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# Fiscal consequences of corporate tax avoidance

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**Abstract:** Multinational corporations shift a large share of their foreign profits to tax havens and, due to this corporate tax avoidance, governments worldwide lose a portion of their tax revenues. In this paper we study the consequences of multinational tax avoidance for the structure of government tax revenues. First, we show that, at the country level, countries with large revenue losses due to profit shifting have lower corporate tax revenues and rates. At the same time, they raise a larger share of tax revenues from personal and indirect taxes and have higher indirect tax rates. Second, to establish causality, we use German municipal data and analyse the effects of changes in municipal tax rates levied on corporate profits on local tax revenue structure. We show that following a tax rate increase, municipalities with a large presence of aggressive multinational corporations experience a significant decline in that tax revenue share.

**Key words:** corporate tax avoidance, profit shifting, multinational corporations, tax revenue structure

**JEL classification:** E62, H26, H71

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# 1 Introduction

The revelations from the Panama and Paradise papers in 2015 exposed a sizeable amount of international tax avoidance by firms, and in particular multinational corporations (MNCs). This spurred renewed interest in the literature to calculate the extent to which MNCs shift profits to tax havens and the scale of potential tax revenue losses to governments (Bilicka 2019; Fuest et al. 2022; Garcia-Bernardo and Janský 2021; Tørsløv et al. 2020). The estimates from the literature suggest these tax revenue losses are large. What are the consequences of these tax avoidance practices for where governments derive their tax revenues? In this paper, we analyse the relationship between corporate tax avoidance and the structure of tax revenues at both the country and local government levels to answer this question.

First, we motivate our analysis by looking at the relationship between the amount of profits shifted by multinationals and the tax revenue structure at the country level. To do this, we take advantage of the new country-level estimates of profit shifting from Tørsløv et al. (2020). We have three main findings. First, the larger the amount of profits shifted by multinationals, the lower the proportion of tax revenues that a country derives from corporations. This is because MNCs are the largest firms and consequently the largest taxpayers in most countries. When they choose to move taxable profits away from countries, the corporate tax revenue will be strongly affected and taxing domestic firms may not compensate for that. Second, when corporate tax revenues decline, governments choose to use other tax instruments to keep the total tax revenues from declining. We find a positive correlation between the amount of shifted profits and the share of revenues derived from indirect taxes such as VAT. Third, consistent with the revenue results, we find that countries with higher shares of shifted profits also have lower corporate tax rates and higher indirect tax rates.

We follow the country-level analysis with municipal-level estimates using Germany as a case study. German municipalities set their own multipliers on trade tax and property tax rates. Trade tax is a municipal tax on corporate profits, while property tax is levied on the value of property. This local tax rate flexibility allows us to identify the relationship between tax revenue structure and profit shifting at the local level causally. We take advantage of a large variation in municipal tax rates across over 11,000 municipalities in Germany combined with firm-level data on the geographical presence of multinational subsidiaries. In particular, we focus on a comparison between municipalities that are more exposed to aggressive MNCs and those that are not. We define aggressive MNCs as those having at least one tax haven in their ownership structure, following the large literature (Bilicka and Scur 2021; Davies et al. 2018; Gumpert et al. 2016; Hines and Rice 1994). We use two identification strategies to understand the relationship between profit shifting and tax revenue structure. First, we consider cross-sectional variation in tax rates and aggressive MNC presence across municipalities. Second, we consider the effects of changes in tax rates at the municipal level on the evolution of tax revenue structures following such changes (Fuest et al. 2018).

We have two sets of main results using the municipal data. First, we find that municipalities with higher shares of more aggressive MNCs derive a lower share of tax revenues from trade taxes, controlling for trade tax and property tax rates and municipal characteristics. They do not compensate for this with higher property tax revenues or rates. Consequently, they also have lower levels of trade tax and total tax revenues. We do not find similar effects for municipalities with a larger share of all MNCs, which we use as placebo tests. Second, we find that following a tax rate increase at the municipal level, the share of trade tax revenues in municipalities with more aggressive MNCs falls. Again, this is driven by the fall in trade tax revenues, with no change in property tax revenues.

Taken together, our country- and municipal-level estimates suggest that the ability of firms to shift profits is strongly related to tax revenues structure and has potential distributional consequences. At the country level it is related to the share of revenues derived from corporate vs indirect taxes. At the municipal level

it is causally linked with lower revenue shares coming from corporations through the trade tax. As such, profit shifting affects the tax revenue structure and, in particular, the share of revenues coming from corporations. This matters from a policy perspective as it suggests that countries that are more exposed to profit shifting multinationals choose to rely more on indirect taxes. To the extent that indirect taxes can be viewed as more regressive (Crawford et al. 2010; Decoster et al. 2010), this may amplify the inequality in countries that lose more tax revenue due to profit shifting.

The paper closest to ours is that of Becker et al. (2012), who show that German municipalities use local tax rates to attract foreign MNCs as a source of skilled labour, physical capital, and local business tax income. In their context, higher tax rates negatively impact the number of foreign MNCs, their employment, and fixed assets. If MNCs respond to increases in tax rates by lowering their presence in municipalities, this will mechanically lower the tax revenues in that jurisdiction. However, we find no significant effect on tax revenues in municipalities with larger MNC presence nor with larger *foreign* MNC presence. Instead, our results *only* hold for municipalities that have a larger share of more *tax aggressive* MNCs. Competition among municipalities for those more aggressive firms is unlikely to yield much local business tax revenue due to potential profit shifting activities of those firms. Given this, we do not think that tax competition, and consequently reverse causality, is a potential threat to our specific identification strategy. Further, these results confirm that the potential mechanism behind a decline in tax revenue at the municipal level is profit shifting, rather than reallocation of real firm operations. We verify these finding further using turnover, employment, and assets of firms residing in the affected municipalities.

We further contribute to the literature analysing the effects of tax rates on local tax revenues. Fajgelbaum et al. (2019) find that heterogeneity in state tax rates leads to aggregate welfare losses, while Suárez Serrato and Zidar (2018) estimate the effects of tax rates and tax bases on state tax revenues more generally. In our paper, we focus on the implications of profit shifting for this relationship. As such, we ask what happens to tax revenues when firms shift profits away from a country or municipality that imposes a particular tax rate.

More broadly, this paper builds on the existing studies that analyse the magnitude and consequences of profit shifting for other margins. First, recent work has estimated the effects of profit shifting on tax revenues lost in developed and developing countries (Garcia-Bernardo and Janský 2021; Tørsløv et al. 2020), including the costs of personal and capital gains tax losses (Garcia-Bernardo et al. 2021). Further, Bilicka (2019) examines the extent of disparity between profits reported by MNCs and domestic firms in the UK using micro-level data, while Fuest et al. (2022) show similar magnitudes of losses for German firms using country-by-country reporting data. Second, growing empirical work has been focusing on examining the consequences of profit shifting on real firm operations (Becker and Riedel 2012; Bilicka et al. 2021; Egger and Wamser 2015; Grubert and Slemrod 1998; Mintz and Smart 2004; Suárez Serrato 2018). None of these studies discuss the consequences of profit shifting on tax revenue structure. Third, the incidence of corporate income taxes, especially those of MNCs, has been difficult to estimate (Clausing 2011). The notable exception includes Fuest et al. (2018), who analyse the incidence of corporate taxes on wages in Germany and show that MNCs do not pass the cost of tax increases on to workers because they can shift profits abroad.

## 2 Country-level estimates

We start our analysis by showing simple country-level correlations between the new estimates of profit shifting and tax revenue structure. We focus on tax revenue shares coming from corporations, individuals, sales of goods and services (and VAT), and others. We then show results using the shares of

each component of tax revenues in GDP and present them using tax rates for corporations, individuals, indirect taxes, and social security contribution rates.

### 2.1 Data and methodology

The main data source for the country-level tax structure is the UNU-WIDER (2021) Government Revenue Dataset, which we complement with the IMF (2021) Government Finance Statistics and UNCTAD (2021) statistical data. We obtain tax rates from KPMG (2021). The combined dataset includes information on the tax revenue structure of governments, GDP per capita, population, foreign direct investment (FDI) inward stock of the countries, the top corporate, individual, and sales tax rates, and employer and employee social security tax rates at the country level.

We combine this data with country-level profit shifting estimates, relying on the leading set of estimates from Tørsløv et al. (2020). They use foreign affiliate statistics to show that affiliates of foreign MNCs are substantially more profitable than local firms in a number of low-tax countries. From this differential profitability, they derive time series estimates for 2015–18. Given that Tørsløv et al.'s (2020) estimates vary across years (Figure B1) in a non-systematic manner, we do not rely on the time series variation but rather pool these across years. Hence, we estimate the following equation as a baseline for our analysis:

$$Y_{it} = \beta_0 + \beta_1 T_i + \beta_n X_{it} + \psi_t + \varepsilon_{it} \tag{1}$$

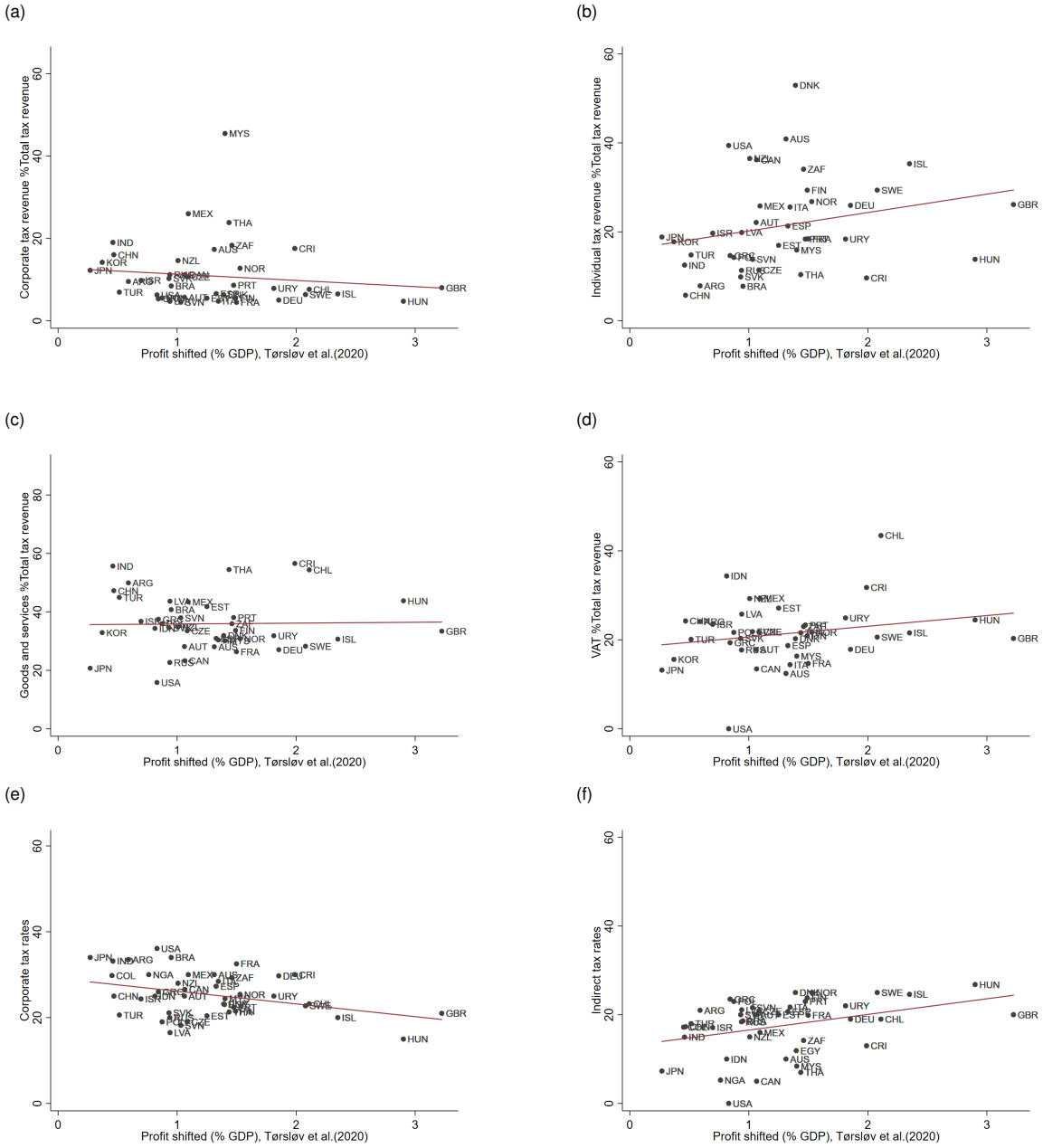
where $Y_{it}$ is a specific tax structure measure, such as percent of corporate tax revenues in total tax revenues, percent of individual tax revenues in total tax revenues, percent of indirect tax revenues in total tax revenues, and other tax revenue contributions (also as shares of GDP); $T_i$ is a tax avoidance measure; $X_{it}$ are country control variables; $\psi_t$ are year fixed effects; and $\varepsilon_{it}$ is an error term. As country controls, we use the logarithm of GDP per capita, the stock of FDI as a percentage of GDP, the logarithm of population, and employer and employee social security rates. Further, we control for corporate, individual, and indirect tax rates in all specifications to account for strong correlation between the tax revenues, tax rates, and tax bases (Kawano and Slemrod 2016). Then, we examine the correlations between tax rates and profit shifting estimates directly, using tax rates as $Y_{it}$ in equation (1).

### 2.2 Baseline correlations

In Figure 1 we visualize the correlations between profit shifting and tax revenue structure. The first four panels correspond to correlations with tax revenue shares from various sources: (a) corporate tax revenues, (b) individual tax revenues, (c) sales and goods tax revenues, and (d) VAT revenues. The last two panels correspond to correlations with tax rates: (e) corporate tax rates and (f) indirect tax rates. On the horizontal axis we use profits shifted away from each country as a percentage of GDP. First, we find that countries that lose more revenues to profit shifting have lower shares of corporate tax revenues in all revenues. This suggests that there is no substitution from domestic firms to make up for the lost corporate tax revenues coming from profit shifting MNCs.

Second, we show a positive correlation between personal tax revenue shares and profit shifting. Countries with a larger share of profits shifted likely have a larger multinational presence, and these firms employ a large share of the population. With MNC wages being higher than domestic firm wages (e.g. Alstadsæter et al. 2022; Setzler and Tintelnot 2021), it is possible that this generates larger shares of individual tax revenues in these countries. Third, we find a positive correlation between sales tax revenues and profit shifting, especially for VAT. This suggests that countries that lose tax revenues due to profit shifting may choose to rely more on indirect taxes, especially VAT.

