Corporate profit shifting and the role of tax havens: Evidence from German country-by-country reporting data

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Abstract

This paper is the first to use information from individual country-by-country (CbC) reports to assess the extent of profit shifting by multinational enterprises (MNEs). Unlike other data often used to evaluate the extent of profit shifting and tax avoidance, CbC reports provide a complete coverage of the global distribution of profits and production factors for MNEs that exceed a certain revenue threshold. Using information from CbC reports filed by German MNEs, we find that subsidiaries located in tax havens are notably more profitable than subsidiaries in non-havens. However, only 9 percent of German MNEs' profits are reported in tax havens. Results from regression analyses suggest that about 40 percent of the profits reported in tax havens are a result of tax-induced profit shifting. The associated annual loss in tax revenues for Germany amounts to roughly EUR 1.6 billion. Adding estimates of profit shifting by firms not covered by the CbC data leads to an overall estimate for the German tax revenue loss due to corporate profit shifting to tax havens of EUR 5.7 billion per year.

Keywords: Corporate taxation, tax avoidance, profit shifting, multinational enterprises, country-by-country reporting

JEL: F23, H25, H26

1. Introduction

Tax avoidance and profit shifting activities by multinational enterprises (MNEs) frequently lead to heated public debates. The view is widespread that MNEs shift a large part of their profits to low-tax countries or 'tax havens' and therefore do not pay their fair share in high-tax countries where they produce and sell most of their products. There is a growing body of academic research supporting this view by showing that activities of MNEs in low-tax countries are much more profitable than their activities in high-tax countries or than those of local firms. However, empirical work on international corporate tax avoidance faces severe data limitations, mostly due to missing information about MNEs' activities in tax havens.

This paper investigates profit shifting using new data which comes from country-by-country (CbC) reports filed by German MNEs. These reports provide a complete coverage of the global distribution of profits, sales, and factors of production of large German MNEs. CbC reporting has been introduced in the context of the OECD/G20 Base Erosion and Profit Shifting (BEPS) project. It is mandatory for MNEs with consolidated revenues of at least EUR 750 million and whose headquarters are located in one of the 90 member countries of the Inclusive Framework on BEPS that introduced a corresponding filing obligation into national legislation (see Section 2 for details). In Germany, a CbC reporting obligation was introduced in 2016.

The main results of our analysis are as follows. First, activities of German MNEs in countries classified as tax havens are much more profitable than in non-haven countries. The share of profits reported in tax havens is not very high though – just 9 percent of global profits. At the same time, only 4 percent of German MNEs' tangible assets and 3 percent of their employees are located in tax havens. Of the tax haven profits, 87 percent are reported in European tax havens like Switzerland, Ireland, and the Netherlands. Tax havens outside of Europe such as Bermuda or the British Virgin Islands only play a minor role. Second, we estimate that tax-induced profit shifting of large German MNEs increases the profits they report in tax havens by EUR 9 billion per year. This is equal to roughly 3 percent of their worldwide profits and less than the amount of profit shifting found in other recent studies. For instance, Zucman (2014) estimates that U.S. MNEs shift almost 20 percent of their profits to tax havens; Tørsløv et al. (2018) estimate that globally, 40 percent of the profits MNEs report outside their residence country are shifted to tax havens. Third, findings from regression analyses show that the profits as well as the intra-firm revenues large German MNEs report in a

country are sensitive to effective average tax rates. In our baseline specification, we obtain a semi-elasticity of profits with respect to differences in the effective average tax rate of −0.5 and a tax semi-elasticity of intra-firm revenues of −1.3. In contrast, differences in standard ('headline') statutory tax rates do not seem to matter. We attribute this finding to the fact that nowadays, tax competition between countries mainly takes place through instruments other than statutory tax rates, such as R&D tax subsidies, patent boxes, and tax exemptions. As a result, statutory tax rates are only an imperfect measure of the actual tax burden. Moreover, our regression results confirm that profit shifting by large German MNEs mainly takes place through tax havens, whereby European tax havens are much more important for German MNEs than tax havens outside of Europe. Fourth, we find that German MNEs shift more profits to tax havens the larger they are in terms of consolidated revenues. Fifth, we demonstrate that using Orbis data in profit shifting regressions leads to biased estimates, as they contain a systematic measurement error.

This paper contributes to a growing body of research on tax avoidance by MNEs. The extent of tax avoidance by MNEs is typically assessed based on estimates of the tax-sensitivity of pre-tax profits. In a recent survey of the literature, Beer et al. (2020) review 37 studies that empirically evaluate the tax elasticity of MNE profits. These studies can be broadly divided into two groups. The first group uses micro data to assess the extent of tax avoidance and profit shifting at the firm level. The second group relies on macro data, that is data aggregated at the country level. However, studies in both groups suffer from certain drawbacks.

Firm-level studies often rely on data from the Orbis or Amadeus database, provided by Bureau van Dijk and collected from public business registries. The problem with this data is that information about the activities of MNEs in many countries, in particular tax havens, is missing. A series of recent leaks as well as national accounts data suggests that MNEs book a significant share of their profits in tax havens (Zucman, 2014; Torslov et al., 2018). Estimates of the total extent of profit shifting and tax avoidance by MNEs based on business registry data are thus likely biased downward. To the best of our knowledge, micro evidence using data with complete coverage of MNEs' residence countries is restricted to U.S. MNEs (Dowd et al., 2017). Macroeconometric analyses, on the other hand, have been criticized for failing to control for MNEs' scale

of real economic activity, potentially resulting in biased estimates of the tax-sensitivity of corporate profits and an overstatement of the extent of profit shifting (Beer et al., 2020; Dharmapala, 2014; Heckemeyer and Overesch, 2017).

The CbC data we use avoids these problems. To the best of our knowledge the only country that has made information from CbC reports publicly available is the U.S. (Garcia-Bernardo et al., 2019). However, the U.S. does not publish the information at the MNE level. Instead, the information is aggregated across all U.S. MNEs obliged to file a CbC report at the level of the countries in which these MNEs have affiliates. Studies using this data thus suffer from similar problems as other macro approaches. Our data, in contrast, covers information from individual CbC reports, allowing us to assess the extent of profit shifting at the MNE level while controlling for real economic activity.

