies that $\mathbb{E}(\epsilon|\mathrm{W}) = 0$. In order to estimate the effect of changes in the corporate tax rate on the consumption tax rate, variation must only come from changes in the tax policy and may not stem from changes in the weighting scheme. Thus, W needs to be time-constant and the panel completely balanced. Bounded row-sums are required as each entry of W for row $i$ and column $j$ $w_{ij}$ is row-sum normalized such that:

$$\sum_{j=1}^{N} w_{ij} = 1.$$

The zero-diagonal elements ensure that the dependent variable is not included in the weighted average.

Inverse distance weighting is the first weighting scheme employed in the paper. The argument behind using inverse distance weighting is that countries located in geographic proximity have a bigger influence on country $i$ compared to countries located further away. W is calculated using bilateral distances between countries.

The second weighting scheme is based on 'natural' trade flows. Employing actual trade flows would bias the results since trade flows are likely affected by tax policy. Thus, following Egger and Raff (2015), I estimate counterfactual trade flows according to:

$$Exports_{ijt} = \alpha_0 + \alpha_1 dist_{ij} + \alpha_2 border_{ij} + \alpha_3 language_{ij} + \alpha_4 FTA_{ijt} + \eta_i + \gamma_j + \epsilon_{ijt}. \tag{A.1}$$

*Exports* represents the bilateral export volume from country $i$ to country $j$ in year $t$, *dist* is the bilateral distance between $i$ and $j$. *border* is an indicator variable taking on the value one if $i$ and $j$ share a common border and zero otherwise. *language* is an indicator variable taking on the value one if $i$ and $j$ share a common official language and zero otherwise. $FTA$ is an indicator variable taking on the value one if $i$ and $j$ are in a free trade agreement and zero otherwise. Equation A.1 is estimated using Pseudo Poisson Maximum Likelihood (PPML) following Silva and Tenreyro (2006). The results of estimating equation A.1

are illustrated in Table A.1. Based on these results counterfactual trade flows between country $i$ and $j$ are calculated.

Table A.1: PPML Estimation for Natural Trade Weighting

| | (1) Importvolume |
|---|---|
| log distance | -0.308*** |
| | (0.013) |
| Contiguity | 1.294*** |
| | (0.038) |
| Common Language | 0.380*** |
| | (0.029) |
| FTA | 0.483*** |
| | (0.027) |
| Constant | 20.596*** |
| | (0.116) |
| Observations | 318402 |
| $Pseudo - R^2$ | 0.8750 |

The table presents PPML estimates. *** denotes significance at the 1% level; ** denotes significance at the 5% level; * denotes significance at the 10% level.

## A.2 Tax Competition

The existence of international corporate tax competition is crucial to the argument made in this paper. The descriptive evidence presented in Devereux and Griffith (2003), Loretz (2008), Steinmüller, Thunecke, and Wamser (2019), and Figure 1 illustrate that corporate tax rates have continuously decreased from the early 1980s to the 2020s. While this development may serve as tentative evidence for tax competition, it could also be the result of other developments unrelated to strategic interaction in corporate tax instruments, stemming from capital mobility. These potential developments could include yardstick competition or overall liberal political tendencies. In the following, I will present empirical evidence illustrating that strategic interaction in corporate tax rates, i.e. tax competition, is the driving force behind the downward trend in corporate tax rates.[19] I will also briefly outline the methodology used to derive this results. Several authors have documented this results for earlier periods in the OECD context including Devereux, Lockwood, and Redoano (2008), Overesch and Rincke (2011) and Egger and Raff (2015). Thus, the following section illustrates that corporate tax competition is still relevant for the time period covered in this paper and that it is not only

[19]Note that I am not explicitly looking at the corporate tax base as a policy instrument as within country variation of depreciation allowances is minimal.

limited to well developed countries in the OECD context.