Figure 1: Impact of tax avoidance on different types of tax revenues and rates



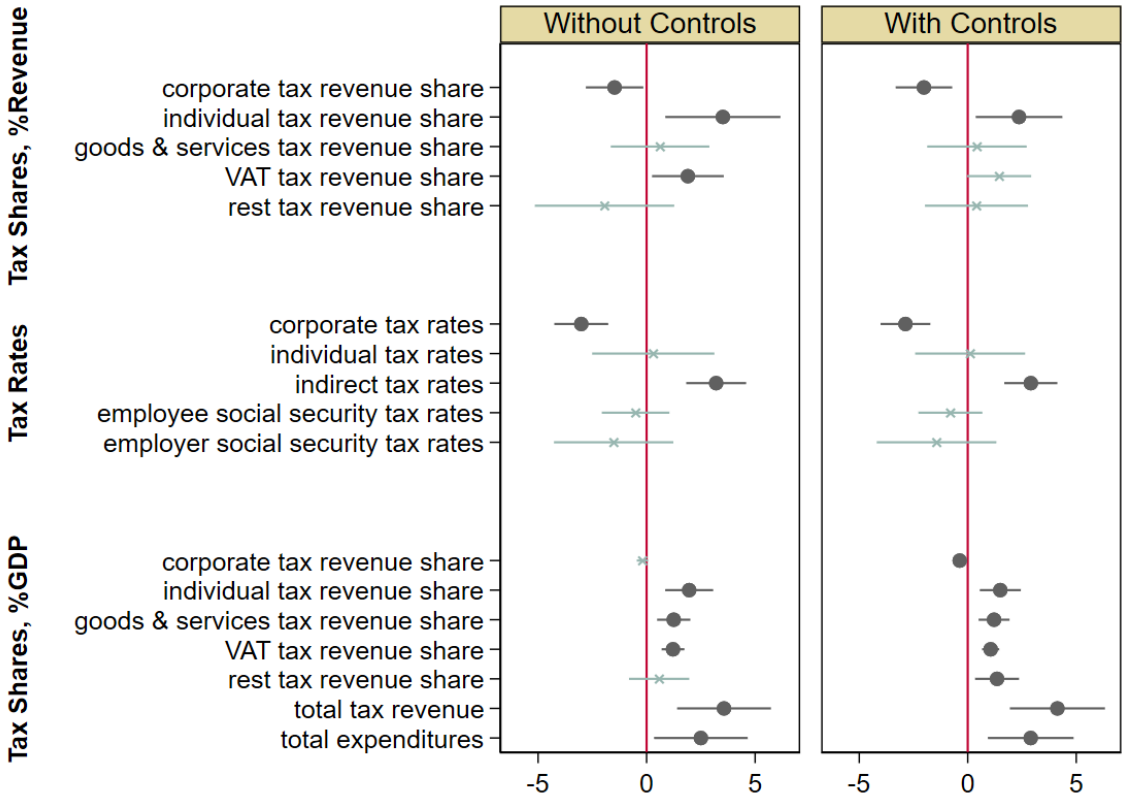

Note: on the vertical axis is the average tax revenue share during 2015–18 as a percentage of total tax revenue. (a) Revenue share of income, profits, and capital gains taxes on corporations; (b) revenue share of income, profits, and capital gains taxes on individuals; (c) revenue share of taxes on goods and services; (d) revenue share from VAT. On the vertical axis of the bottom two graphs is the average tax rate during 2015–18. (e) Corporate tax rates; (f) indirect tax rates. On the horizontal axis of all graphs is the average profit shifted out of each country as a percentage of GDP during 2015–18, from Tørsløv et al. (2020). We exclude tax havens defined by Tørsløv et al. (2020).

Source: authors' compilation based on data from UNU-WIDER, IMF, KPMG, Tørsløv et al. (2020).

Further, we show a strong negative correlation between corporate tax rates and share of profits shifted. This suggests that countries that potentially lose a large share of their revenues due to profit shifting attempt to keep the multinationals in their countries by having lower tax rates. These lower tax rates, of course, reduce the share of corporate tax revenues in those countries. At the same time, we show that a large share of shifted profits is correlated with higher indirect tax rates. This again is consistent with a larger share of indirect taxes that these countries have.

In Figure 2 we quantify these results using a simple regression framework. We summarize results across three different types of dependent variables: (1) tax revenue as a fraction of total tax revenues, (2) tax rates, and (3) tax revenue as a fraction of GDP. In the left panel we provide baseline estimates for the correlation without controls; in the right panel we include a host of country-level business cycle, size, and tax system controls. The corresponding coefficient estimates are presented in Table B1 in the Appendix.

Figure 2: Summary of country-level results




Note: in the left panel we present estimates from regressions without controls. The dark grey markers indicate statistically significant coefficients (at the 10 per cent level) and the crossed light green markers indicate not statistically significant coefficients. The dependent variables in the 'Tax Shares, %Revenue' section are all scaled by total tax revenues. The dependent variables in the 'Tax Rates' section refer to different types of tax rates. The dependent variables in the 'Tax Shares, %GDP' section are all scaled by total GDP. The independent variable in all panels is the profit shifted as a percentage of GDP from Tørsløv et al. (2020). We exclude tax havens, which are defined by Tørsløv et al. (2020). In all specifications we include year fixed effects. In the right panel we present estimates from regressions with controls. These include employer and employee social security tax rates, the logarithm of GDP per capita, the logarithm of population, FDI inward stock as a percentage of GDP for the sections 'Tax Shares' and 'Tax Shares, %GDP'. Controls for the section 'Tax Rates' include the logarithm of GDP per capita, the logarithm of population, and FDI inward stock as a percentage of GDP. For a table with corresponding coefficients, see Table B1 in the Appendix.

Source: authors' compilation based on data from UNU-WIDER, IMF, Tørsløv et al. (2020), KPMG, and UNCTAD.

First, we find a strong negative significant correlation between profits shifted and the share of tax revenues derived from corporations. Specifically, a 1 percentage point increase in the amount of profits shifted out of the country reduces the share of revenues derived from corporations by 1.5 percentage points. Controlling for country-level observables does not change this estimate much.

Second, we show a positive significant relationship between profits shifted and share of individual tax revenues in all tax revenues. The magnitude of the coefficient suggests that a 1 percentage point increase in the share of shifted profits increases the share of revenues from individuals by 3.5 percentage points. Third, there is a positive relationship between profit shifting and sales and goods tax share, especially in

countries that use VAT. Finally, there is no significant association between other types of tax revenues and profit shifting. Our results suggest that countries may be substituting the lower corporate tax revenue shares with indirect tax revenues.

In the second panel in Figure 2 we quantify the correlations between profit shifting estimates and tax rates. We find that a 1 percentage point increase in the amount of profit shifted out of the country reduces the corporate tax rate by 3 percentage points. At the same time, it increases the indirect tax rate by 3.2 percentage points. We find no additional significant relationship between other tax rates and the amount of profits shifted. These results suggest that countries where multinationals shift a large portion of tax revenues try to directly offset these losses with higher indirect tax rates, which is then reflected in the indirect tax revenues, especially in countries with VAT tax systems.

In the third panel in Figure 2 we provide estimates with revenue shares of tax components as a percentage of GDP. Additionally, in Table B2 in the Appendix we show the results for gross operating surplus, which we use as a proxy for the overall tax base, and expenditures. These results are consistent with the baseline and additionally show that there is a positive correlation between total tax revenue as a share of GDP and profit shifting, as well as total expenditures and profit shifting. This suggests that countries that lose a share of corporate tax revenues due to profit shifting are more than able to compensate for that lost share using other types of tax revenues. Further, even though profit shifting is negatively correlated with our proxy for the tax base, this correlation is not significant. Hence, we should not be concerned about the effect of profit shifting on overall tax revenues, but about the distributional consequences profit shifting may potentially have as countries switch from taxing individuals indirectly through corporate taxes to taxing individuals directly through individual taxes and indirectly through VAT.[1]

In summary, the country-level results provide suggestive evidence that a larger share of shifted profits is related to lower corporate tax revenue shares, that likely come from lower tax rates, and higher indirect tax revenue shares, that likely come from higher indirect tax rates. Depending on tax incidence of corporate tax rates and the progressivity of the indirect and individual tax rates, these results point towards large distributional consequences of profit shifting. Given the cross-sectional nature of the sample, however, we cannot draw any causal conclusions from these country-level results. To obtain causal estimates linking tax revenue structure and profit shifting, we turn to municipal-level data.

## 3 Municipal-level estimates

To establish the causal relationship between profit shifting and tax structure, we use municipal-level data on tax rates and tax revenues in Germany combined with firm-level information. Our identification strategy relies on the municipal variation in tax rates and the presence of aggressive multinationals.

### 3.1 Institutional context

In Germany tax revenue is collected at the federal, state, and municipal levels. Germany has over 11,000 municipalities and 16 states. Each governmental unit has control over different types of taxes: the federal government has exclusive power over customs duties and fiscal monopolies; income tax revenue (excluding shares of municipalities) and corporation tax are shared by states and the federal government; 75 per cent of VAT is redistributed across states (European Committee of the Regions n.d.).

[1] In Appendix A we show that using changes in tax revenues and rates, we get results that are qualitatively similar to the baseline, but not statistically significant. Further, using the alternative set of profit shifting estimates from Garcia-Bernardo and Janský (2021), we find qualitatively similar results that we report in Table B4 and Figure B2. We also show that there is heterogeneity in our estimates according to country income levels, with low- and lower-middle-income countries being potentially more exposed to these revenues losses. However, the sample size is too small to make meaningful inference.

Municipalities collect trade tax and property tax (Deloitte 2018). Germany's total tax revenue was €740 billion in 2020, according to the Federal Statistical Office of Germany (n.d.). Out of that total, the tax revenue collected at the municipal level was €108 billion (15 per cent), at the state level (Länder) it was €316 billion (43 per cent), and at the federal level it was €283 billion (39 per cent). EU contributions totalled €33 billion (4 per cent). In this paper we focus on municipal tax rate changes. Hence, below we describe in detail how the tax revenue collection at the municipal level is organized.

Municipalities derive their tax revenues mostly from two sources: trade tax and property tax. A total of 38 per cent of their revenues comes from trade tax and 14 per cent comes from property tax. These taxes are the exclusive tax revenues of municipalities. The rest comes from federal and state tax apportionment.[2] Specifically, municipalities get a share of wage and assessed income tax and final withholding tax (41 billion, 38 per cent) and a share of value added tax (€9 billion, 8 per cent). In return, municipalities have to apportion a share of their trade tax revenue to the state and federal governments; in 2020 this apportionment amounted to €4 billion out of the total €41 billion trade tax revenue.

Trade tax (Gewerbesteuer) is a tax on companies' profits, and the tax rate is a combination of a base rate of 3.5 per cent, which is uniform across Germany, and a municipal tax rate (Hebesatz), determined by each municipality and applicable according to where the companies' permanent establishments are located. The tax rate is determined with the multiplier ($m_i$) in the following way: $t_i = m_i \times f/[100+(m_i \times f)]$, where $f$ is a fixed tax rate which is uniform for all municipalities. In January 2022, municipalities with at least 80,000 inhabitants currently levy trade tax at a rate of between 8.75 per cent (Hebesatz of 250 per cent) and 20.3 per cent (Hebesatz of 580 per cent). Trade tax is levied not only on corporations, but also on sole proprietorships and partnerships. In addition to trade tax collected by municipalities, corporate profits are taxed by the federal government at a uniform rate of 15.825 per cent (including a solidarity surcharge).

Property tax (Grundsteuer) is a tax on the assessed value of the property and the tax rate is a combination of a base rate (which depends on the type of property, but is uniform across Germany) and the local tax rate or multiplier, determined by each municipality. In 2019 there was a property tax reform, which gave more flexibility to states in designing the tax from 2022 and therefore it does not influence the period covered by our analysis.

### 3.2 Data and methodology

*Municipal-level data*

We choose Germany for our case study due to the availability of high-quality municipal- and firm-level data. Detailed information on tax structure is available from the German Office of Statistics for each of the 11,000 municipalities in Germany, and each of them chooses its own rate of trade tax and property tax. This level of local autonomy is rare. The municipal-level data includes information on total tax revenue, which includes the amounts apportioned to and from federal and state governments, trade tax revenue, and property tax revenue. We use this data to construct a share of trade tax and property tax in total tax revenue as well as the logarithm of both trade and property tax. We also include results using overall tax revenues and property tax rate as outcome variables. Given that we rely on the variation in trade tax rates to identify the relationship between tax revenue structure and profit shifting, we cannot consider trade tax rates as an outcome variable. We have data at the municipal level available between 2008 and 2019.[3]

[2] Other municipal taxes, such as a tax on dog ownership, are negligible (€1 billion, 1 per cent).

[3] In the main analysis we use the total trade tax revenue that includes the apportionment component. We explore the apportionment component separately in Appendix F and find no changes in that component. We also provide a robustness check with trade tax revenues less apportionment in that Appendix and the results are consistent with the baseline.

*Firm-level data*

The firm-level data comes from the Bureau van Dijk Orbis dataset and includes the location of over 3.9 million German firms. We have a detailed firm address, postcode, and city for each of those firms. We match each of those firm addresses to the municipal location using GIS (geographic information system) software and we find a match for 85 per cent of our firm-level observations. We use Orbis ownership data from 2019 to identify firms into domestic standalones, domestic groups, foreign multinationals, and domestic multinationals.[4] We define foreign multinationals as those firms with headquarters outside of Germany and domestic multinationals as firms that are headquartered in Germany but have at least one foreign affiliate that they own by more than 50 per cent. Our sample includes over 4,000 foreign MNCs and 16,000 domestic MNCs, which are 4.8 per cent and 19.8 per cent of all German firms with known parents, correspondingly.[5] Using the ownership structure of firms, we define aggressive multinationals as those that have at least one affiliate in a tax haven (Bilicka and Scur 2021; Gumpert et al. 2016; Hines and Rice 1994).[6] We identify over 8,000 affiliates that belong to more aggressive MNCs, of which 835 belong to foreign MNCs and the remainder to domestic MNCs.

We then collect balance sheet information for each of those affiliates in Germany, which allows us to have total assets, fixed assets, employment, profits, and other variables. In Appendix C we discuss the limitations of this financial data and why we use firm counts over the size of their business operations in our preferred identification strategy.

*Unit of analysis*

We conduct our analysis at the municipality–year level. As such, we collapse the firm-level data by the municipality in which these firms are located. This results in 111,534 observations across 9,317 municipalities for the period 2008–19. The variation we explore in this paper is the presence of multinational affiliates, especially those that are more tax aggressive, in each municipality. For that purpose, we calculate the share of multinational affiliates in all firms in each municipality.[7] Further, we calculate the share of aggressive multinationals based on the number of multinationals that have a tax haven presence in their ownership tree. On average, a municipality has 486 firms with two domestic MNC affiliates and 0.5 foreign affiliates. One of those 2.5 average affiliates is aggressive. As such, the share of MNCs in each municipality firm count is, on average, 0.2 per cent, with a large variation ranging from municipalities that have no MNC presence to those that have over 3.5 per cent of their firms being multinationals.[8]

### 3.3 Cross-sectional variation

To understand the role of tax avoidance, we use two identification strategies, both relying on the rich variation in the municipal tax rates and the presence of aggressive MNCs in each municipality. First,

[4] This requires us to assume that ownership did not change during the analysed period (2008–19). This is a plausible assumption used in other papers in this literature (e.g. Bilicka 2019).

[5] There are 3,945,304 German firms in Orbis, most of which are small domestic standalones, for which no ownership information data is provided.