The new data at our disposal allows us to make several contributions to the existing literature. First, the full coverage of large German MNEs' global activities enables us to provide a complete picture of the global distribution of their profits – including profits reported in tax havens – and to compare it to the global distribution of (tangible) assets, employment, and sales. Studies relying on Orbis or Amadeus data are not able to do so. Second, the completeness of the CbC data also allows us to provide a more credible estimate of the tax-sensitivity of corporate profits and the total amount of profits shifted to tax havens. Third, the CbC reports contain information about revenues generated through transactions with other affiliates of the same MNE group, allowing us to assess whether the location of subsidiaries that mainly provide inputs and services for associated firms is sensitive to the level of taxation. Intra-company trade, loans, and the strategic location of intellectual property (IP) are considered particularly important channels through which MNEs shift profits to low-tax jurisdictions (e.g., Buettner and Wamser, 2013; Dischinger and Riedel, 2011; Fuest et al., 2011; Griffith et al., 2014). Since the revenues from intra-firm transactions reported in the CbC reports include royalties, interest payments, and premiums, we are able to assess the relevance of these channels.

The rest of the paper is organized as follows. Section 2 describes the CbC data and our sample of German MNEs. In Section 3, we investigate the global distribution of German MNEs' profits and factors of production. In addition, we analyze the profitability of German MNEs across tax havens and non-haven countries. Section 4 compares the CbC data to data from Bureau van Dijk's Orbis database. We introduce our regression

model and show the results of our profit shifting regressions based on CbC data in Section 5. Section 6 presents estimates of the total amount of profits shifted to tax havens and the associated loss in corporate tax revenue. In Section 7, we re-estimate our regression model based on Orbis data. Section 8 concludes.

2. CbC Data and Sample

The data that we use for our analysis are taken from CbC reports filed by German MNEs. CbC reporting was initiated by the OECD and G20 in the context of the BEPS project. The CbC reports collect information on the global activities of MNEs. They are prepared by the MNE and submitted to the tax authority of the country where the MNE's headquarters are based. An MNE is legally obliged to submit a CbC report in case its consolidated global group revenue exceeds a threshold of EUR 750 million (or an equivalent amount in a different currency), and if the country where its headquarters are based takes part in the OECD/G20 Inclusive Framework on BEPS, provided that the country has introduced a corresponding reporting obligation into national legislation.[1] In general, membership in the Inclusive Framework on BEPS is open to all interested countries. However, membership requires commitment to certain minimum standards, the introduction of CbC reporting being one of them. As of December 2019, 137 countries have joined the Inclusive Framework on BEPS, 90 of which already introduced a CbC reporting obligation into national legislation.[2] In Germany, a CbC reporting obligation was introduced in 2016. The tax authority of the MNE's headquarters country shares the CbC report with the tax authorities of other Inclusive Framework members in which subsidiaries of that MNE are located. However, the reports are not made public. The goal of the CbC reporting obligation is to "[…] provide tax administrations with a high level overview of the operations and tax risk profile of the largest multinational enterprise groups" (OECD, 2017: 11), allowing tax authorities to use their auditing capacities more efficiently.[3]

The CbC reports contain basic financial information about the global activities of an MNE. More precisely, they include the following information:

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[1] Note that a country can also require constituent entities of an MNE that are resident in that country for tax purposes to file a CbC report if the MNE is not obliged to do so in the country where its headquarters are based and its consolidated group revenues exceed EUR 750 million.

[2] A regularly updated list of Inclusive Framework member countries can be found here: https://www.oecd.org/tax/beps/beps-actions/action13/ (last accessed on 12 September 2020).

[3] Hugger (2020) provides more details on CbC reporting.

- Profit/loss before taxation
- Taxes paid
- Taxes accrued (year of reporting)
- Stated capital
- Accumulated earnings
- Number of employees (full-time equivalents)
- Net book value of tangible assets
- Revenues generated from transactions with independent parties (revenues unrelated), including revenues from sales of inventory and properties, services, royalties, interest, and premiums
- Revenues generated from transactions with associated enterprises (revenues related), including revenues from sales of inventory and properties, services, royalties, interest, and premiums
- Total revenues (revenues unrelated plus revenues related)

Note that the information provided in the CbC reports is aggregated at the level of the tax jurisdiction. The CbC reports do not contain information at the subsidiary level. However, the information we use refers to the activities of individual MNEs. Hence, our analysis is based on a different level of aggregation than (most) existing micro and macro-analyses. Micro-analyses typically use information at the subsidiary level and, thus, more disaggregated data than we do. Exceptions are the studies by Dowd et al. (2017) and Huizinga and Leuven (2008), who use data at the same level of aggregation. Macro-analyses (including those that use U.S. CbC data, like Garcia-Bernardo et al., 2019) typically use data that are aggregated by tax jurisdiction, which implies a higher level of aggregation.

Our data set covers the information from the CbC reports filed by German MNEs for the years 2016 and 2017. The original data covers 386 German MNEs. However, we exclude some companies from our sample for different reasons. First, we exclude all non-corporate and public MNEs since they are subject to different tax regulations than corporate MNEs in Germany. Profits of corporate enterprises are subject to the corporate income tax plus the local business tax, the latter being levied by the municipalities. Non-corporate enterprises have to pay the local business tax as well, but are not subject to the corporate income tax. Instead, their income is taxed at the level of the

owner and, therefore, subject to the personal income tax.[4] Second, we exclude corporate groups that reported information for the financial years 2015 or 2018 instead of 2016 and/or 2017. Our final sample comprises 333 corporate MNEs. By definition, these companies all exceed the revenue threshold of EUR 750 million. Table B1 provides summary statistics for the CbC sample.