In order to investigate whether corporate tax competition is present, I will estimate tax policy reaction functions following Egger and Raff (2015). Tax policy reaction functions are estimated following:

$$\tau_{\mathrm{t}} = \beta_{\tau}\tilde{\tau}_{\mathrm{t}} + \mathrm{X}_{\mathrm{t}}\gamma_{\tau} + \epsilon_{\tau,\mathrm{t}}, \tag{A.2}$$

where $\tau_{\mathrm{t}}$ $N \times 1$ vector of corporate tax rates in year $t$. $\tilde{\tau}_{\mathrm{t}}$ is a $N \times 1$ vector of the weighted average corporate tax rates of country $i's$ competitors with $\tilde{\tau}_{\mathrm{t}} \equiv \mathrm{W} \times \tau_{\mathrm{t}}$. W is a $N \times N$ weighting matrix.[20] $\mathrm{X}_{\mathrm{t}}$ is an $N \times K$ matrix with $K = 3 + N$ containing controls for country size, production cost, trade cost and country fixed effects. $\epsilon_{\tau,\mathrm{t}}$ is the disturbance term. In line with the well-established theoretical literature on tax competition, the empirical model in equation A.2 implies that corporate tax rates are simultaneously determined.[21] Furthermore, we expect corporate tax rates to be strategic complements ($\beta_{\tau} > 0$). Additionally, since we do not empirically observe a race to the bottom, we expect $\beta_{\tau} > 0$ to be bounded between zero and 1.[22] Due to the simultaneity in the tax setting behavior of countries, estimating equation A.2 with OLS will return biased results. To resolve this endogeneity problem, the weighted average of foreign tax policy instruments needs to be instrumented. Following Kelejian and Prucha (1999) and Kelejian, Prucha, and Yuzefovich (2004), $\mathrm{WX}_{\mathrm{t}}$, $\mathrm{W}^2\mathrm{X}_{\mathrm{t}}$ and $\mathrm{W}^3\mathrm{X}_{\mathrm{t}}$ are used as instruments. Intuitively, this approach exploits spatial interdependence between country implying that a countries tax setting behavior is influenced by its GDP, labor cost and trade cost, and the effect of its neighbors and the neighbors of its neighbors on these variables. This two-stage least squares approach yields consistent estimates if the instruments are relevant and exogenous to the disturbance term. The disturbance term is heteroskedasticity, spatial and serial autocorrelation-consistent (SHAC) following Driscoll and Kraay (1998).

For the estimation of equation A.2, I use three different tax rate variables to test for strategic complementarity, the STR, foward-looking effective marginal (EMTR), and effective average tax rates (EATR). In contrast to the statutory tax rate, the EMTR and EATR also take depreciation allowances and, therefore, base effects into account. Thus, the statutory corporate tax rate captures competition for corporate profits, while the EMTR (EATR) capture the competition for marginal (discrete) investment projects. For country size, I use log GDP in constant 2010 USD from the World Bank World Development Index (WDI). Log GDP per capita in constant 2010 USD is used as production cost and is also taken from the WDI. Log cost of insurance and freight from the CEPII trade unit value data set. The analysis is based on a balanced panel

[20] For a more detailed description of W and how it is calculated see Appendix A.1.

[21] For for a comprehensive summary of the theoretical tax competition literature, see Wilson (1999).

[22] The empirical absence of a race to the bottom is implying that capital is not perfectly mobile or that governments have the ability to tax location specific rents.

of 133 countries from 2001 to 2018.

Table A.2: Strategic Interaction in Corporate Tax Rates

| Weighting scheme | inverse distance | | | 'natural' trade flow | | |
|---|---|---|---|---|---|---|
| | (1) STR | (2) EMTR | (3) EATR | (4) STR | (5) EMTR | (6) EATR |
| TAX | 0.869*** | 0.919*** | 0.871*** | 0.905*** | 0.889*** | 0.899*** |
| | (.044) | (0.047) | (0.044) | (0.048) | (0.048) | (0.048) |
| log GDP | -0.0284** | -0.022*** | -0.025** | -0.029* | -0.029*** | -0.027** |
| | (0.0140) | (0.008) | (0.012) | (0.015) | (0.009) | (0.013) |
| log GDP p.c. | 0.027 | 0.026** | 0.025 | 0.029 | 0.032*** | 0.026 |
| | (0.018) | (0.011) | (0.015) | (0.019) | (0.012) | (0.017) |
| log trade cost | 0.0001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | (0.001) | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) |
| Country FE | X | X | X | X | X | X |
| $N$ | 2394 | 2394 | 2394 | 2394 | 2394 | 2394 |
| Hansen J stat | 6.289 | 6.261 | 6.286 | 7.738 | 7.846 | 7.721 |
| P-val | 0.6149 | 0.6180 | 0.6152 | 0.1713 | 0.1649 | 0.1723 |
| F-test | 976.18 | 605.90 | 857.84 | 139.49 | 160.71 | 140.28 |