[6] As Tørsløv et al. (2020) point out, Orbis data has poor coverage for financial information in tax havens, but firms do report a presence in tax havens and this is the only information we require here. Bilicka and Scur (2021) use this same nomenclature to define more plausibly tax-aggressive firms.

[7] We break it down by the share of domestic and share of foreign multinationals and show the results in Appendix E. Our results are consistent with prior literature that shows that foreign MNCs are largely drivers of more aggressive tax avoidance; see, for example, Bilicka (2019).

[8] We provide descriptive statistics on these municipalities in Table G1 and maps outlining the municipal variation in Appendix H.

we take advantage of cross-sectional differences in tax rates and aggressive multinational presence to estimate the following model:

$$Taxrev_{it} = \alpha + \beta_1 MNCsh_i + \beta_2 taxr_{it} + \beta_3 MNCsh_i \times taxr_{it} + \gamma_1 X_{it} + \eta_i + \delta_t + \varepsilon_{it} \quad (2)$$

where $Taxrev_{it}$ is a share of tax revenues coming from trade tax or property tax, the log of tax revenues coming from each of the trade tax or property tax sources, or property tax rate. $MNCsh_i$ is a continuous variable that describes the share of aggressive multinationals in all firms in a given municipality. $taxr_{it}$ is a municipal trade tax multiplier that varies across municipalities and years, $X_{it}$ includes property tax rates, number of firms in each municipality, and population.[9] $\eta_i$ are municipality fixed effects and $\delta_t$ are year fixed effects. We cluster standard errors at the municipal level in each estimation.

Here, we estimate the differences in tax revenue structures between municipalities that have a different composition of aggressive multinationals, multinationals, and domestic firms contributing to their revenues, controlling for municipal tax rates. We present the results in Table 1. In Panel A we present baseline results in which we use a share of aggressive MNCs in all firms in the municipality as the interaction with tax rates. Column (1) presents the results using the share of tax revenues coming from trade taxes. We find that municipalities with a higher share of aggressive MNCs derive a lower share of their revenues from trade taxes. In column (2) we show that these same municipalities derive a higher share of their tax revenues from property taxes. In columns (3) and (4) we find that the municipalities that have a higher share of aggressive MNCs have lower trade tax revenue more generally, and that the presence of aggressive MNCs does not affect their property tax revenues. Consequently, in column (5) we also show that these municipalities have overall lower total tax revenues, which drives the results using property tax revenue shares. In column (6) we show that municipalities with more aggressive MNCs do levy higher property tax rates, but this does not affect their share of property tax revenues, as shown in column (4). Note that total tax revenue data is not available for all municipalities for the years 2011–15. As such, we have a smaller sample in columns (1), (2), and (5).

In Panel B we use the share of all MNCs in all firms as a placebo test. We find that municipalities with simply more multinationals do not derive lower revenues from trade taxes, but they do have higher property tax rates. Hence, it is not the simple presence of MNCs that affects the tax revenue collection, but the presence of aggressive MNCs. These results suggest that firms that are more likely to be able to shift profits out of Germany towards lower-tax countries affect the trade tax revenue collection at the municipal level. Specifically, it may be that profit shifting affects tax revenue structure at the municipal level.

[9] The GDP data is not collected for all municipalities, hence we do not use it as a control in our specifications. We look at it directly as an outcome variable in Appendix D.

Table 1: Summary of cross-sectional results

**Panel A: Aggressive MNCs**

| | (1) Trade tax share | (2) Property tax share | (3) ln(trade tax rev) | (4) ln(prop tax rev) | (5) ln(tot tax rev) | (6) Property tax rate |
|---|---|---|---|---|---|---|
| tax rate | –0.072* | 0.005*** | –0.172*** | 0.007 | –0.199* | 0.193*** |
| × agg MNC share | (0.043) | (0.001) | (0.064) | (0.018) | (0.107) | (0.020) |

**Panel B: All MNCs**

| | (1) Trade tax share | (2) Property tax share | (3) ln(trade tax rev) | (4) ln(prop tax rev) | (5) ln(tot tax rev) | (6) Property tax rate |
|---|---|---|---|---|---|---|
| tax rate | 0.002 | 0.001 | 0.004 | 0.007 | –0.014 | 0.136*** |
| × MNC share | (0.029) | (0.001) | (0.057) | (0.011) | (0.063) | (0.014) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 36,362 | 36,447 | 80,939 | 82,203 | 36,419 | 82485 |
| # firms | 9,188 | 14,517 | 9,363 | 9,278 | 14,347 | 9241 |
| Mean | 0.299 | 0.021 | 5.945 | 2.902 | 7.470 | 5.763 |

Note: the dependent variable in column (1) is the share of trade tax in all tax revenue, in column (2) the share of property tax revenue, in column (3) the logarithm of trade tax revenue, in column (4) the logarithm of property tax revenue, in column (5) the logarithm of total tax revenue, and in column (6) the logarithm of property tax rate. The tax rate is the trade tax rate. In Panel A, agg MNC share is the share of aggressive MNCs in all firms in that municipality. In Panel B, share MNCs is a share of MNCs in all firms in that municipality. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level. In columns (1), (2), and (5) we only have data for total tax revenue at the municipality level for the period 2016–19, which reduces the number of observations. In columns (3) and (4) we have data for trade and property tax revenues for the years 2011–19.

Source: authors' compilation based on data from Orbis and the German Statistical Office.

### 3.4 Event study evidence

As a second step, we identify municipalities that increased their tax rates and use these changes to show the effect of tax rate increases on the tax revenue structure for municipalities with different exposures to aggressive MNCs.[10] In that, we use the event study framework that follows Fuest et al. (2018), who look at municipal tax rate changes and their effect on wages. In our data we identify 9,606 events when the municipality increased the tax rate. We stack each of these events to occur in time $t = 0$. The identification relies on a comparison across municipalities that increased their tax rates and between municipalities with higher shares of more aggressive MNCs. We convert the continuous MNC share to a binary variable that splits the share according to a median share of aggressive MNCs across municipalities to differentiate between those more exposed to more aggressive firms.[11] The identifying assumption is that the treated municipalities did not evolve differently from the control group before the reform. To verify this assumption and to provide a dynamic evolution of the effects, we estimate the following event study model:

$$Taxrev_{it} = \alpha + \sum_{\kappa=-4}^{4} \delta_t \mathbb{1}[t=\kappa] + \sum_{\kappa=-4}^{4} \beta_t \left(\mathbb{1}[t=\kappa] \times hMNCsh_i\right) + \sigma_1 X_{it}^{'} + \eta_i + \delta_t + \varepsilon_{it} \tag{3}$$

[10] The majority of municipal rate changes are tax rate increases. In fact, only 6 per cent of tax rate changes in our sample are tax decreases.

[11] The results with continuous exposure are consistent and we provide these in Table G3 in Appendix G.

where $Taxrev_{it}$ is a share of tax revenues coming from corporations, property taxes, the log of tax revenues coming from each source, and property tax rates. $\sum_{\kappa=-4}^{4} \mathbb{1}[t=\kappa]$ is a series of year dummies that equal 1 when the tax reform was $\kappa$ years away, with the dummy variable corresponding to $\kappa=-1$ as the omitted category. $hMNCsh_i$ is a dummy equal to 1 when the share of aggressive MNCs in a given municipality is larger than a median. $X_{it}$ includes municipal and property tax rates, the number of firms in each municipality, and population. $\eta_i$ are municipality fixed effects and $\delta_t$ are year fixed effects. We cluster standard errors at the municipal level in each estimation.

The coefficients of interest are the $\beta_t$: they estimate the difference in the share of trade tax revenues between municipalities with a high and low share of aggressive MNCs, $\kappa$ years before or after the reform, relative to the control group of municipalities that did not change their tax rate at all. Following McCrary (2007), we bin event dummies at endpoints of the event window (in our case, at $t=-4$ and $t=4$) such that the end dummies include any years beyond the window. This is to account for the different timing of tax rate cuts across municipalities, which yields an unbalanced panel for event times.[12]

We start by pooling all of the post-reform coefficients for periods $t=1$ up to $t=3$ as a post dummy equal to 1 and all coefficients before as a post dummy equal to 0. We summarize these results in Table 2, including the share of aggressive MNCs in Panel A and a share of all MNCs in Panel B. We use a dummy equal to 1 when the share of firms is above the median across all municipalities. We find that municipalities that have a larger share of more aggressive MNCs significantly reduce the share of tax revenue they derive from trade taxes following a tax rate increase. This is not the case for municipalities that simply have a larger share of MNCs more generally. There is also a reduction in trade tax revenue and overall tax revenue for those municipalities with more aggressive MNCs, but not much compensation from property tax revenues. In turn, in our placebo experiment in Panel B, we find that property tax rates increase and so do property tax revenues.

We then plot the event study coefficients in Figure 3 to show the evolution of tax revenue structure around the tax rate increase. Panel (a) shows the evolution of the share of trade tax and property tax in total tax revenue across the years in our sample for municipalities that have a higher share of aggressive MNCs relative to those with a lower share. We find that following a tax rate increase there is a steady decline in the share of trade tax revenues in the affected municipalities, but no significant change in the share of property tax revenues. Before the tax rate increase there is no difference between the two types of municipalities in any of the time periods. In Panel (b) we break it down into changes in trade tax and property tax revenues and show almost no change in property tax revenues and a large decline in trade tax revenues around the time of reform. These changes are reflected in a reduction in the overall tax revenue following a tax rate increase. Further, we find no evidence of a differential evolution in tax revenue structure components between municipalities with a larger share of more aggressive MNCs before the reform.[13]

Does the reduction in tax revenues affect municipal expenditures and consequently their GDP and debt? There are two caveats that come with this analysis. First, the GDP and expenditures data available to us does not cover the full set of municipalities. Second, the apportionment of tax revenues from state and federal governments to municipalities and vice versa could affect these estimates. Specifically, because federal and state governments may apportion some of their revenues to municipalities that see a reduction in their own tax revenues, apportionment may reduce the magnitude of the trade tax revenue estimates. However, since municipalities also apportion some of their revenues back to state and federal

[12] The binning at the endpoints of the window is the reason we do not plot the endpoint estimates in the event study graphs.

[13] In Appendix C, instead of firm counts we use the share of assets, employment, turnover, and profits that firms have in each municipality to understand the intensity of the MNC presence. The caveat is that Orbis data has poor coverage of financial information, especially for domestic firms, which means that these results are heavily skewed towards reporting larger shares of multinational real business operations. Nevertheless, the results confirm our baseline story.

governments, this may attenuate the effect. In Appendix D we find no effects of tax rate increases on municipal expenditures, GDP, or debt, and in Appendix F we find no significant effects directly on apportionment. Hence, apportionment does not play a large role in our estimates. However, given the two caveats, the results for expenditures and GDP should be treated with caution.

Table 2: Difference in difference results: pre- and post-tax rate increase

**Panel A: Aggressive MNCs**

| | (1) Trade tax share | (2) Property tax share | (3) ln(trade tax rev) | (4) ln(prop tax rev) | (5) ln(tot tax rev) | (6) Property tax rate |
|---|---|---|---|---|---|---|
| High share = 1 | –0.024** | 0.002*** | –0.093*** | 0.005 | -0.050** | 0.006 |
| × post = 1 | (0.010) | (0.000) | (0.015) | (0.005) | (0.020) | (0.005) |

**Panel B: All MNCs**

| | (1) Trade tax share | (2) Property tax share | (3) ln(trade tax rev) | (4) ln(prop tax rev) | (5) ln(tot tax rev) | (6) Property tax rate |
|---|---|---|---|---|---|---|
| High share = 1 | –0.008 | 0.002*** | –0.051*** | 0.010** | –0.026 | 0.013*** |
| × post = 1 | (0.009) | (0.001) | (0.015) | (0.004) | (0.016) | (0.004) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 19,195 | 19,242 | 41,884 | 42,608 | 19,226 | 48,627 |
| # firms | 9,320 | 9,736 | 6,765 | 6,641 | 9,737 | 5,870 |
| Mean | 0.290 | 0.022 | 5.733 | 2.742 | 7.260 | 5.731 |

Note: the dependent variable in column (1) is the share of trade tax in all tax revenue, in column (2) the share of property tax revenue, in column (3) the logarithm of trade tax revenue, in column (4) the logarithm of property tax revenue, in column (5) the logarithm of total tax revenue, and in column (6) the logarithm of property tax rate. In Panel A, a high share is a dummy equal to 1 if the share of aggressive MNCs is larger than a median across all municipalities, in Panel B it is 1 if the share of MNCs is larger than a median across all municipalities. Post is equal to 1 after the tax rate increase and 0 beforehand. In each specification, we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level. In columns (1), (2), and (5) we only have data for total tax revenue at the municipality level for the period 2016–19, which reduces the number of observations. In columns (3), (4), and (6) we have data for trade and property tax revenues for the years 2011–19.

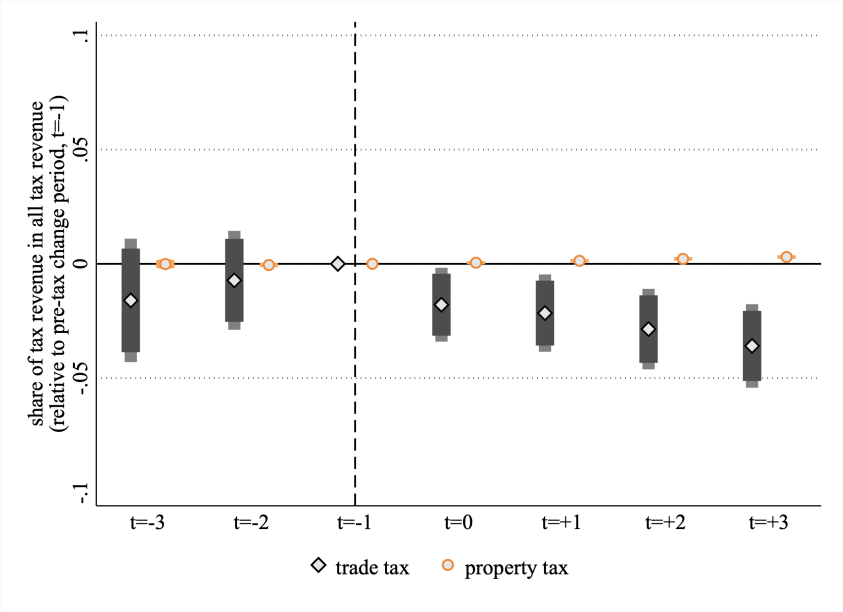
Source: authors' compilation based on data from Orbis and the German Statistical Office.