3.   Where do German MNEs report their profits?

To get a first impression of the role tax havens play for the global activities of German MNEs, we compute two common profitability measures – the ratio of profits to tangible assets and the ratio of profits to the number of employees – separately for three country groups: (i) countries not considered tax havens (including Germany), (ii) European tax havens, and (iii) tax-havens located outside of Europe.[5] Note that there is disagreement in the extant literature concerning the countries which qualify as tax havens. Menkhoff and Miethe (2019) provide a summary of the classifications used in six different publications. For our analysis, we decided to include only those countries to our list of tax havens which are labelled accordingly in all of the six publications reviewed by Menkhoff and Miethe (2019).[6] We believe that this procedure yields the least arbitrary classification. The profitability measures are computed by dividing the sum of positive profits reported by all subsidiaries of German MNEs in each of these country groups by the value of tangible assets and the number of employees, respectively.

The results are illustrated in Figures 1 and 2. Subsidiaries located in European tax havens are much more profitable than subsidiaries located in non-havens. In European tax havens, the return to tangible assets is roughly 39 percent, which is more than two times larger than the value for subsidiaries located in non-havens (Figure 1). Profits per employee reported in European tax havens are even three time larger than in non-havens (Figure 2). In tax havens outside of Europe, the return to tangible assets is

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[4] The corporate income tax rate in Germany is 15 percent. The local business tax varies across municipalities, with an average of also 15 percent, so that the overall statutory tax rate on corporate profits is, on average, equal to 30 percent. The personal income tax is characterized by a progressive tax schedule, with an initial tax rate of 14 percent and a maximum tax rate of 45 percent.

[5] The numbers for non-havens also include the information of the parent companies located in Germany.

[6] We make one exception: We follow a current classification of the IMF (2019) and include Ireland to our list of European tax havens, since the IMF (2019) stresses Ireland's importance for the profit shifting and tax planning activities of MNEs. Moreover, the 'double Irish with a Dutch sandwich' has gained substantial prominence as a major profit shifting tool. Table A1 of Appendix A provides the corresponding lists of European and non-European tax havens.

about 170 percent higher than in non-havens and profits per employee are 80 percent higher. These findings indicate that there is a notable imbalance between the global distribution of profits and the global distribution of factors of production.

Figure 1: Return to tangible assets
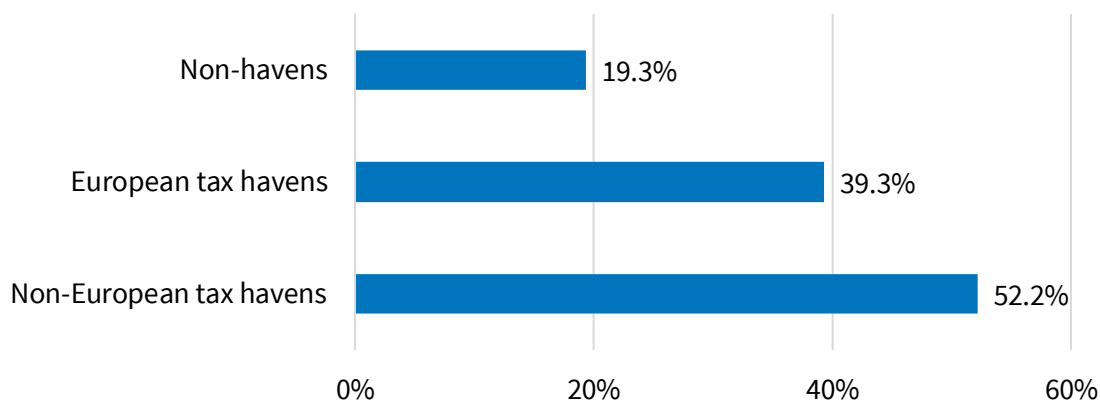
Figure 2: Profits per employee (in million EUR)
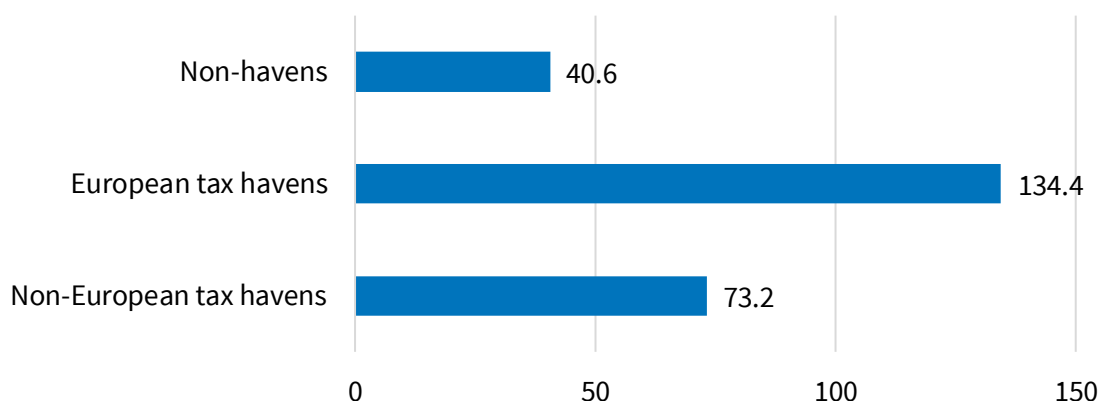
Figure 3 gives a first indication that differences in the taxation of corporate profits may play a role in explaining the cross-country differences in profitability. The figure shows the effective average tax rates across the three country groups, calculated by dividing the sum of taxes paid by German MNEs in the respective countries by the sum of their profits.[7] In 2016 and 2017, the effective average tax rate of German MNEs in non-haven

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[7] Note that we only use MNE-country observations with positive profits and tax payments when computing the effective average tax rates.

countries was roughly 21 percent. In both European and non-European tax havens, the effective average tax rate was only about half that size.