The table presents IV estimates. Standard errors are reported in parentheses. Standard errors are heteroskedasticity, spatial and serial autocorrelation-consistent. *** denotes significance at the 1% level; ** denotes significance at the 5% level; * denotes significance at the 10% level.

Table A.2 presents the estimation results for equation A.2. Columns (1)-(3) are based on inverse distance weights, while Columns (4)-(6) reflect the results for 'natural' trade weights. Throughout Columns (1)-(6) the coefficients of interest have the desired signs and are statistically significant indicating that countries strategically interact in their corporate and effective tax rates. Tax rates are strategic complements and the tax reaction is substantial. The coefficients imply that a 1 percentage point decrease in the weighted average of the tax rates of country $i's$ competitors results on average in a 0.9 percentage point decrease in country $i$.[23] Looking at the F-test, we cannot reject the hypothesis that the chosen instruments are relevant. Furthermore, the Hansen J statistic indicates that the exogeneity hypothesis of the chosen instruments cannot be rejected. Taking thse results together, I can confidently conclude that the instrumental variable chosen for the identification in Section 3.3 is relevant. I also test the exclusion restriction of the instrument, by ruling out that countries compete in consumption tax rates. I test this by estimating the following model:

$$\theta_{\mathrm{t}} = \gamma_\tau \tilde{\tau}_{\mathrm{t}} + \gamma_\theta \tilde{\theta}_{\mathrm{t}} + \mathrm{X}_{\mathrm{t}} \gamma_\tau + \epsilon_{\theta,\mathrm{t}}. \tag{A.3}$$

Where $\theta_{\mathrm{t}}$ $N \times 1$ vector of consumption tax rates in year $t$. $\tilde{\theta}_{\mathrm{t}}$ is a $N \times 1$ vector of the weighted average

[23] The reaction of country $i$ to a rate change in a particular country $j$ is equal to $\beta_\tau \times w_{ij}$.

consumption tax rates of country $i's$ competitors with $\tilde{\theta_t} \equiv W \times \theta_t$. Due to data availability, the sample period reduces to the years 2003-2018. All other variables and the estimation strategy remain the same. In line with my argument, I expect foreign consumption taxes to have no impact on domestic consumption taxes and thus $\gamma_\theta$ needs to be statistically insignificant. Table A.3 summarizes the estimation results from equation A.3. Columns (1)-(3) are calculated with inverse distance weights. Results in Columns (4)-(6) are based on natural trade flow weights. Throughout all specifications $\gamma_\theta$ is statistically insignificant. Thus, implying that the weighted average of the consumption tax rate of country $i's$ neighbors has no significant impact on the consumption tax rate in $i$. Consequently, the exclusion restriction is not violated.