*Mechanisms*. There are two potential reasons why the share of trade tax revenues at the municipal level may decline as a result of tax rate increases. The first is profit shifting, which is the mechanism we propose in this paper. Multinationals may choose to move profits away from municipalities that levy larger taxes on them. Given that profits are mobile across borders, this can potentially be immediately reflected in tax revenues. The second possibility is that tax rate increases result in reallocation of firms away from municipalities that enact those tax rate hikes. To the extent that incentives for the reallocation of real operations should not differ between more and less aggressive MNCs, our placebo tests using the share of MNCs demonstrate that the reallocation does not explain the observed patterns. However, to test whether more aggressive MNCs are also more likely to reallocate their real operations, we show that following a tax rate hike employment, total assets, and turnover of firms residing in municipalities with more aggressive MNCs do not systematically decline. As such, we can rule out real responses.[14]

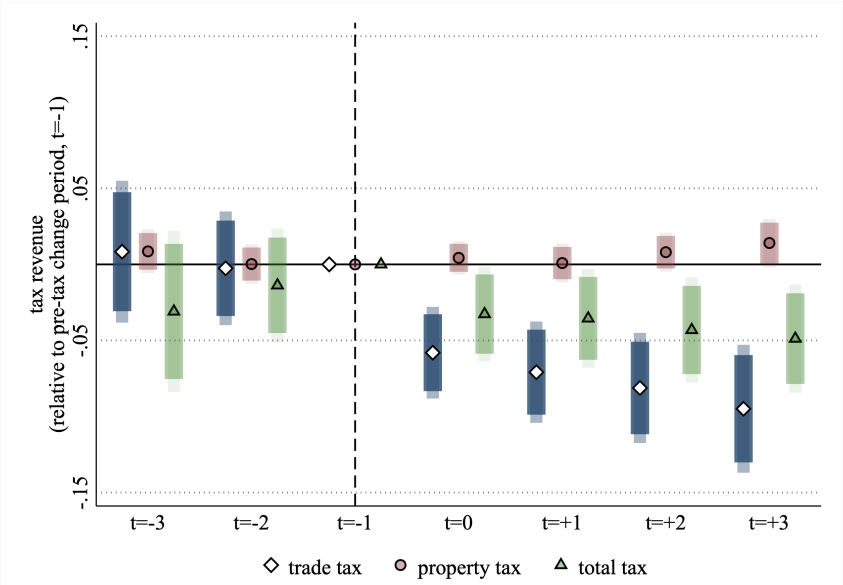
[14] If anything, we observe an increase in assets and turnover, but the effect is not statistically significant. We find a negative effect for employment, but event study analysis shows that this is because employment has been declining in those municipalities even before the tax rate hikes.

Figure 3: Dynamic effects of the tax rate increase on municipal revenue structure

(a) Share of trade tax in total tax




(b) Trade tax vs property tax




Note: this figure reports the dynamic effects of the tax rate increase on the share of trade tax and property tax in total tax (a) and the logarithm of trade tax, property tax, and total tax revenue (b). All panels include the event study coefficient plots for municipalities with a high share of aggressive MNCs relative to those with a low share and relative to the control group from three years before the tax rate increase to three or more years after the tax rate increase. The high share of aggressive MNCs is defined as the above median. Each dot represents the coefficient estimate using the different difference in difference methodology, the darker shaded box represents the 95 per cent confidence interval, while the lighter shaded box is the 90 per cent confidence interval. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level. In (a) we only include the period 2016–19 as we only have data for total tax revenue at the municipality level for that period. In (b) we include the full 2011–19 period for property and trade tax revenue estimates and the limited time period for total tax revenue estimates.

Source: authors' compilation.

*Summary*. The municipal-level results show a strong causal relationship between changes in tax rates in municipalities with larger shares of more aggressive MNCs and tax revenue structure. As such, these results suggest that firms with opportunities to avoid taxes will move profits out of municipalities that

increase tax rates. This, in turn, will affect the ability of these municipalities to collect tax revenues from those more aggressive firms. Consequently, we show that profit shifting practices causally affect tax revenue structure at the municipal level.

## 4 Discussion

This paper provides novel estimates of how tax revenue structures are affected by profit shifting practices of MNCs. From a policy perspective, it is important to understand how governments raise revenues in the presence of profit shifting by MNCs. In particular, we provide the first evidence on sources of tax revenues in countries where governments may be unable to raise revenues from MNCs. More broadly, our analysis allows us to understand which groups of firms or individuals may bear the burden of taxes which are not paid by MNCs. This is important, especially for developing countries, which have much lower fiscal capacity and, as a consequence, lower ability to raise tax revenues.

At the municipality level, we provide casual evidence that the presence of more aggressive MNCs reduces local capacity to collect tax revenues from those firms and consequently affects tax revenue structure. As such, profit shifting appears to be causally linked with the tax revenues structure. These municipal-level estimates lend credibility to the country-level correlations. Further, our findings have implications for local governments that are trying to increase their revenues from MNCs. We find that increasing tax rates in municipalities that have a large presence of aggressive firms has an opposite effect and reduces these revenues. We rule out that the observed revenue changes are driven by reallocation of real operations.

Do our results mean that profit shifting affects income inequality through changes in tax revenues and tax rates structure? Our findings suggest that higher profit shifting is correlated with lower corporate tax revenues but higher individual, VAT, and other indirect tax revenues and rates. We can infer the direct effect of profit shifting on inequality using the literature on corporate tax incidence. Corporate income taxes are mostly borne by capital and labour—MNCs' shareholders, employees, and customers (Clausing 2013; Fuest et al. 2018; Gravelle 2013; Suárez Serrato and Zidar 2016). A share of those individuals are likely to be located in foreign countries, and thus not directly affecting the within-country inequality. A share of those individuals who live in the affected country are likely to be relatively high-income ones, and high-income individuals are more likely to own, be employed by, or buy the products of most MNCs. As such, corporate tax is likely to reduce inequality, while not paying that tax will directly increase inequality. We can infer the indirect effect of profit shifting on inequality by using the data from the Commitment to Equity (CEQ) Institute (Commitment to Equity Institute 2022; Lustig 2018) on the incidence of various taxes. Individual direct taxes tend to be progressive, whereas indirect and VAT taxes are regressive in almost all cases. As a consequence, the overall effect is likely to differ between individual countries and be hard to determine without further research, which goes beyond the scope of this paper and will likely depend on the country-specific characteristics of profit shifting and tax systems, such as tax rates and their progressivity.

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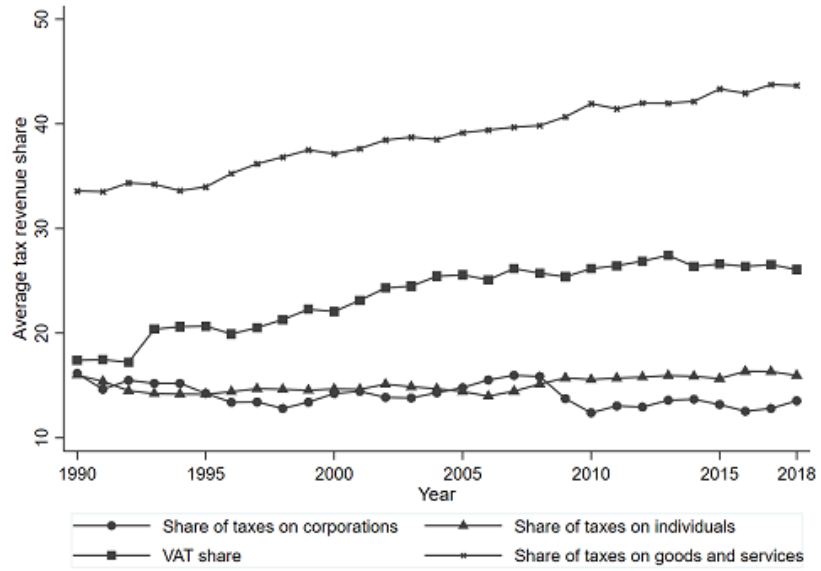
## Appendix A: The evolution of tax revenue structure

In recent decades the size of profit shifting has increased, despite numerous unilateral and multilateral efforts of governments to reduce the ability of MNCs to shift profits out of high-tax-rate countries (Clausing et al. 2016; OECD 2017). In Figure A1 we show that over the recent decades the share of corporate tax revenues in total tax revenues has declined accordingly, while the share of tax revenues coming from indirect taxes on goods and service, VAT in particular, has increased. At the same time, corporate and individual tax rates have increased and indirect tax rates and social security contribution rates have increased substantially (Fuest et al. 2021). It appears that as multinationals are shifting profits extensively, countries are also changing the rates and revenue structures to tax the less mobile capital and employment over more mobile corporate profits.

Since profit shifting and tax revenue structures are a dynamic process, it may well be that countries that are losing the most of their tax revenues due to profit shifting may be those that are also more likely to switch to taxing consumption over corporate profits. In Table A1 we look at the correlations between changes in tax revenue structure over the last 25 years and the extent of profit shifting. Consistent with the time trend figures, we find that countries that are facing a lot of tax revenue pressure because multinationals shift a lot of profits out of those countries are also those that reduced their share of tax revenues coming from corporations. Specifically, a 1 percentage point increase in profits shifted out reduces the share of corporate tax revenues over the time period by 0.6 percentage points. We do not find a corresponding increase in the share of indirect tax revenues or VAT.

Figure A1: The evolution of tax revenue shares




Note: the vertical axis on the graph represents the average tax revenue shares (taxes on income, profits, and capital gains from corporations and individuals; VAT; taxes on goods and services) among countries (excluding tax havens) as a percentage of total tax revenue. The horizontal axis represents the time evolution. The list of tax havens is defined by Tørsløv et al. (2020) and Garcia-Bernardo and Janský (2021).

Source: authors' compilation based on data from UNU-WIDER.

Table A1: Summary of the dynamic country-level results

**Panel A: Baseline correlations for tax shares**

| | (1) corp.share90 | (2) indiv.share90 | (3) gs.share90 | (4) vat.share90 | (5) rest.share90 |
|---|---|---|---|---|---|
| Profit shifted % GDP | –0.162 | –0.369 | 0.004 | –0.180 | –0.115 |
| | (0.180) | (0.385) | (0.053) | (0.146) | (0.187) |
| Number of countries | 26 | 26 | 27 | 20 | 26 |

**Panel B: Tax shares, including controls**

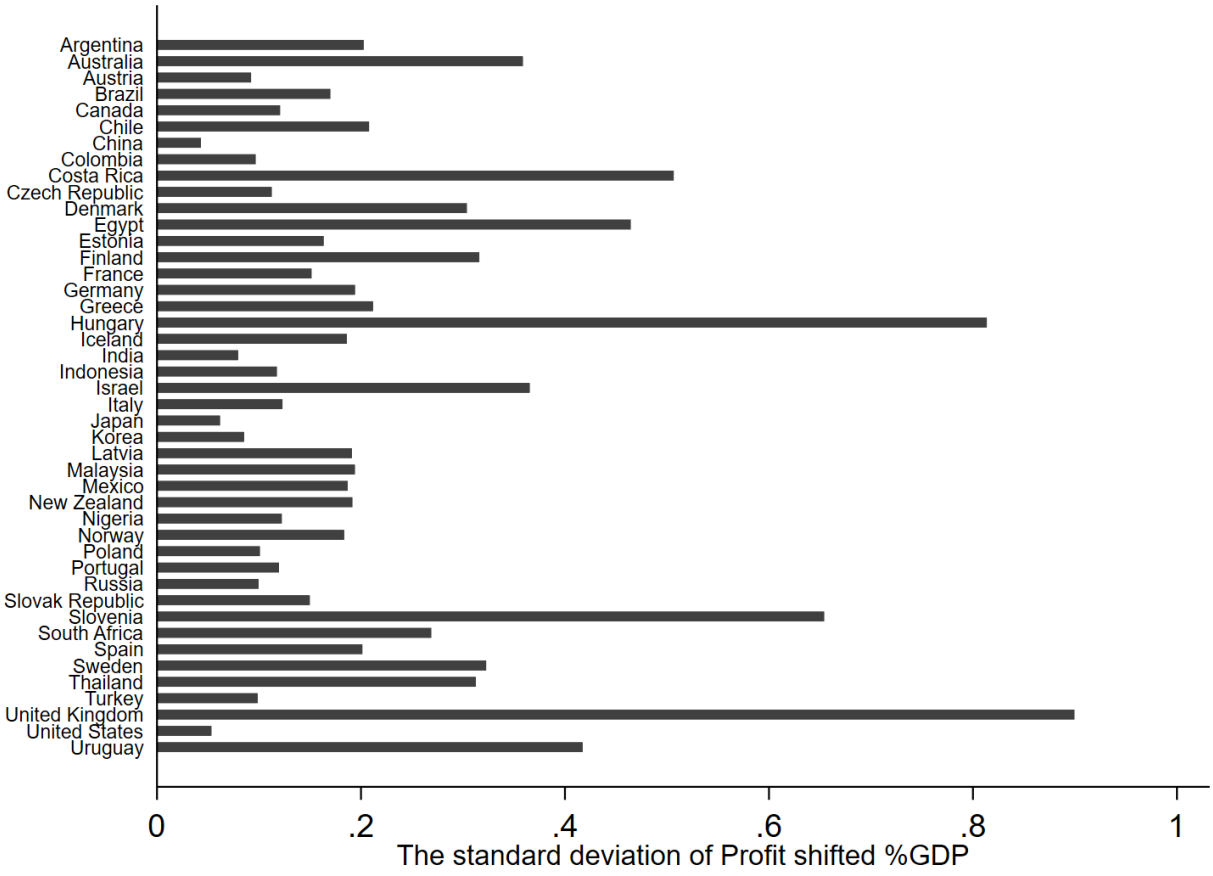
| | (1) corp.share90 | (2) indiv.share90 | (3) gs.share90 | (4) vat.share90 | (5) rest.share90 |
|---|---|---|---|---|---|
| Profit shifted % GDP | –0.616* | –0.676 | –0.081 | –0.067 | –0.097 |
| | (0.258) | (0.391) | (0.069) | (0.149) | (0.257) |
| Logarithm of GDP per capita | 1.082* | 1.811* | 0.067 | 0.078 | 0.065 |
| | (0.493) | (0.748) | (0.138) | (0.294) | (0.504) |
| Logarithm of population | –0.066 | –0.253 | 0.090 | –0.050 | 0.037 |
| | (0.185) | (0.280) | (0.050) | (0.104) | (0.184) |
| Individual tax rates | –0.008 | –0.096*** | –0.008 | 0.026* | 0.004 |
| | (0.016) | (0.024) | (0.004) | (0.011) | (0.015) |
| Corporate tax rates | –0.052 | 0.129* | –0.016 | 0.017 | –0.066 |
| | (0.033) | (0.050) | (0.009) | (0.024) | (0.032) |
| Indirect tax rates | 0.035 | 0.143*** | –0.002 | –0.070* | –0.049 |
| | (0.024) | (0.036) | (0.007) | (0.023) | (0.024) |
| Number of countries | 25 | 25 | 26 | 19 | 25 |

Note: the dependent variable in column (1) is the average growth of tax revenue share from income, profits, and capital gains taxes on corporations between 1990 and 2018; in column (2) is the average growth of tax revenue share from income, profits, and capital gains taxes on individuals between 1990 and 2018; in column (3) is the average growth of tax revenue share from taxes on goods and services between 1990 and 2018; in column (4) is the average growth of tax revenue share from VAT between 1990 and 2018; in column (5) is the average growth of tax revenue share from social contributions, payroll and workforce, property, and other taxes between 1990 and 2018. The independent variable is the average profit shifted as a percentage of GDP from Tørsløv et al. (2020) during 2015–18 period. All the data in the table exclude tax havens, which are defined by Tørsløv et al. (2020). Controls in Panel B include the logarithm of GDP per capita, the logarithm of population, and individual, corporate, and indirect tax rates.