Figure 3: Effective average tax rates (taxes over profits)
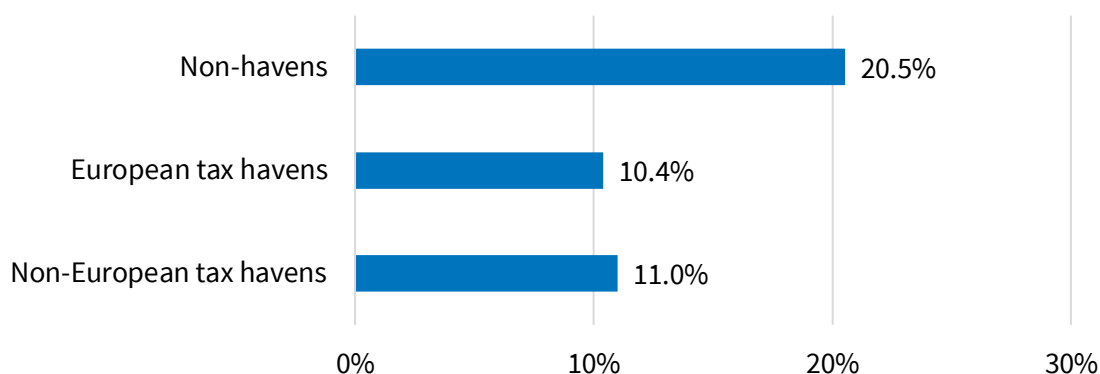
In a summary of the literature, Heckemeyer and Overesch (2017) identify three main channels through which MNEs may shift profits to low-tax jurisdictions. The first one is the transfer price channel. MNEs can locate subsidiaries that provide inputs for affiliate companies in low-tax jurisdictions, which then charge high transfer prices for these inputs. The second channel is the interest rate channel. Subsidiaries in low-tax jurisdictions can extend loans to affiliates located in high-tax jurisdictions and receive interest payments in return. Third, MNEs can strategically locate intangible assets such as patents, licenses, or trademarks in low-tax jurisdictions. Affiliates located in high-tax jurisdictions then pay fees or royalties for using these intangibles. The use of any one of these channels implies that subsidiaries located in low-tax jurisdictions generate revenues through intra-firm transactions. Figure 4 shows the share of intra-firm revenues in total revenues for the three country groups. The figure suggests that subsidiaries of German MNEs located in European and – even more so – non-European tax havens are indeed particularly important for the provision of inputs and services for affiliated firms. Subsidiaries located in non-European tax havens (European tax havens) generate roughly 42 percent (36 percent) of their revenues through transactions with affiliated firms. For subsidiaries in non-havens, the share of intra-firm revenues is almost 11 percentage points (5 percentage points) lower. Against the background of the higher profitability in tax havens, this finding may be interpreted as a first indication of a strategic location of inputs by German MNEs with the aim of shifting profits

to low-tax jurisdictions. Moreover, the fact that the share of intra-firm revenues is particularly high in non-European tax havens is also in line with the conjecture that those countries are an important location for financial service companies.

Figure 4: Revenues related over total revenues
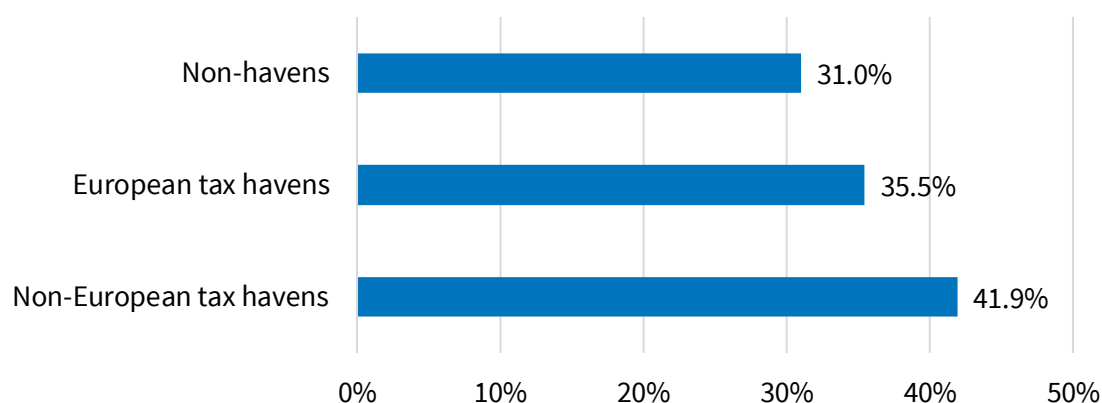
The evidence presented so far suggests that German MNEs indeed shift profits to reduce their tax burden. But how important are tax havens altogether? Put differently, how large is the profit share German MNEs report in tax haven countries? Panel (a) of Figure 5 provides the answer. In 2016 and 2017, just 9 percent of German MNEs' global profits were booked in tax havens, while 91 percent were booked in non-havens. Considering that the political and public debate on profit shifting and tax avoidance by MNEs mainly focuses on the role of tax havens, this finding may come as a surprise. Another interesting insight Panel (a) of Figure 5 offers is that European tax havens appear to be far more important for German MNEs than tax havens outside of Europe. About 87 percent of all tax-haven profits are booked in European tax havens, and only 13 percent in non-European tax havens.

As the profitability measures already indicated, the share of tangible assets and employees located in tax havens is disproportionately low compared to profits. Just 4 percent of German MNEs' assets (Panel (b) of Figure 5) and 3 percent of employees (Panel (c) of Figure 5) are located in tax havens. Again, the shares for European tax havens are much larger than those for non-European tax havens.