Table A.3: Testing for Consumption Tax Competition

| Weighting scheme | inverse distance | | | 'natural' trade flow | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Weighted $\theta$ | 0.112 | 0.212 | 0.131 | -0.111 | -1.531 | -0.271 |
| | (0.312) | (0.320) | (0.314) | (3.656) | (10.654) | (4.463) |
| Weighted $TAX$ | -0.350*** | -0.550*** | -0.403*** | -0.416 | -1.260 | -0.531 |
| | (0.073) | (0.132) | (0.086) | (0.890) | (4.307) | (1.272) |
| log GDP | -0.031*** | -0.034*** | -0.031*** | -0.030*** | -0.030*** | -0.030*** |
| | (0.004) | (0.004) | (0.004) | (0.005) | (0.006) | (0.005) |
| log GDP p.c. | 0.022*** | 0.024*** | 0.022*** | 0.020*** | 0.019*** | 0.020*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.004) | (0.003) |
| log trade cost | 0.001 | 0.001* | 0.001 | 0.001** | 0.001** | 0.001** |
| | (0.001) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Country FE | X | X | X | X | X | X |
| $N$ | 2128 | 2128 | 2128 | 2128 | 2128 | 2128 |
| Hansen J stat | 5.686 | 5.454 | 5.432 | 7.265 | 7.846 | 7.721 |
| P-val | 0.5768 | 0.7081 | 0.7106 | 0.2017 | 0.1649 | 0.1723 |
| F-value ($\theta$) | 185.51 | 185.51 | 185.51 | 210.06 | 210.06 | 210.06 |
| F-value ($TAX$) | 2082.94 | 493.24 | 1585.96 | 66.07 | 88.96 | 67.93 |

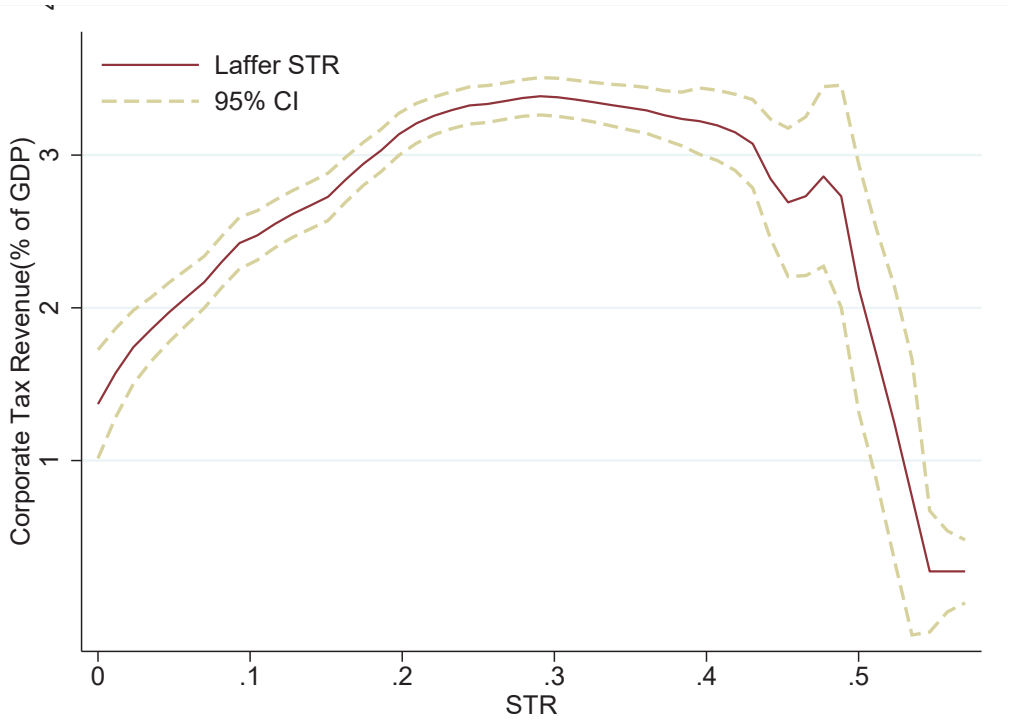
The table presents IV estimates. Standard errors are reported in parentheses. Standard errors are heteroskedasticity, spatial and serial autocorrelation-consistent. *** denotes significance at the 1% level; ** denotes significance at the 5% level; * denotes significance at the 10% level. The independent variable $TAX$ represents the STR in Columns (1) and (4), the EMTR in Columns (2) and (5), and the EATR in Columns (3) and (6).