Source: authors' compilation based on data from UNU-WIDER, IMF, and Tørsløv et al. (2020).

## Appendix B: Additional country-level estimates

Figure B1: The standard deviation of profit shifted as a percentage of GDP




Note: the graph reports the volatility of profit shifted as a percentage of GDP (Tørsløv et al. 2020) with standard deviation during 2015–18 with a breakdown into countries. On the graph we exclude countries defined as tax havens by Tørsløv et al. (2020).

Source: authors' compilation.

Table B1: Summary of country-level results

**Panel A: Baseline correlations for tax shares**

| | (1) corp.share | (2) indiv.share | (3) gs.share | (4) vat.share | (5) rest.share |
|---|---|---|---|---|---|
| Profit shifted % GDP | —-1.475* | 3.516** | 0.620 | 1.903* | –1.938 |
| | (0.670) | (1.342) | (1.150) | (0.836) | (1.623) |
| # Observations | 146 | 146 | 151 | 145 | 137 |

**Panel B: Tax shares, including controls**

| | (1) corp.share | (2) indiv.share | (3) gs.share | (4) vat.share | (5) rest.share |
|---|---|---|---|---|---|
| Profit shifted % GDP | –2.019** | 2.364* | 0.424 | 1.447 | 0.404 |
| | (0.659) | (1.008) | (1.159) | (0.746) | (1.199) |
| Controls | ✓ | ✓ | ✓ | ✓ | ✓ |
| # Observations | 131 | 131 | 136 | 130 | 122 |

**Panel C: Baseline correlations for tax rates**

| | (1) corp | (2) indiv | (3) indir | (4) socsecemployee | (5) socsecemployer |
|---|---|---|---|---|---|
| Profit shifted % GDP | –3.010*** | 0.308 | 3.206*** | –0.507 | –1.519 |
| | (0.630) | (1.426) | (0.699) | (0.788) | (1.392) |
| # of Observations | 165 | 165 | 165 | 158 | 152 |

**Panel D: Tax rates, including controls**

| | (1) corp | (2) indiv | (3) indir | (4) socsecemployee | (5) socsecemployer |
|---|---|---|---|---|---|
| Profit shifted % GDP | –2.870*** | 0.111 | 2.907*** | –0.800 | –1.436 |
| | (0.581) | (1.283) | (0.619) | (0.746) | (1.394) |
| Controls | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ |
| # Observations | 165 | 165 | 165 | 158 | 152 |

Note: the dependent variable in Panels A and B in column (1) is the share of tax revenue from income, profits, and capital gains taxes on corporations, in column (2) is the share of tax revenue from income, profits, and capital gains taxes on individuals, in column (3) is the share of tax revenue from goods and services taxes, in column (4) is the share of tax revenue from VAT, and in column (5) is the share of tax revenue from social contributions, payroll and workforce, property, and other taxes. The dependent variable in Panels C and D in column (1) is the corporate tax rate, in column (2) is the individual tax rate, in column (3) is the indirect tax rate, in column (4) is the employee social security tax rate, and in column (5) is the employer social security tax rate. The independent variable in all panels is the profit shifted as a percentage of GDP from Tørsløv et al. (2020). We exclude tax havens, which are defined by Tørsløv et al. (2020). In all specifications we include year fixed effects. Controls in Panel B include employer and employee social security tax rates, the logarithm of GDP per capita, the logarithm of population, FDI inward stock as a percentage of GDP. Controls in Panel D include the logarithm of GDP per capita, the logarithm of population, FDI inward stock as a percentage of GDP.

Source: authors' compilation based on data from UNU-WIDER, IMF, Tørsløv et al. (2020), KPMG, and UNCTAD.

Table B2: Summary of country-level results: robustness, scaling by GDP

**Panel A: Baseline correlations for total tax revenue, expenditures, operating surplus, tax shares**

| | (1) tax.tot | (2) exp | (3) opersurp | (4) tax.corp | (5) tax.indiv | (6) tax.gs | (7) tax.vat | (8) tax.rest |
|---|---|---|---|---|---|---|---|---|
| Profit shifted % GDP | 3.567** | 2.501* | –0.105 | –0.192 | 1.963*** | 1.251** | 1.217*** | 0.578 |
| | (1.095) | (1.091) | (1.963) | (0.131) | (0.559) | (0.387) | (0.266) | (0.702) |
| Year FE | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ |
| # Observations | 160 | 139 | 165 | 152 | 149 | 156 | 148 | 137 |

**Panel B: Total tax revenue, expenditures, operating surplus, tax shares, including controls**

| | (1) tax.tot | (2) exp | (3) opersurp | (4) tax.corp | (5) tax.indiv | (6) tax.gs | (7) tax.vat | (8) tax.rest |
|---|---|---|---|---|---|---|---|---|
| Profit shifted % GDP | 4.133*** | 2.902** | –1.037 | –0.370*** | 1.502** | 1.214*** | 1.056*** | 1.350** |
| | (1.107) | (0.998) | (2.062) | (0.107) | (0.477) | (0.360) | (0.200) | (0.511) |
| Employer soc. sec. tax rates | 0.146* | 0.256*** | –0.325** | –0.006 | –0.099*** | 0.026 | 0.010 | 0.203*** |
| | (0.065) | (0.064) | (0.106) | (0.006) | (0.028) | (0.021) | (0.012) | (0.035) |
| Employee soc. sec. tax rates | 0.487*** | 0.287* | –0.039 | –0.066*** | –0.056 | 0.171*** | 0.080*** | 0.472*** |
| | (0.129) | (0.115) | (0.190) | (0.012) | (0.055) | (0.041) | (0.022) | (0.067) |
| Logarithm of GDP per capita | 3.165*** | 4.297*** | 0.289 | 0.382*** | 1.635*** | 0.078 | 0.256 | 2.538*** |
| | (0.909) | (0.857) | (1.772) | (0.088) | (0.391) | (0.303) | (0.170) | (0.460) |
| Logarithm of population | –0.513 | 0.457 | –6.171** | 0.226* | 0.129 | –0.564 | –0.568** | –0.799 |
| | (1.102) | (0.958) | (2.014) | (0.102) | (0.453) | (0.350) | (0.194) | (0.482) |
| FDI % GDP | –0.028 | –0.032* | –0.044* | –0.007*** | –0.001 | –0.025*** | –0.027*** | –0.004 |
| | (0.018) | (0.016) | (0.017) | (0.002) | (0.008) | (0.006) | (0.003) | (0.008) |
| Year FE | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ |
| # Observations | 144 | 126 | 165 | 135 | 134 | 140 | 131 | 122 |

Note: the dependent variable in column (1) is the total tax revenue as a percentage of GDP; in column (2) is the total expenditures as a percentage of GDP; in column (3) is the average gross operational surplus as a percentage of GDP during the 2010–20 period for each country; in column (4) is the revenue from income, profits, and capital gains taxes on corporations as a percentage of GDP; in column (5) is the revenue from income, profits, and capital gains taxes on individuals as a percentage of GDP; in column (6) is the revenue from goods and services taxes as a percentage of GDP; in column (7) is the revenue from VAT as a percentage of GDP, and in column (8) is the revenue from social contributions (compulsory and voluntary social insurance contributions from employers, employees, and the self-employed), payroll and workforce, property, and other taxes (tax revenues that are not otherwise classified or identified) as a percentage of GDP. The independent variable is the profit shifted as a percentage of GDP from Tørsløv et al. (2020). All the data in the table exclude tax havens, which are defined by Tørsløv et al. (2020). In each specification, we include year fixed effects except column (3). Controls in Panel B include employer and employee social security tax rates, the logarithm of GDP per capita, the logarithm of population, FDI inward stock as a percentage of GDP. In column (3) of Panel B controls are presented as the average during the 2010–20 period for each country.

Source: authors' compilation based on data from UNU-WIDER, IMF, Tørsløv et al. (2020), KPMG, and UNCTAD.

Table B3: Summary of country-level results: additional controls

| | (1) corp.share | (2) indiv.share | (3) gs.share | (4) vat.share | (5) rest.share |
|---|---|---|---|---|---|
| Profit shifted % GDP | –0.085 | 2.650* | 0.469 | 1.123 | –0.773 |
| | (0.637) | (1.094) | (1.336) | (0.863) | (1.318) |
| Individual tax rates | –0.024 | 0.249*** | –0.169* | –0.130* | 0.157 |
| | (0.040) | (0.069) | (0.085) | (0.059) | (0.085) |
| Corporate tax rates | 0.118 | 0.112 | 0.157 | 0.102 | –0.485** |
| | (0.079) | (0.136) | (0.170) | (0.121) | (0.161) |
| Employer soc. sec. tax rates | 0.099* | –0.209** | –0.081 | –0.081 | 0.461*** |
| | (0.040) | (0.068) | (0.083) | (0.054) | (0.095) |
| Employee soc. sec. tax rates | –0.336*** | –0.517*** | 0.031 | –0.063 | 1.013*** |
| | (0.066) | (0.114) | (0.139) | (0.089) | (0.151) |
| Indirect tax rates | –0.561*** | 0.136 | 0.040 | 0.101 | 0.081 |
| | (0.102) | (0.175) | (0.218) | (0.145) | (0.209) |
| Logarithm of GDP per capita | 0.771 | 1.112 | –2.911* | –0.659 | 2.982* |
| | (0.554) | (0.952) | (1.177) | (0.799) | (1.261) |
| Logarithm of population | 0.376 | 0.734 | –0.746 | –1.445 | –1.612 |
| | (0.538) | (0.924) | (1.140) | (0.732) | (1.090) |
| FDI % GDP | –0.058*** | 0.049** | –0.064** | –0.075*** | 0.071** |
| | (0.011) | (0.018) | (0.023) | (0.014) | (0.021) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ |
| # Observations | 131 | 131 | 136 | 130 | 122 |

Note: the dependent variable in column (1) is the share of tax revenue from income, profits, and capital gains taxes on corporations, in column (2) is the share of tax revenue from income, profits, and capital gains taxes on individuals, in column (3) is the share of tax revenue on goods and services, in column (4) is the share of tax revenue from VAT, and in column (5) is the share of tax revenue from social contributions (compulsory and voluntary social insurance contributions from employers, employees, and the self-employed), payroll and workforce, property, and other taxes (tax revenues that are not otherwise classified or identified). The independent variable is the profit shifted as a percentage of GDP from Tørsløv et al. (2020). All the data in the table exclude tax havens, which are defined by Tørsløv et al. (2020). In each specification we include year fixed effects. Controls in Panel B include individual tax rates, corporate tax rates, employer and employee social security tax rates, the logarithm of GDP per capita, the logarithm of population, and FDI inward stock as a percentage of GDP.

Source: authors' compilation based on data from UNU-WIDER, IMF, Tørsløv et al. (2020), KPMG, and UNCTAD.

## B1 Alternative profit shifting estimates

We test the robustness of our findings using an alternative set of profit shifting estimates from Garcia-Bernardo and Janský (2021). They use country-by-country reporting data to show that MNCs report substantially more profits in a number of low-tax countries than their corresponding economic activity. On the basis of their misalignment model, they provide estimates for up to 190 countries, but only for one year, 2017. As such, Tørsløv et al.'s (2020) estimates are more established and cover panel data, while Garcia-Bernardo and Janský (2021) cover a broader range of countries, but for one year only.

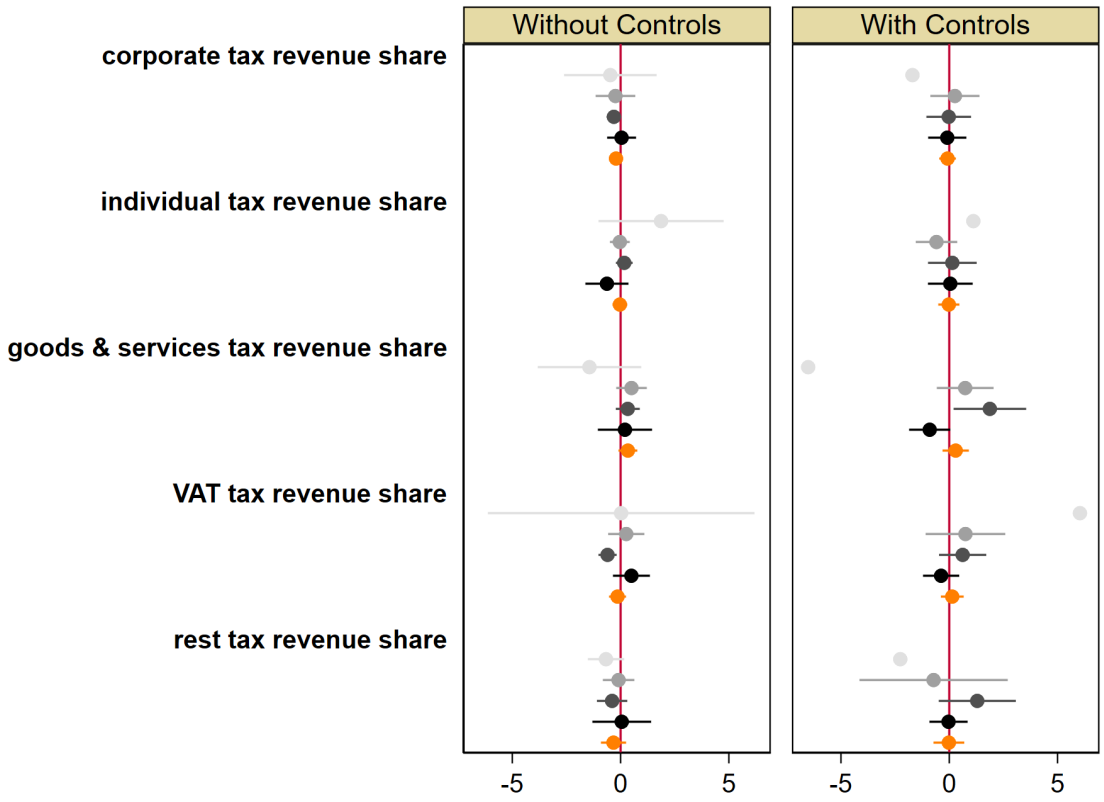
Table B4: Summary of country-level results with an alternative measure of profit shifting

| | (1) corp_share | (2) indiv_share | (3) gs_share | (4) vat_share | (5) rest_share |
|---|---|---|---|---|---|
| Profit shifted % GDP | –0.079 | –0.020 | 0.298 | 0.139 | –0.018 |
| | (0.193) | (0.244) | (0.306) | (0.265) | (0.356) |
| Employer soc. sec tax rates | –0.107 | –0.122 | –0.148 | –0.122 | 0.607*** |
| | (0.072) | (0.091) | (0.110) | (0.094) | (0.154) |
| Employee soc. sec. tax rates | –0.307* | –0.348* | 0.058 | 0.121 | 0.777** |
| | (0.121) | (0.154) | (0.187) | (0.160) | (0.245) |
| Logarithm of GDP per capita | 0.479 | 0.803 | –2.374* | 0.685 | 0.530 |
| | (0.772) | (0.977) | (1.177) | (1.018) | (1.431) |
| Logarithm of population | 0.862 | 1.703 | –1.955 | –1.766 | 0.873 |
| | (0.881) | (1.115) | (1.393) | (1.207) | (1.665) |
| FDI % GDP | –0.009 | 0.072* | –0.107** | –0.104** | 0.103* |
| | (0.024) | (0.031) | (0.039) | (0.033) | (0.044) |
| # Countries | 82 | 82 | 94 | 85 | 72 |

Note: the dependent variable in column (1) is the tax revenue share from income, profits, and capital gains taxes on corporations, in column (2) is the tax revenue share from income, profits, and capital gains taxes on individuals, in column (3) is the tax revenue share on goods and services, in column (4) is the VAT tax revenue share, and in column (5) is the tax revenue share from social contributions (compulsory and voluntary social insurance contributions from employers, employees, and the self-employed), payroll and workforce, property, and other taxes (tax revenues that are not otherwise classified or identified). The independent variable is the profit shifted as a percentage of GDP from Garcia-Bernardo and Janský (2021). All the data in the table exclude tax havens, which are defined by Garcia-Bernardo and Janský (2021). In each specification we include year fixed effects. Controls in Panel B include employer and employee social security tax rates, logarithm of GDP per capita, logarithm of population, and FDI inward stock as a percentage of GDP.