Figure 5: Global distribution of German MNEs' profits, assets, and employees (2016 and 2017)

	(a) Profits	(b) Assets	(c) Employees

7.6% 1.1%   3.9% 0.4%   2.4% 0.6%

91.3%   95.7%   96.9%

■ Non-havens   ■ European tax havens   ■ Non-European tax havens
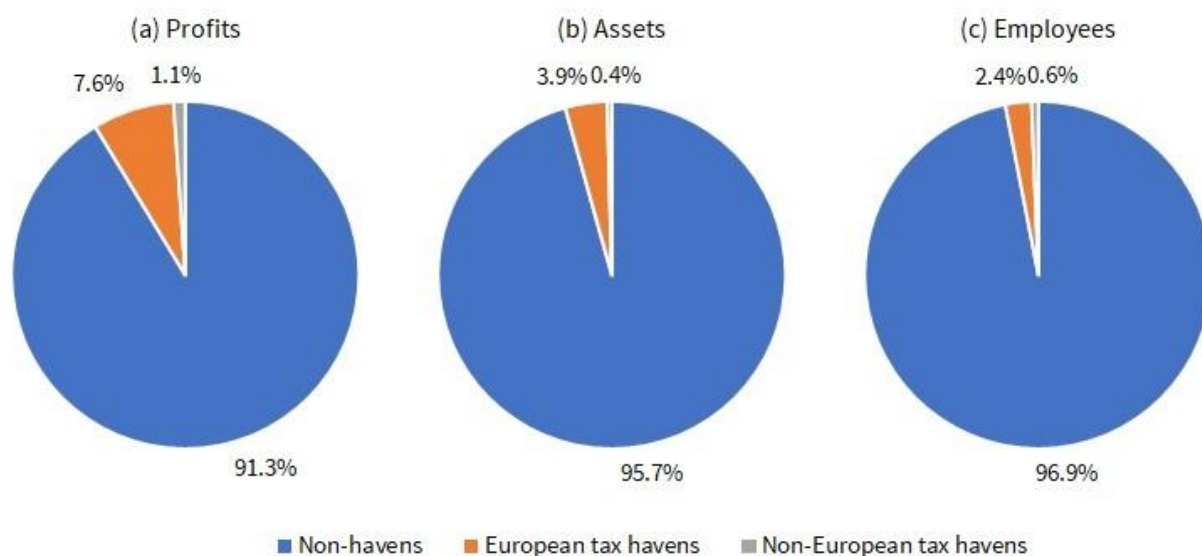
4.   Comparing CbC to Orbis data

A large fraction of the existing literature on corporate tax avoidance and profit shift-
ing, including studies by the OECD (Johansson et al., 2017), uses data from Bureau van
Dijk's Orbis database for their analyses. It is thus instructive to compare it to the CbC
data. Figure 6 compares the number of subsidiaries of German MNEs included inCbC
and Orbis data as well as the information about the subsidiaries' global (unconsoli-
dated) profits, tangible assets, and employment.[8] We again compare the information
for three groups of countries: non-tax havens, European tax havens, and non-Euro-
pean tax havens. The figures represent the ratio of the variables' realizations in the
Orbis data to their realizations in the CbC data. Assuming that the information about
German MNEs' global activities provided in the CbC data is complete (and we have no
reason to doubt that), the figures shed light on the coverage of the Orbis data base.

Figure 6: Coverage of CbC data by Orbis

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[8] Summary statistics for the Orbis sample are provided in Table B2.

100%
80%
60%
48%
42%
40%
35%
37%
26%
20%
17%
14%
4%
0%
0%
0%
0%

Subsidiaries   Profits   Assets   Employment

■ Non-havens   ■ European tax havens   ■ Non-European tax havens
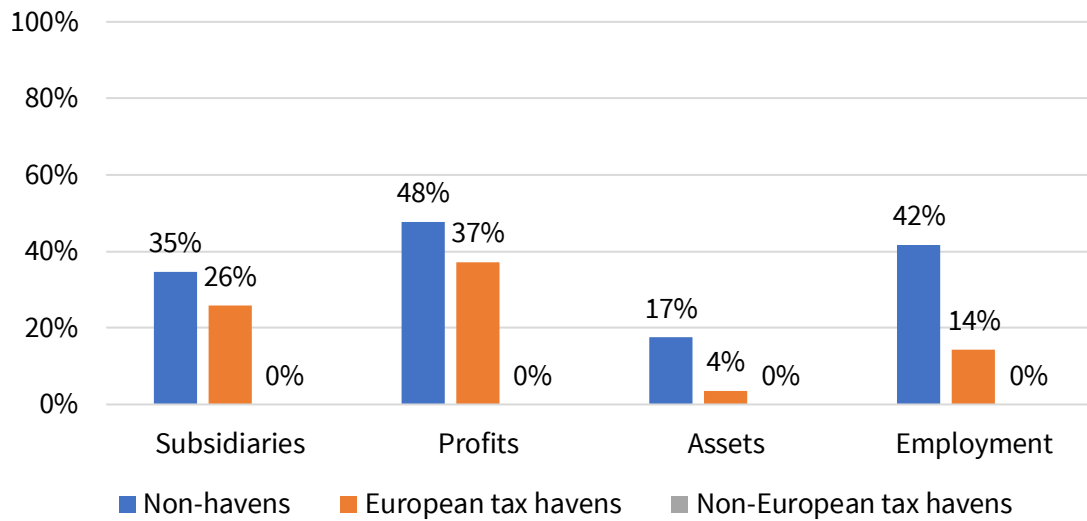
Figure 6 indicates that the coverage of the Orbis data must be considered poor, especially in tax havens. Orbis only covers 35 percent of German MNEs' subsidiaries located in non-tax havens. The non-haven subsidiaries covered by Orbis account for roughly half (48 percent) of the profits all subsidiaries of German MNEs make in these countries. The coverage of employment (42 percent) and assets (17 percent) in non-tax havens is even lower. In European tax havens, only 26 percent of the subsidiaries of German MNEs and 37 percent of the profits are accounted for in Orbis. Information about the activities in Cyprus, Liechtenstein, Malta, and Switzerland, which are all included in the list of European tax havens, are completely missing. What is more, Orbis does not cover any activities of the German MNEs included in our sample in tax havens outside of Europe.

There are several reasons for the incomplete coverage of the Orbis data. First, some countries are not covered by Orbis since they do not keep business registries or do not publish the information therein. This is true for a large number of tax haven countries. Second, in some countries, the obligation to report financial information is limited to certain firm types. For example, it is quite common that reporting obligations only apply to large firms or firms of certain legal forms (cf. Kalemli-Ozcan et al., 2015). Third, some countries, although covered by Orbis as they keep public business registries, do either not require firms to report their profits, value of assets, and/or number of employees, or do not publish this particular information, which is why the corresponding information is missing in Orbis. Fourth, the information about ownership structures and, hence, the list of subsidiaries in Orbis is incomplete.