## A.3 Descriptive Evidence of the Rate-Revenue Relationship

The choice of the rate-revenue relationship in the context of corporate taxation is motivated by the previous literature that finds strong evidence for an inverted U-shape. However, there is very little evidence on the relationship between consumption tax rates and revenues. While the working hypotheses in Section 3.1 are deduced from economic theory, I also took an inductive approach by looking only at the data. Figures A.1 and A.2 illustrate the results for local polynomial regressions of the respective tax revenue on the tax rate.

The advantage of this approach is its non-parametric nature. Consequently, I do not superimpose a functional form on the data. The non-linear shape of this relationship is solely determined from the data. Turning to Figure A.1, we observe that the relationship between corporate tax revenue and rates follows approximately an inverted U-shape. While corporate tax revenue initially increases with rising corporate tax rates, the slope gradually decreases and becomes negative when STRs are exceeding the revenue-maximizing tax rate at approximately 30%. Looking at Figure A.2, we do not observe an inverted U-shape. The relationship is almost perfectly linear with very narrow confidence intervals. The evidence from these figures both motivates the hypotheses generated in Section 3.1 and supports the results discussed in Section 4.

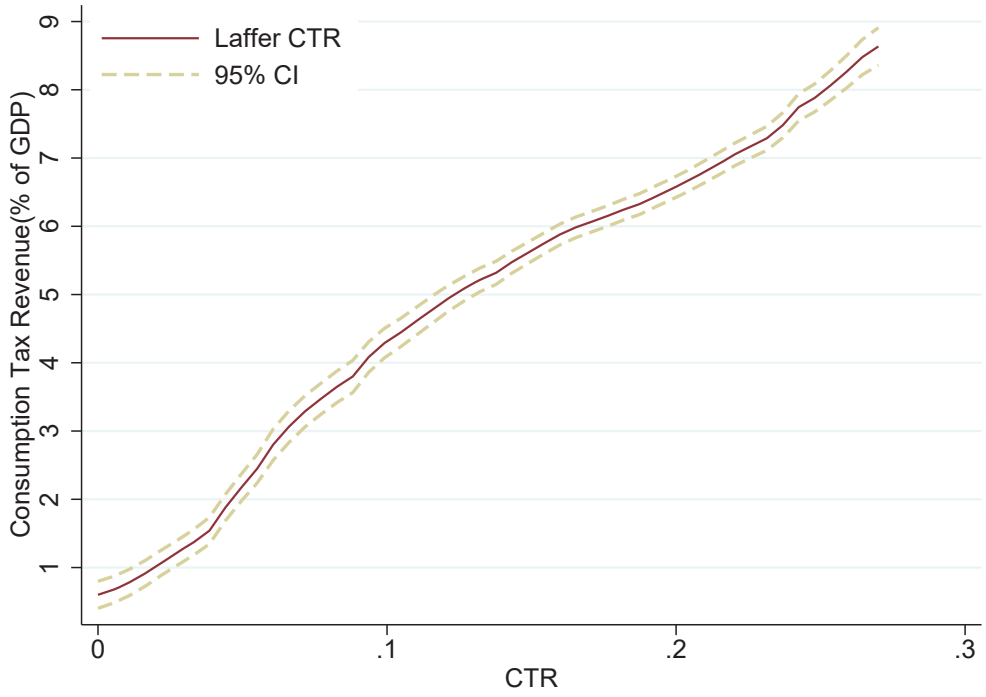
Figure A.1: Local Polynomial Results for the Corporate Tax Rate-Revenue Relationship