Source: authors' compilation based on data from UNU-WIDER, IMF, Garcia-Bernardo and Janský (2021), KPMG, and UNCTAD.

Figure B2: Summary of country-level results with an alternative measure of profit shifting by countries' income levels




Note: in orange we show the overall coefficient. The black marker indicates high-income countries and the lightest grey is low-income countries (classification by the World Bank). The dependent variables are all scaled by total tax revenues. The independent variable is the profit shifted as a percentage of GDP from Garcia-Bernardo and Janský (2021). In each specification we include year fixed effects. Controls on the right part of the figure include employer and employee social security tax rates, logarithm of GDP per capita, logarithm of population, and FDI inward stock as a percentage of GDP.

Source: authors' compilation based on data from UNU-WIDER, IMF, Garcia-Bernardo and Janský (2021), KPMG, and UNCTAD.

## Appendix C: Municipal-level estimates using real business operation

In the main body of the paper we use the number of subsidiaries that belong to multinationals to calculate the exposure to more aggressive MNCs. In principle, the more assets, profits, turnover, or employment these firms have in each municipality, the larger the potential responses to tax rate differences and tax rate changes. Orbis data collects information on these real business operations, but the data has much smaller coverage. In Table C1 we summarize the municipal-level coverage for financial information in Orbis for all firms (Panel A) and multinational firms (Panel B). On average, the coverage is quite poor, with about 13 per cent of firms reporting employment and turnover and 2 per cent reporting profits. Multinationals have better coverage, with over 40 per cent of their subsidiaries having information on employment and turnover and 20 per cent on profits.

In Table C2 we replicate the results from column (3) of Table 1 using real business operations shares to proxy for municipal exposure to more aggressive multinationals (Panel A) and multinationals (Panel B). The caveat with these results is that we have much lower coverage of real business operations that is highly skewed towards MNCs. Nevertheless, we find results consistent with our baseline estimates. The trade tax revenue is lower in municipalities with higher tax rates and a larger share of real business operations done by more aggressive MNCs. The magnitude of this effect is much larger than that for municipalities with a larger share of real business operations done simply by multinationals.

Table C1: Orbis data coverage: counts and financials

| Stats | Total assets (1) | Employment (2) | Turnover (3) | Profits (4) | Firm count (5) | MNC count (6) |
|---|---|---|---|---|---|---|
| **Panel A: firm coverage** | | | | | | |
| Mean | 0.066 | 0.131 | 0.134 | 0.020 | 37,156 | 197 |
| Median | 0.062 | 0.124 | 0.127 | 0.019 | 2,823 | 13 |
| Standard deviation | 0.023 | 0.045 | 0.045 | 0.010 | 70,313.274 | 369.302 |
| **Panel B: MNC coverage** | | | | | | |
| Mean | 0.309 | 0.429 | 0.437 | 0.203 | | |
| Median | 0.286 | 0.406 | 0.417 | 0.172 | | |
| Standard deviation | 0.213 | 0.227 | 0.228 | 0.184 | | |

Note: this table summarizes the data coverage in Orbis. Columns (1)–(4) show the fraction of firms that have financial data coverage for total assets, employment, turnover, and profits, respectively. Column (5) shows the number of firms and column (6) the number of multinational subsidiaries by municipality. Panel A shows these statistics for overall firm coverage and Panel B for multinational firms only.

Source: authors' compilation based on data from Orbis.

Table C2: Summary of cross-sectional results: real business operations weighted

**Panel A: Aggressive MNCs**

| Dep.var.: ln(trade tax rev) | (1) Share assets | (2) Share empl | (3) Share turnover | (4) Share profits |
|---|---|---|---|---|
| Tax rate × agg MNC share | –0.011*** | –0.023*** | –0.016** | –0.003 |
| | (0.004) | (0.008) | (0.006) | (0.002) |

**Panel B: All MNCs**

| Dep.var.: ln(trade tax rev) | (1) Share assets | (2) Share empl | (3) Share turnover | (4) Share profits |
|---|---|---|---|---|
| tax rate × MNC share | –0.005*** | –0.009*** | –0.006*** | –0.003*** |
| | (0.002) | (0.002) | (0.002) | (0.001) |
| Year FE | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ |
| Observations | 64,557 | 71,216 | 71,329 | 44,727 |
| # Municipalities | 7,274 | 8,057 | 8,064 | 8,064 |
| Mean | 6.540 | 6.288 | 6.285 | 7.239 |

Note: the dependent variable in all columns is the logarithm of trade tax revenue. The tax rate is the trade tax rate. In Panel A agg MNC share is the share of assets, employment, turnover, and profits that aggressive MNCs hold in each municipality relative to assets, employment, turnover, and profits reported by all firms in that municipality. In Panel A, MNC share is the share of assets, employment, turnover and profits that all MNCs hold in each municipality relative to assets, employment, turnover, and profits reported by all firms in that municipality. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level.

Source: authors' compilation based on data from Orbis and German Statistical Office.

Table C3: The effect of tax rate hikes on real firm presence

**Panel A: Aggressive MNCs**

| | (1) Employment | (2) Total assets | (3) Turnover | (4) Number of firms |
|---|---|---|---|---|
| Tax rate × agg MNC share | –0.325* | 0.251 | 0.263 | –0.011 |
| | (0.182) | (0.161) | (0.200) | (0.018) |
| Year FE | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ |
| Observations | 54,038 | 54,699 | 52,624 | 62,755 |
| # Municipalities | 7,981 | 7,225 | 7,786 | 7,945 |
| Mean | 0.319 | 6.635 | 3.206 | 2.411 |

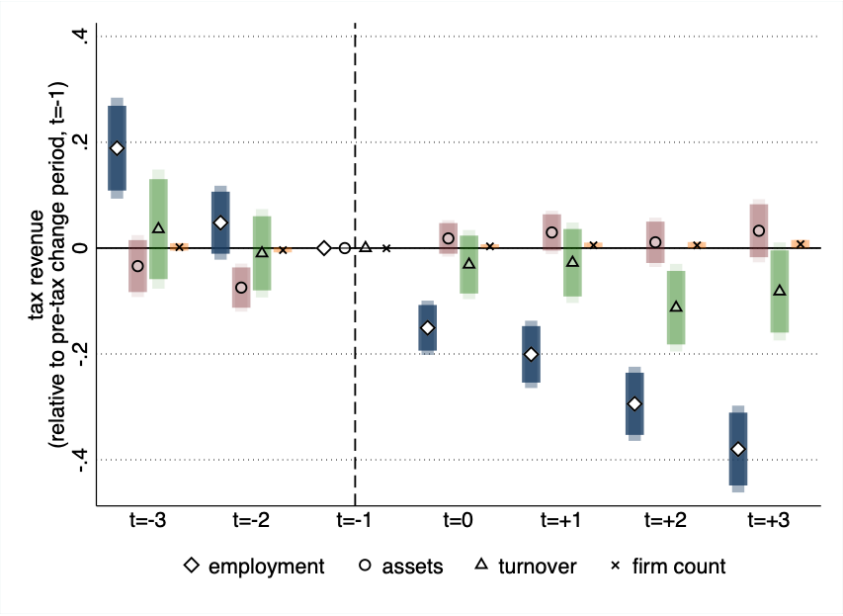
**Panel B: All MNCs**

| | (1) Employment | (2) Total assets | (3) Turnover | (4) Number of firms |
|---|---|---|---|---|
| Tax rate × MNC share | –0.302*** | 0.085 | 0.279** | –0.017 |
| | (0.102) | (0.058) | (0.128) | (0.015) |
| Year FE | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ |
| Observations | 54,038 | 54,699 | 52,624 | 62,755 |
| # Municipalities | 7,981 | 7,225 | 7,786 | 7,945 |
| Mean | 0.319 | 6.635 | 3.206 | 2.411 |

Note: the dependent variable in column (1) is the logarithm of the number of employees, in column (2) the logarithm of total assets, in column (3) the logarithm of turnover, in column (4) the logarithm of the number of firms. In Panel A agg MNC share is the share of aggressive MNCs in all firms in that municipality. In Panel B, share MNCs is a share of MNCs in all firms in that municipality. In each specification, we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, and municipal population in all specifications. In addition, in columns (1)–(3) they include the number of firms in each municipality. Standard errors are clustered at the municipality level.

Source: authors' compilation based on data from Orbis and the German Statistical Office.

Figure C1: Dynamic effects of tax rate hikes on real firm presence




Note: this figure reports the dynamic effects of the tax rate increase on municipal aggregates of firm employment, total assets, turnover, and firm numbers. The figure plots the event study coefficient for municipalities with a high share of aggressive MNCs relative to those with a low share and relative to the control group from three years before the tax rate increase to two or more years after the tax rate increase. The high share of aggressive MNCs is defined as above the median. Each dot represents the coefficient estimate using the different difference in difference methodology; the darker shaded box represents the 95 per cent confidence interval, while the lighter shaded box is the 90 per cent confidence interval. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality (with the exception of regressions with firm counts as the outcome variable, where we do not control for that). Standard errors are clustered at the municipality level. The sample time period includes the years 2012–19 for which we have observations of firm financial data.

Source: authors' compilation.

## Appendix D: Expenditures, debt, and local GDP

Municipalities that increase their tax rates see a reduction in trade tax revenues when they are home to more tax-aggressive subsidiaries of MNCs. Does the reduction in tax revenues affect municipal expenditures and consequently their GDP and debt? In Figure D1 we plot the event study coefficients to show the evolution of gross municipal expenditures, total debt, and municipal GDP around the tax rate increase.[15] We find no significant change in municipal expenditures, GDP, or debt.

One of the potential explanations for finding no effects of expenditures, debt, or GDP could be that the German tax system includes the apportionment of wage, income tax, withholding tax, and VAT from federal and state governments. It is entirely possible that the reduction in tax revenues from trade taxes in municipalities that have more aggressive MNCs may be compensated by the apportionment from federal and state revenues. Given that the apportionment data that we have includes both the amounts coming from the state and federal levels and amounts being sent to state and federal government, it is hard to disentangle the two. Evidence from Appendix D shows no effect on apportionment components.

Table D1: Difference in difference results: pre- and post-tax rate increase, expenditures, debt and GDP

**Panel A: Aggressive MNCs**

| | (1) log(gross exp) | (2) log(GDP) | (3) log(debt) | (4) log(gross exp) | (5) log(GDP) | (6) log(debt) |
|---|---|---|---|---|---|---|
| agg MNC share × post=1 | –3.693* | 1.613 | –7.469 | | | |
| | (2.000) | (2.128) | (8.625) | | | |
| High share=1=1 × post=1=1 | | | | –0.021 | 0.005 | –0.046 |
| | | | | (0.013) | (0.012) | (0.062) |

**Panel B: All MNCs**

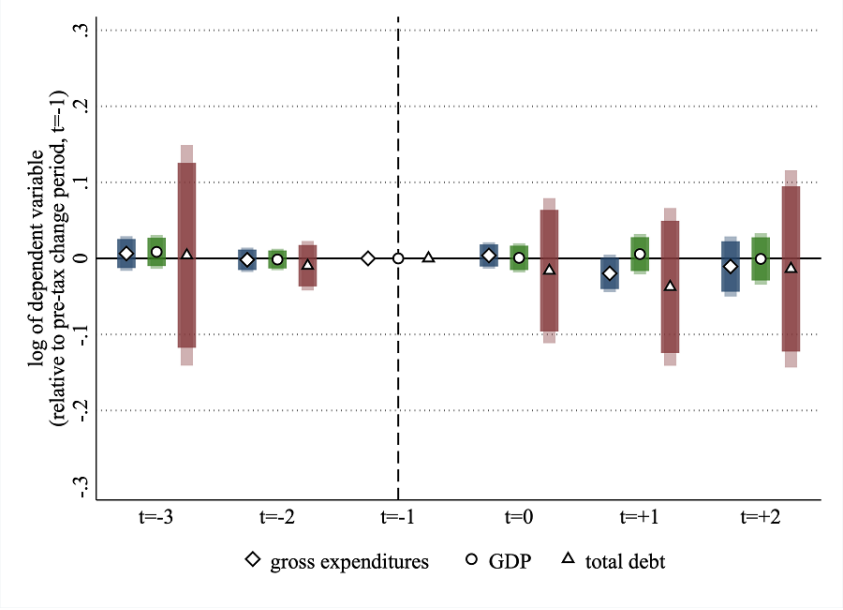
| | (1) log(gross exp) | (2) log(GDP) | (3) log(debt) | (4) log(gross exp) | (5) log(GDP) | (6) log(debt) |
|---|---|---|---|---|---|---|
| MNC share × post=1 | 0.275 | 2.893** | –0.626 | | | |
| | (1.250) | (1.283) | (5.963) | | | |
| High share=1=1 × post=1=1 | | | | –0.024* | 0.006 | –0.040 |
| | | | | (0.013) | (0.021) | (0.107) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 11,758 | 940 | 940 | 11,758 | 940 | 940 |
| # firms | 11,666 | 11,617 | 11,617 | 11,664 | 11,618 | 11,618 |
| Mean | 7.717 | 15.678 | 12.342 | 7.717 | 15.678 | 12.342 |

Note: the dependent variable in columns (1) and (4) is the share of logarithm of gross expenditures, in columns (2) and (5) the logarithm of GDP, in columns (3) and (6) the logarithm of debt. Columns (1)–(3) use the continuous share of MNC presence and columns (4)–(6) use a dummy equal to 1 if the share of MNCs is larger than a median across all municipalities. Post is equal to 1 after the tax rate increase and 0 beforehand. MNCs share is a share of MNCs in all firms in that municipality. agg MNC share is the share of aggressive MNCs in all firms in that municipality. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level.