Table C1 of the Appendix documents the coverage at the country level. According to the CbC reports, the 333 German MNEs included in our sample have subsidiaries in 193 countries. The Orbis data only covers subsidiaries in 46 of these countries. I.e., Orbis lacks information for more than three quarters of the countries in which German MNEs have subsidiaries. What is more, in 21 of these 46 countries, less than half of the profits made by German MNEs are accounted for in Orbis. In contrast, the coverage of profits by Orbis is above 80 percent in only nine countries. Interestingly, there are four countries in our data set for which the ratio of profits reported in Orbis to profits reported in the CbC data exceeds 100 percent. One potential explanation for this is the different treatment of profits made by legally dependent permanent establishments (PEs) between Orbis and CbC data. In Orbis, profits made by a legally dependent PE are reported at the level of its direct parent company. Hence, if the direct parent is located in country A, but the PE is located in country B, the profit of the PE is reported in A. In the CbC data, in contrast, the profit of a PE is reported in the country it is situated in, irrespective of the location of its direct parent company. Note that the treatment of profits made by foreign PEs constitutes another important advantage of the CbC data over Orbis. When estimating the extent of tax avoidance and profit shifting, researchers are interested in where profits are actually booked, and not where they are reported due to accounting conventions.

The incomplete coverage of the Orbis data is also documented by Tørsløv et al. (2018). The authors compare the consolidated global profits of MNEs covered by Orbis to the sum of unconsolidated profits reported by those MNEs' subsidiaries. They find that on average, only 17 percent of MNEs' global profits can be traced in unconsolidated Orbis information.

5.   Profit shifting regressions based on CbC data

5.1 Empirical approach

The imbalance between the global distribution of profits and the distribution of the factors of production gives a first indication that German MNEs shift profits to low-tax jurisdictions (Section 3). Ultimately, though, the numbers presented above are only simple bivariate correlations. In this section, we use multivariate regressions to analyze the relationship between the global distribution of profits and corporate taxes in more detail.

We follow the extant empirical literature on corporate profit shifting and estimate a modified version of the empirical model proposed by Hines and Rice (1994). Our baseline specification looks as follows:

$$(1)\ y_{ict} = \alpha_i + \beta\tau_{ct} + \gamma' Firm_{ict} + \delta' Country_{ct} + \theta_t + \varepsilon_{ict}$$

Index i refers to the corporate group, c to the residence country of the group's affiliates, and t to the year.[9] We employ two different dependent variables in our analysis: (i) the log of the sum of profits of group i's affiliates located in country c and (ii) the log of intra-firm revenues generated by group i's affiliates in country c. Note that the latter variable includes royalty and interest payments. An inverse relationship between this variable and the level of taxation in a country would thus provide (suggestive) evidence that the strategic location of inputs and services (including IP and financial services/intra-company loans) is an important instrument of profit shifting.[10] The vector $Firm$ includes three variables that depict group i's activities in country c and year t. These variables are the number of employees, the value of tangible assets, and the revenues group i's affiliates in country c generate from sales to third parties (revenues unrelated). Arguably, the latter variable captures the importance of country c as a market country for the group. The vector $Country$ includes the log of PPP adjusted GDP per capita, log population (both taken from the Penn World Table 9.1; cf. Feenstra et al., 2015), as well as Amnesty International's Corruption Perception Index. α_i is a corporate group fixed effect, θ_t is a year fixed effect. Standard errors are clustered at the corporate group level.[11]

The variable of main interest is the tax variable τ. In our empirical analysis, we use two different tax variables: (i) the statutory tax rate of country c and (ii) the effective average tax rate. Existing studies either use the statutory tax rate (e.g., Huizinga and Laeven, 2008; Dischinger and Riedel, 2011) or effective average tax rates (e.g., Clausing, 2016), but rarely both (an exception is Dowd et al., 2017). Statutory tax rates

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[9] In some cases, the financial year does not correspond to the calendar year. In those cases, we assign the financial information to year t if the financial year ended before or on 30 June of the following year, and to year $t + 1$ if the financial year ended after 30 June.

[10] Admittedly, this variable is only an imperfect indicator for the strategic location of IP and debt. Unfortunately, though, CbC reports do not contain separate information about royalty and interest payments.

[11] Note that we do not include country fixed effects to our specification since there is virtually no variation in our tax variables and controls across the two sample years. However, even studies that cover longer time spans rarely control for country fixed effects.

are taken from KPMG's Corporate Tax Surveys and EY's Annual Worldwide Corporate Tax Guides. Effective average tax rates are computed by dividing the sum of taxes MNEs in our sample pay in country c by the sum of profits they report in this country. To circumvent endogeneity problems, we follow Dowd et al. (2017) and compute the effective average tax rate for group i in country c only based on the information about taxes paid and profits made by other MNEs in that country. Also, we compute effective average tax rates only for countries in which at least ten of the MNEs in our sample have affiliates. Due to that, our sample size is slightly smaller when using effective average tax rates instead of statutory tax rates. Note that since all MNEs in our sample have their headquarters in Germany, using the level of the tax rate in country c as an explanatory variable is equivalent to using the difference between the tax rate in country c and the tax rate in an MNE's base country.