## A.4 Evidence on Personal Income Tax Rate

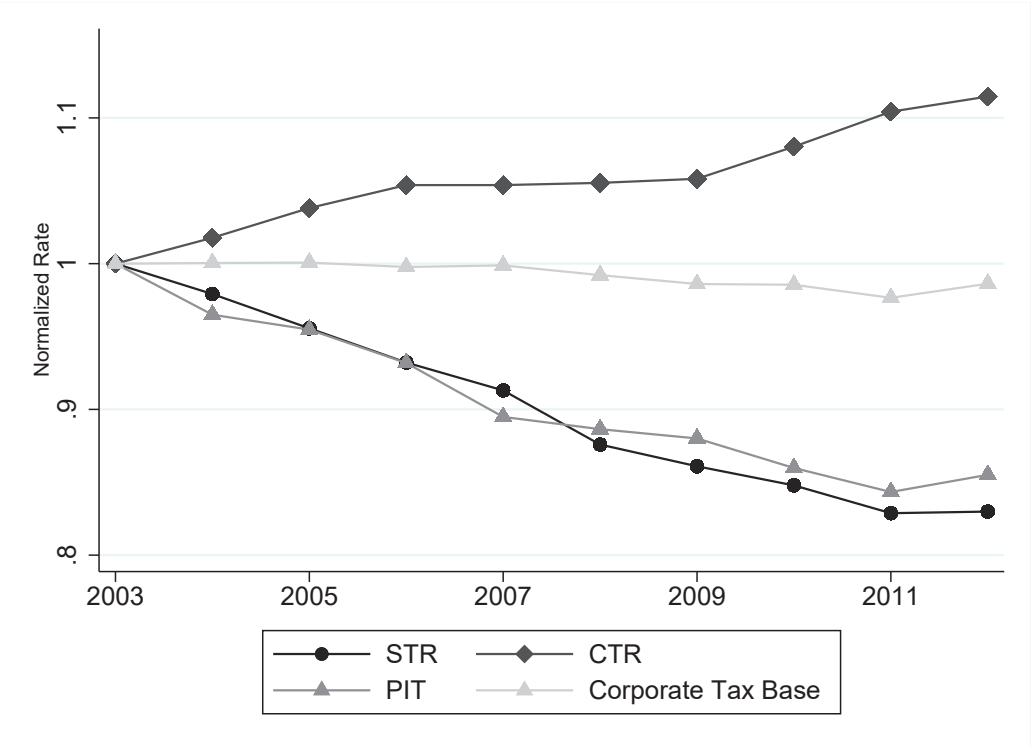
The following section describes the development of personal income tax rates (PIT) and the revenue consequences of PIT changes. I am focusing on effective average tax rates as they are the relevant measure from a revenue perspective. Figure A.3 illustrates the development of the STR, CTR, PIT, and the NPV of depreciation allowances. The PIT exhibits an almost identical development as the STR. This emphasizes the fact that the STR and PIT are closely linked, both due to their legal design (backstop function) and

Figure A.2: Local Polynomial Results for the Consumption Tax Rate-Revenue Relationship




their economic characteristics (mobile tax base). Similar to corporate taxation, a mobile tax base allows for the possibility that a rate cut results in a net revenue gain if the behavioral effect dominates the mechanical effect. I replicate the rate-revenue estimation from Section 4 for PITs, results are depicted in Table A.4. As expected, the PIT also follows an inverted U-shape pattern with a positive mechanical and a negative behavioral effect. From these estimates we can calculate the revenue-maximizing PIT rate, which is approximately 52 %. The mean PIT rate in 2003 was 14.09 % which dropped by roughly 2 percentage points to 12.05 in 2012. Thus, similar to the STR, the mean PIT rate lay substantially below the revenue-maximizing tax rate and moving further away throughout the observational period. Consequently, the drop in PITs cannot have been self-financing for the vast majority of countries.

Figure A.3: Development of Average STR, CTR, PIT, and the NPV of Depreciation Allowances 2003-2012




The figure is based on a balanced panel of 153 countries. All values are normalized to the 2003 value.

Table A.4: Revenue Effects of PIT Rate Changes

| | (1) |
|---|---|
| | Tax Revenue (% of GDP) |
| $PIT$ | 7.773*** |
| | (1.402) |
| $PIT^2$ | -6.838*** |
| | (2.567) |
| GDP growth | -0.005 |
| | (0.006) |
| | 3.387*** |
| | (0.139) |
| Country FE | X |
| Year FE | X |
| $N$ | 1082 |

The table presents OLS estimates. Standard errors are reported in parentheses. *** denotes significance at the 1% level; ** denotes significance at the 5% level; * denotes significance at the 10% level.