Source: authors' compilation based on data from Orbis and the German Statistical Office.

[15] We do not have GDP data for all municipalities, so these coefficients are estimated using a subsample of the German municipalities.

Figure D1: Dynamic effects of the tax rate increase on municipal expenditures, GDP, and debt




Note: this figure reports the dynamic effects of the tax rate increase on municipal expenditures, GDP, and debt. The figure plots the event study coefficient for municipalities with a high share of aggressive MNCs relative to those with a low share and relative to the control group from three years before the tax rate increase to two or more years after the tax rate increase. The high share of aggressive MNCs is defined as above the median. Each dot represents the coefficient estimate using the different difference in difference methodology, the darker shaded box represents the 95 per cent confidence interval, while the lighter shaded box is the 90 per cent confidence interval. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level. The sample time period includes the years 2008–14.

Source: authors' compilation.

## Appendix E: Domestic or foreign MNCs?

In the baseline analysis we do not distinguish between the countries of the MNCs' headquarters. Here, we specifically break down the results from Table 1 into domestic and foreign MNCs. In Table E1 we split the sample of all MNCs into foreign and domestic. We show that our baseline estimates for the relationship between tax structure and the presence of aggressive firms hold only for the sample of foreign MNCs, with no effects for domestic MNCs. In Table E1 we split the sample of aggressive MNCs into foreign and domestic. We find that municipalities with a larger share of foreign aggressive firms have lower tax revenues when they have higher tax rates. This relationship is still significant for the share of domestic firms, but much weaker.

Table E1: Summary of cross-sectional results: foreign vs domestic MNC heterogeneity

| | (1) Trade tax share | (2) Property tax share | (3) ln(trade tax rev) | (4) ln(prop tax rev) | (5) ln(tot tax rev) | (6) property tax rate |
|---|---|---|---|---|---|---|
| **Panel A: Foreign MNCs** | | | | | | |
| Tax rate × sharefmnc | 0.009 | 0.012*** | –0.258 | 0.506*** | –0.271** | 0.517*** |
| | (0.084) | (0.002) | (0.166) | (0.083) | (0.112) | (0.066) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 36,410 | 36,450 | 81,022 | 82,205 | 36,467 | 82,485 |
| # Municipalities | 9,200 | 9,191 | 9,246 | 9,241 | 9,202 | 9,241 |
| Mean | 0.299 | 0.021 | 5.945 | 2.902 | 7.469 | 5.763 |
| **Panel B: Domestic MNCs** | | | | | | |
| tax rate × sharedmnc | 0.012 | 0.002 | 0.023 | 0.001 | -0.002 | 0.137*** |
| | (0.032) | (0.001) | (0.062) | (0.011) | (0.072) | (0.015) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 36362 | 36447 | 80939 | 82203 | 36419 | 82485 |
| # Municipalities | 9188 | 9,240 | 9,241 | 9,190 | 9,190 | 9,241 |
| Mean | 0.299 | 0.021 | 5.945 | 2.902 | 7.470 | 5.763 |

Note: the dependent variable in column (1) is the share of trade tax in all tax revenue, in column (2) the share of property tax revenue, in column (3) the logarithm of trade tax revenue, in column (4) the logarithm of property tax revenue, in column (5) the logarithm of total tax revenue, in column (6) the logarithm of property tax rate. The tax rate is the trade tax rate. In Panel A sharefmnc is the share of foreign MNCs in all firms in that municipality. In Panel B sharedmnc is a share of domestic MNCs in all firms in that municipality. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level. In columns (1), (2), and (5) we only have data for total tax revenue at the municipality level for the period 2016–19, which reduces the number of observations. In columns (3), (4), and (6) we have data for trade and property tax revenues for the years 2011–19.

Source: authors' compilation based on data from Orbis and the German Statistical Office.

## Appendix F: Municipal apportionment

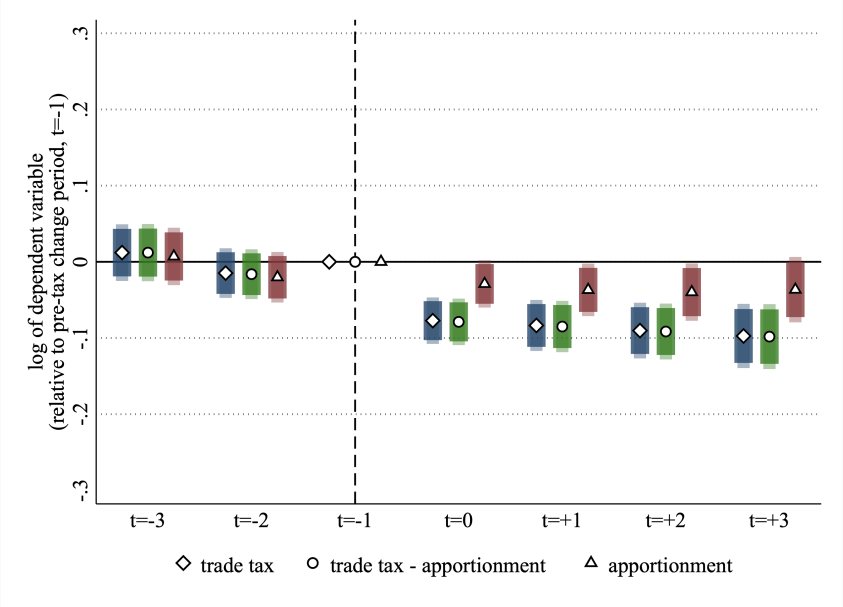
Table F1: Comparison of municipal trade tax revenues

| | (1) Trade tax | (2) Trade tax – appt | (3) Appt | (4) Trade tax | (5) Trade tax – appt | (6) Appt |
|---|---|---|---|---|---|---|
| Tax rate × MNC share | 0.004 | 0.008 | 0.026 | | | |
| | (0.057) | (0.056) | (0.059) | | | |
| Tax rate × agg MNC share | | | | –0.172*** | –0.157** | –0.096 |
| | | | | (0.064) | (0.063) | (0.064) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 80,939 | 80,864 | 79,881 | 80,939 | 80,864 | 79,881 |
| # firms | 9,240 | 9,251 | 9,404 | 9,244 | 9,253 | 9,376 |
| Mean | 5.945 | 2.928 | 7.510 | 5.945 | 7.511 | 7.510 |

Note: the dependent variable in column (1) is the logarithm of total trade tax revenue, in column (2) the logarithm of trade tax revenue minus apportionment, in column (3) the logarithm of apportionment. The tax rate is the trade tax rate. agg MNC share is the share of aggressive MNCs in all firms in that municipality, share MNCs is a share of MNCs in all firms in that municipality. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level.

Source: authors' compilation based on data from Orbis and the German Statistical Office.

Figure F1: Dynamic effects of the tax rate increase on municipal revenue structure: apportionment effects




Note: this figure reports the dynamic effects of the tax rate increase on the logarithm of trade tax, trade tax minus apportionment, and apportionment. All panels include the event study coefficient plots for municipalities with a high share of aggressive MNCs relative to those with a low share and relative to the control group from three years before the tax rate increase to three or more years after the tax rate increase. The high share of aggressive MNCs is defined as above the median. Each dot represents the coefficient estimate using the different difference in difference methodology, the darker shaded box represents the 95 per cent confidence interval, while the lighter shaded box is the 90 per cent confidence interval. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level.

Source: authors' compilation.

## Appendix G: Additional municipal results

Table G1: Descriptive statistics: municipalities

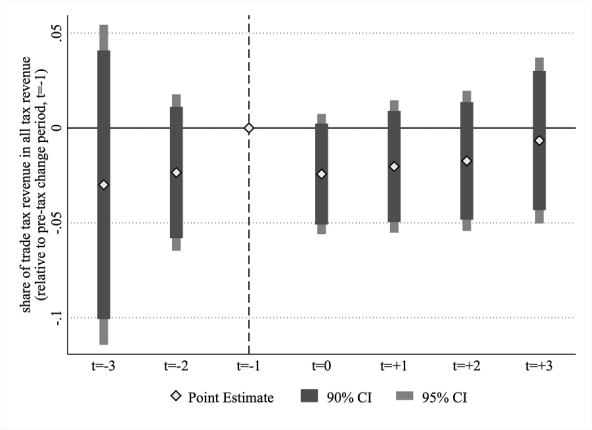
| | (1) High agg share | (2) Low agg share | (3) Diff | *t*-stat |
|---|---|---|---|---|
| Number of firms | 2,411.673 | 107.741 | –2,303.931*** | –29.593 |
| Employment: Orbis | 15,526.447 | 475.229 | –15,051.218*** | –29.550 |
| Total assets: Orbis | 7,698,263.398 | 56,447.687 | –7,641,815.711*** | –15.067 |
| Turnover: Orbis | 5,604,863.125 | 105,245.611 | –5,499,617.513*** | –23.988 |
| Profits: Orbis | 65,605.337 | 1,277.258 | –64,328.080*** | –20.146 |
| Trade tax rate multiplier | 372.453 | 352.932 | –19.521*** | –46.008 |
| Property tax rate multiplier | 319.793 | 321.845 | 2.052*** | 3.389 |
| Population | 72,848.446 | 3,334.138 | –69,514.308*** | –29.363 |
| Share of trade tax in all tax | 0.424 | 0.275 | –0.149*** | –71.053 |
| log(trade tax revenue) | 8.609 | 5.297 | –3.312*** | –199.410 |
| log(property tax revenue) | 3.889 | 2.684 | –1.206*** | –98.300 |
| log(total tax revenue) | 9.741 | 7.028 | –2.713*** | –112.232 |
| log(income share trade tax revenue) | 8.418 | 5.111 | –3.306*** | –199.021 |
| log(apportionmed trade tax revenue) | 6.833 | 3.599 | –3.234*** | –195.971 |
| log(gross expenditures) | 9.985 | 7.569 | –2.416*** | –111.100 |
| log(GDP) | 15.840 | 14.907 | –0.933*** | –23.091 |
| log(debt) | 12.466 | 11.915 | –0.551*** | –8.373 |

Note: we compare characteristics of municipalities across 2008–19. Column (1) shows means for municipalities with a higher share of aggressive MNCs and column (2) shows means for municipalities with a lower share of aggressive MNCs. The high share of aggressive MNCs is defined as above the median across all municipalities in the sample.

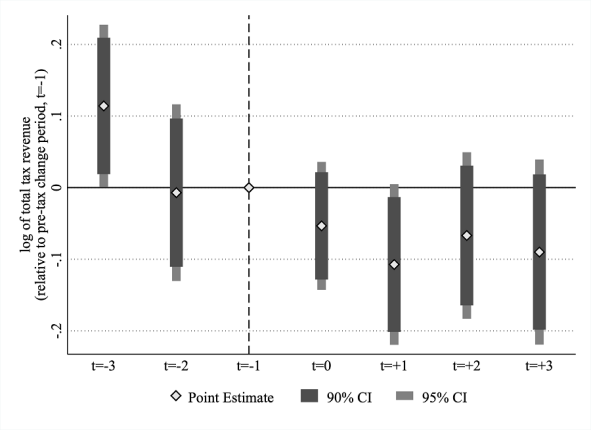
Source: authors' compilation based on data from Orbis and the German Statistical Office.

Figure G1: Dynamic effects of the tax rate increase on municipal revenue structure: placebo

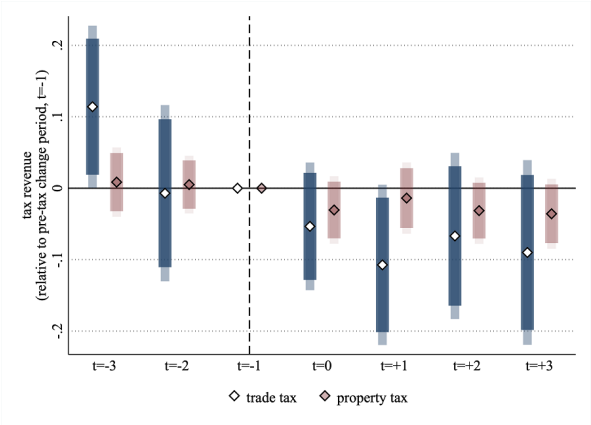
(a) Share of trade tax in total tax




(b) Total tax revenue




(c) Trade tax vs property tax




Note: this figure reports the dynamic effects of the tax rate *decrease* on the share of trade tax in total tax (a) and the logarithm of trade tax and property tax (b). All panels include the event study coefficient plots for municipalities with a high share of aggressive MNCs relative to those with a low share and relative to the control group from three years before the tax rate decrease to three or more years after the tax rate decrease. Each dot represents the coefficient estimate using the different difference in difference methodology, the darker shaded box represents the 95 per cent confidence interval, while the lighter shaded box is the 90 per cnet confidence interval. The high share of aggressive MNCs is defined as above the median. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level. In (a) we only include the period 2016–19, as we only have data for total tax revenue at the municipality level for that period. In (b) we include the full 2011–19 period.

Source: authors' compilation.

Table G2: Robustness of cross-sectional results: share of aggressive MNCs in all MNCs

| | (1) Trade tax share | (2) Property tax share | (3) ln(trade tax rev) | (4) ln(prop tax rev) | (5) ln(tot tax rev) | (6) property tax rate |
|---|---|---|---|---|---|---|
| Tax rate × | –0.001** | 0.000* | –0.001** | –0.000** | –0.001** | 0.002*** |
| agg MNC in MNC share | (0.000) | (0.000) | (0.001) | (0.000) | (0.001) | (0.000) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 10,308 | 10,310 | 23,151 | 23,209 | 10,306 | 23,238 |
| # Municipalities | 2,590 | 2,590 | 2,598 | 2,598 | 2,590 | 2,598 |
| Mean | 0.406 | 0.008 | 8.192 | 3.750 | 9.308 | 5.766 |

Note: the dependent variable in column (1) is the share of trade tax in all tax revenue, in column (2) the share of property tax revenue, in column (3) the logarithm of trade tax revenue, in column (4) the logarithm of property tax revenue, in column (5) the logarithm of total tax revenue, and in column (6) the logarithm of property tax rate. The tax rate is the trade tax rate. agg MNC in MNC share is the share of aggressive MNCs in all MNCs in that municipality. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level. In columns (1), (2), and (5) we only have data for total tax revenue at the municipality level for the period 2016–19, which reduces the number of observations. In columns (3), (4), and (6) we have data for trade and property tax revenues for the years 2011–19.

Source: authors' compilation based on data from Orbis and the German Statistical Office.