To glean further insights, we modify our baseline specification in several ways. In a first modification, we follow Dowd et al. (2017) and add the squared realization of the tax variable to our baseline specification. This allows us to test whether the tax-sensitivity of profits and revenues varies across high and low-tax jurisdictions. The resulting regression equation is:

$$(2)\ y_{ict} = \dot{\alpha}_i + \dot{\beta}_1 \tau_{ct} + \dot{\beta}_2 \tau_{ct}^2 + \dot{\gamma}' Firm_{ict} + \dot{\delta}' Country_{ct} + \dot{\theta}_t + \dot{\varepsilon}_{ict}$$

In a second modification, we add two dummy variables to our baseline specification. The first dummy variable takes on the value of 1 if country c is a European tax haven, the second dummy takes on the value of 1 if country c is a tax haven outside of Europe. The resulting regression equation is:

$$(3)\ y_{ict} = \tilde{\alpha}_i + \tilde{\beta}_1 \tau_{ct} + \tilde{\beta}_2 Haven_c^{Europe} + \tilde{\beta}_3 Haven_c^{\overline{Europe}} + \tilde{\gamma}' Firm_{ict} + \tilde{\delta}' Country_{ct} + \tilde{\theta}_t + \tilde{\varepsilon}_{ict}$$

In a final set of modifications, we test whether the tax-sensitivity of profits and intra-firm revenues varies across MNEs by re-estimating Equation (3) for different subsamples. First, we create subsamples based on information about the importance of intangible assets. To this end, we compute the ratio of the value of intangible assets to total assets and split our sample in four subsamples based on the quartiles of that ratio. The information about the value of intangible assets comes from Orbis since it

is not included in the CbC reports.[12] Second, we test whether the tax-sensitivities vary with the size of the corporate group by creating four subsamples based on the quartiles of total consolidated revenues.

As a robustness test, we replace the tax variable τ with the absolute difference between the tax rate in country c and the weighted average of the tax rates of all other countries in which the corporate group has affiliates. Following Huizinga and Laeven (2008), we use the revenues generated by the corporate group's affiliates in a country as weights in the corresponding calculation. However, the results of all specifications that we estimate remain robust to this modification.[13]

5.2 Results

5.2.1 Baseline specification

The results of our baseline specification are presented in Table 1. Columns (1) and (2) show the results when using profits as dependent variable, Columns (3) and (4) when using intra-firm revenues.

Our results indicate a statistically significant association between the effective average tax rate on the one hand and profits as well as intra-firm revenues on the other hand. Holding other factors such as the value of tangible assets, employment, and revenues fixed, a one percentage point (pp) increase in the effective average tax rate is associated with a decrease in profits by roughly 0.5 percent and a decrease in intra-firm revenues by 1.3 percent. Thus, tax rate differentials between countries apparently matter for the profit allocation of large German MNEs. However, although of relevant magnitude, our estimates are notably smaller than the average semi-elasticities reported in the meta-analyses by Beer et al. (2020) as well as Heckemeyer and Overesch (2017). Beer et al. (2020) find an average tax semi-elasticity of corporate profits of −1, Heckemeyer and Overesch (2017) of −0.8. These differences may be due to differences in the data used, or they may reflect that German MNEs react less sensitively to tax rate differentials, either because their asset structures or other characteristics make profit shifting more difficult, or because anti-tax avoidance legislation in Germany is more stringent than elsewhere.

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[12] We use the consolidated information from Orbis, which is typically considered to be much more reliable than the unconsolidated information.

[13] We do not report the results here for reasons of space but they are available from the authors upon request.

In contrast, the relationships between statutory tax rates and profits as well as between statutory tax rates and intra-firm revenues are insignificant. One explanation for this finding is that the standard statutory tax rate is an inaccurate measure for the actual tax burden in a country. In fact, the coefficient of correlation between the effective average tax rate and the statutory tax rate in our data is only 0.239, indicating a weak correlation between these two variables. Moreover, many countries consistently labelled as tax havens are actually characterized by high standard statutory tax rates. For example, Luxembourg has a statutory corporate income tax rate of 26 percent, Malta even of 35 percent. Discrepancies between effective average tax rates and statutory tax rates can be due to tax exemptions, tax credits for certain activities (such as R&D), and/or patent boxes.

Table 1: Results for the baseline specification

Dependent Variable	log(profits)		log(revenues related)	
	(1)	(2)	(3)	(4)
Statutory tax rate	0.104		0.380	
	(0.266)		(0.421)	
Effective tax rate		−0.517**		−1.262***
		(0.183)		(0.318)
log(assets)	0.153***	0.156***	0.262***	0.269***
	(0.040)	(0.041)	(0.069)	(0.070)
log(employment)	0.369***	0.373***	0.930***	0.925***
	(0.056)	(0.058)	(0.095)	(0.097)
log(revenues unrelated)	0.324***	0.315***	−0.128***	−0.133***
	(0.030)	(0.030)	(0.038)	(0.038)
Corruption perception index	0.461**	0.384*	1.047***	0.935***
	(0.148)	(0.155)	(0.242)	(0.245)
log(GDP pc)	0.258***	0.279***	0.663***	0.644***
	(0.050)	(0.054)	(0.094)	(0.104)
log(population)	0.051**	0.062***	0.058	0.081**
	(0.019)	(0.018)	(0.033)	(0.031)
Dummy year 2017	−0.058	−0.064	−0.036	−0.036
	(0.052)	(0.052)	(0.086)	(0.087)
Constant	1.910***	1.912***	0.698	0.990
	(0.514)	(0.457)	(0.890)	(0.899)
No. of observations	9410	9275	8338	8246
Adjusted R^2	0.797	0.798	0.718	0.721

Notes: Results are based on OLS regression. All specifications include corporate group fixed effects. Standard errors shown in parentheses are clustered at the corporate group level. */**/*** indicate significance at the 5%/1%/0.1% level.

5.2.2 Quadratic specification

Dowd et al. (2017) argue that MNE affiliates located in low-tax jurisdictions may react more sensitively to tax rate differences than those in high-tax jurisdictions, implying that the semi-elasticity of profits with respect to tax rates may be larger (in absolute terms) when the level of taxation in a country is low. To test this conjecture, Dowd et al. (2017) include the squared realization of the tax variable to their empirical model. We follow their approach and report the results for this modification in Table 2. To facilitate the interpretation of the coefficients, we also illustrate the resulting average marginal effects of a tax rate change for different levels of the tax rate graphically. Figure 7 illustrates the marginal effects of a tax rate change on profits, Figure 8 shows the marginal effects of a tax rate change on intra-firm revenues.