Table G3: Difference in difference results: pre- and post-tax rate increase

**Panel A: Aggressive MNCs**

| | (1) Trade tax share | (2) Property tax share | (3) ln(trade tax rev) | (4) ln(prop tax rev) | (5) ln(tot tax rev) | (6) Property tax rate |
|---|---|---|---|---|---|---|
| agg MNC share × post=1 | –0.499 | 0.122 | –7.091*** | 0.393 | 0.456 | 0.728 |
| | (2.461) | (0.076) | (2.700) | (0.734) | (4.533) | (0.588) |

**Panel B: All MNCs**

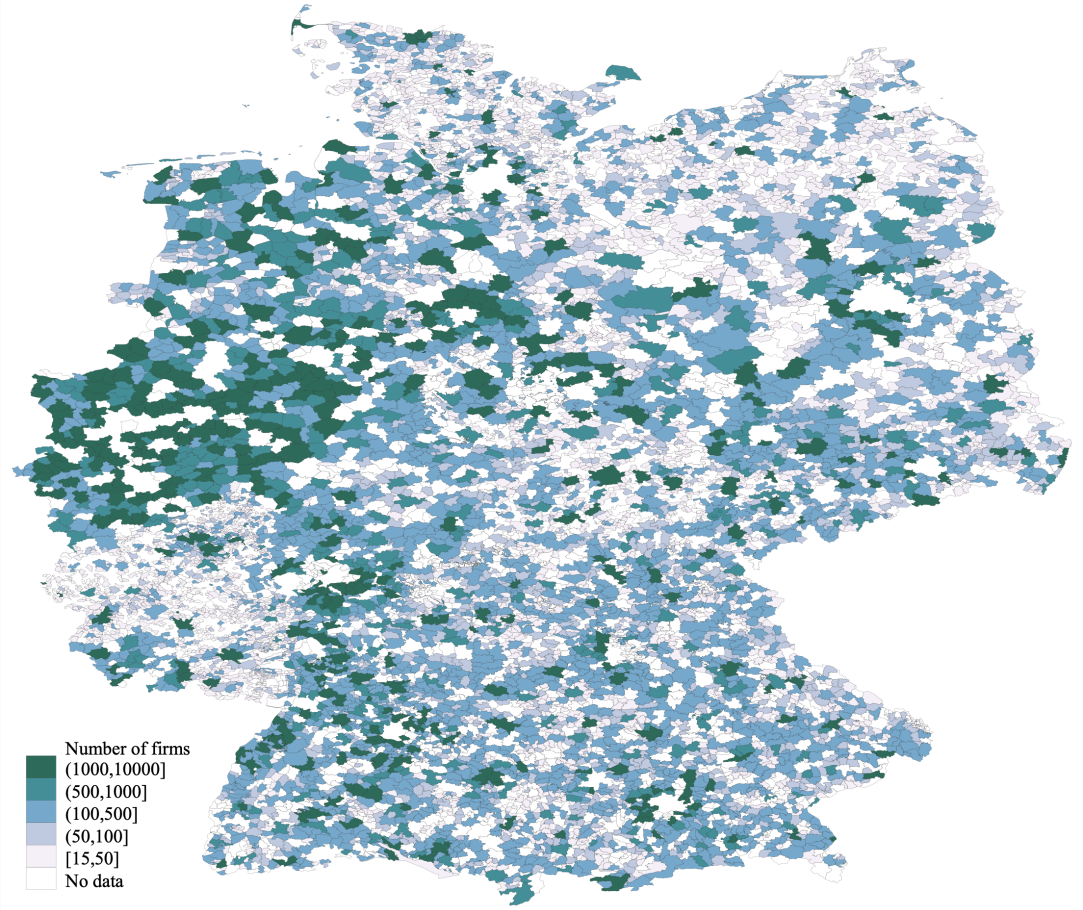
| | (1) trade tax share | (2) property tax share | (3) ln(trade tax rev) | (4) ln(prop tax rev) | (5) ln(tot tax rev) | (6) property tax rate |
|---|---|---|---|---|---|---|
| MNC share × post=1 | –0.178 | 0.109*** | 0.440 | 0.139 | –0.657 | 0.888*** |
| | (0.653) | (0.026) | (1.826) | (0.371) | (1.298) | (0.269) |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Municipality FEs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 19,195 | 19,242 | 41,884 | 42,608 | 19,226 | 48,627 |
| # firms | 5,674 | 8,896 | 5,965 | 5,888 | 8,897 | 5870 |
| Mean | 0.290 | 0.022 | 5.733 | 2.742 | 7.260 | 5.731 |

Note: the dependent variable in column (1) is the share of trade tax in all tax revenue, in column (2) the share of property tax revenue, in column (3) the logarithm of trade tax revenue, in column (4) the logarithm of property tax revenue, in column (5) the logarithm of total tax revenue, and in column (6) the logarithm of property tax rate. MNCs share is a share of MNCs in all firms in that municipality, agg MNC share is the share of aggressive MNCs in all firms in that municipality. In each specification we include year and municipality fixed effects. Controls include trade tax rate, property tax rate, municipal population, and the number of firms in each municipality. Standard errors are clustered at the municipality level. In columns (1), (2), and (5) we only have data for total tax revenue at the municipality level for the period 2016–19, which reduces the number of observations. In columns (3), (4), and (6) we have data for trade and property tax revenues for the years 2011–19.

Source: authors' compilation based on data from Orbis and the German Statistical Office.

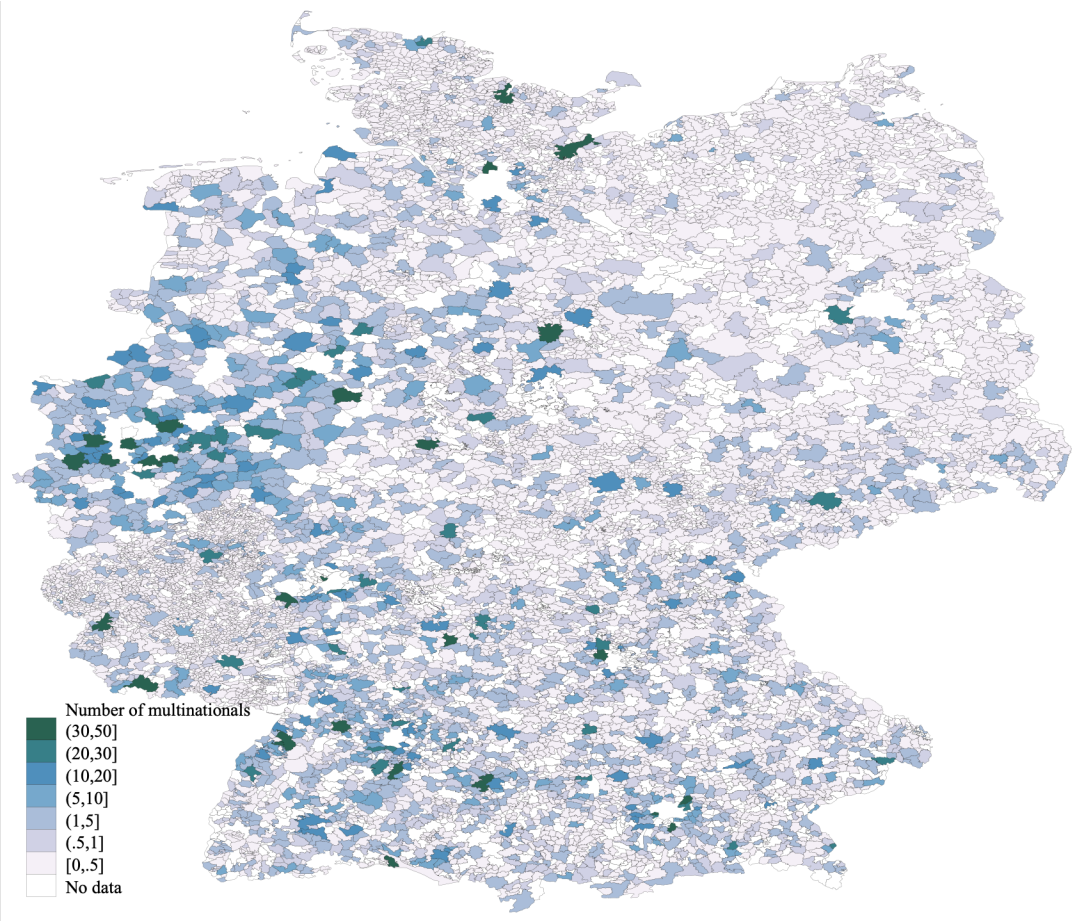
## Appendix H: Maps

Figure H1: Number of firms across municipalities




Note: this map outlines all German municipalities and the number of firms in each from Orbis.
Source: authors' compilation based on data from Orbis and the German Statistical Office.

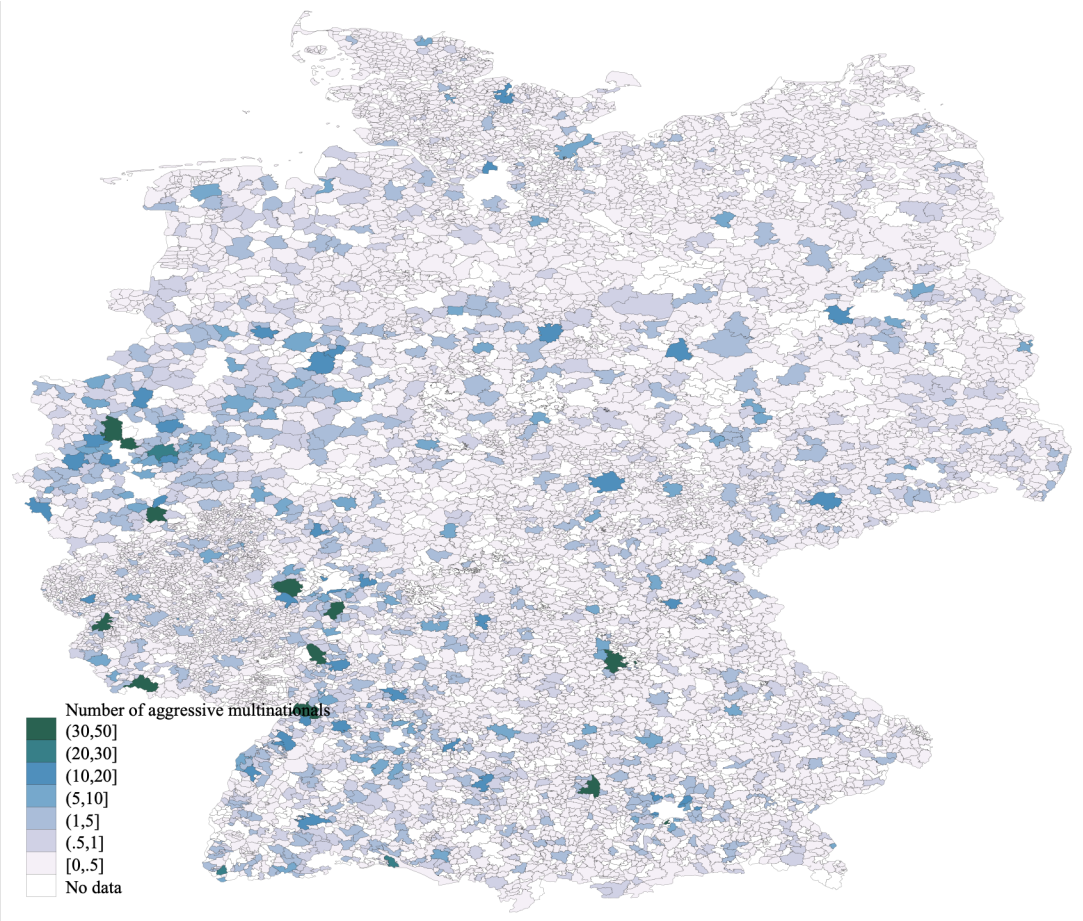
Figure H2: Number of multinationals across municipalities




Note: this map outlines all German municipalities and the number of multinationals in each from Orbis.

Source: authors' compilation based on data from Orbis and the German Statistical Office.

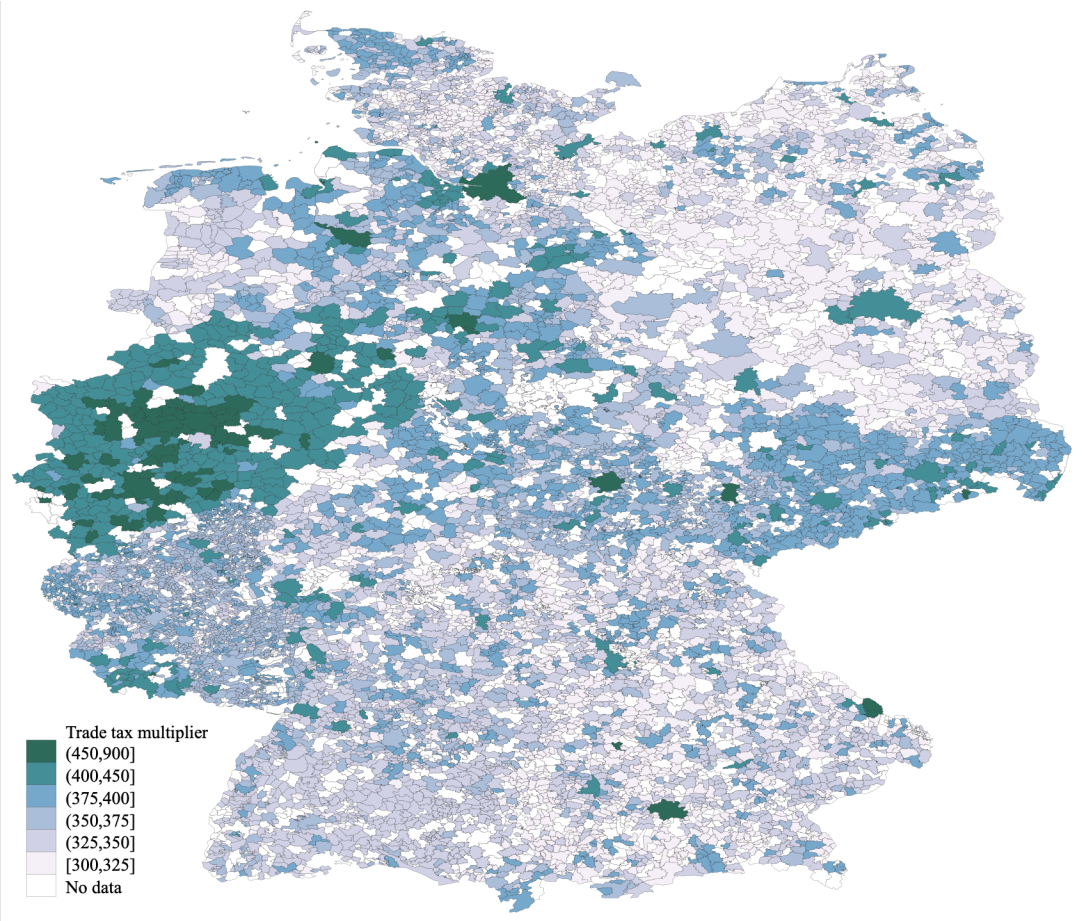
Figure H3: Number of aggressive multinationals across municipalities




Note: this map outlines all German municipalities and the number of aggressive multinationals in each from Orbis. An aggressive multinational subsidiary is defined as a subsidiary belonging to a firm that owns a tax haven subsidiary as well.

Source: authors' compilation based on data from Orbis and the German Statistical Office.

Figure H4: Trade tax multipliers




Note: this map outlines all German municipalities and the trade tax multipliers variation across municipalities.

Source: authors' compilation based on data from the German Statistical Office