Table 2: Results for the quadratic specification

Dependent Variable	log(profits)		log(revenues related)	
	(1)	**(2)**	**(3)**	**(4)**
Statutory tax rate	1.410		1.597	
	(0.914)		(1.613)	
Statutory tax rate squared	−2.311		−2.140	
	(1.499)		(2.614)	
Effective tax rate		−1.216*		−2.872***
		(0.515)		(0.806)
Effective tax rate squared		1.393		3.306*
		(0.942)		(1.465)
No. of observations	9410	9275	8338	8246
F statistic (joint sign. tax variables)	1.22	5.04**	0.63	9.67***
Adjusted R^2	0.797	0.798	0.718	0.721

Notes: Results are based on OLS regression. Coefficients of control variables are omitted to conserve space. All specifications include corporate group fixed effects. Standard errors shown in parentheses are clustered at the corporate group level. */**/*** indicate significance at the 5%/1%/0.1% level.

The results we obtain when using the effective average tax rate as an explanatory variable are well in line with those reported by Dowd et al. (2017). The lower the level of taxation, the more sensitive profits are to tax rate differences. For instance, if the average tax rate is 10 percent, a 1 pp increase in the tax rate is associated with a decrease in profits by about 1 percent (cf. Figure 7). For an effective average tax rate of 25 percent, the resulting marginal effect of a tax rate change is only half that size. Moreover, once the effective average tax rate exceeds a level of about 30 percent, the marginal

effect becomes insignificant. Note that the result of an F-test indicates that the coefficients of the linear and quadratic tax variable are jointly highly significant (second last row of Table 2). Thus, the weak individual significance of the coefficient estimates is apparently due to a collinear relationship. The results we obtain when using intra-firm revenues are qualitatively similar. Finally, we again do not find a statistically significant association (neither individually nor jointly) between statutory tax rates and profits or intra-firm revenues.

Figure 7: Marginal effect of a tax rate change on profits
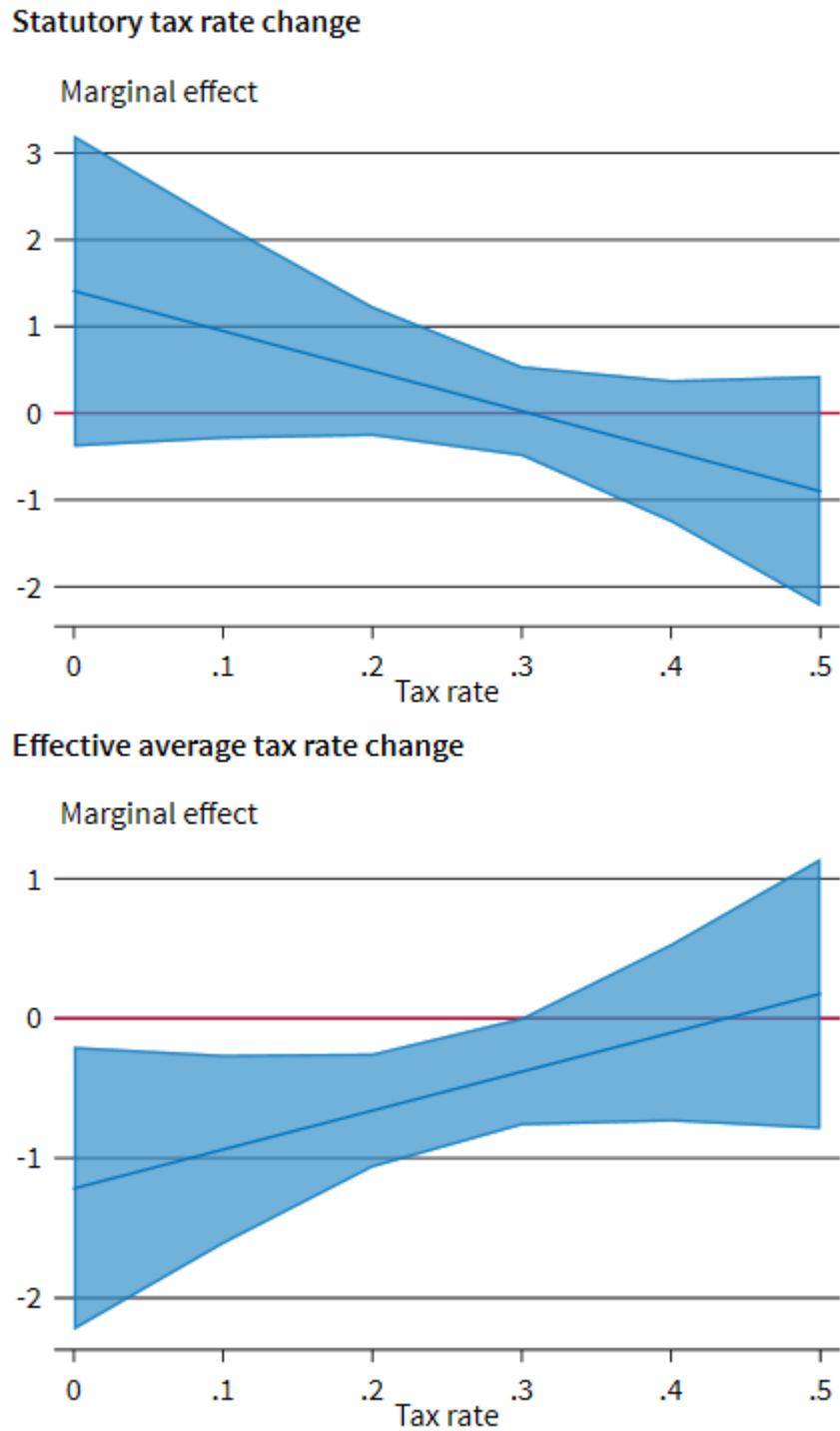
Statutory tax rate change

Effective average tax rate change

Notes: The figures illustrate the average marginal effects of a change in the statutory tax rate (upper figure) and the effective average tax rate (lower figure) on the log of profits for different realizations of the tax rate. Average marginal effects are computed based on the coefficient estimates in Table 2. The shaded areas show 95% confidence intervals.

Figure 8: Marginal effect of a tax rate change on intra-firm revenues
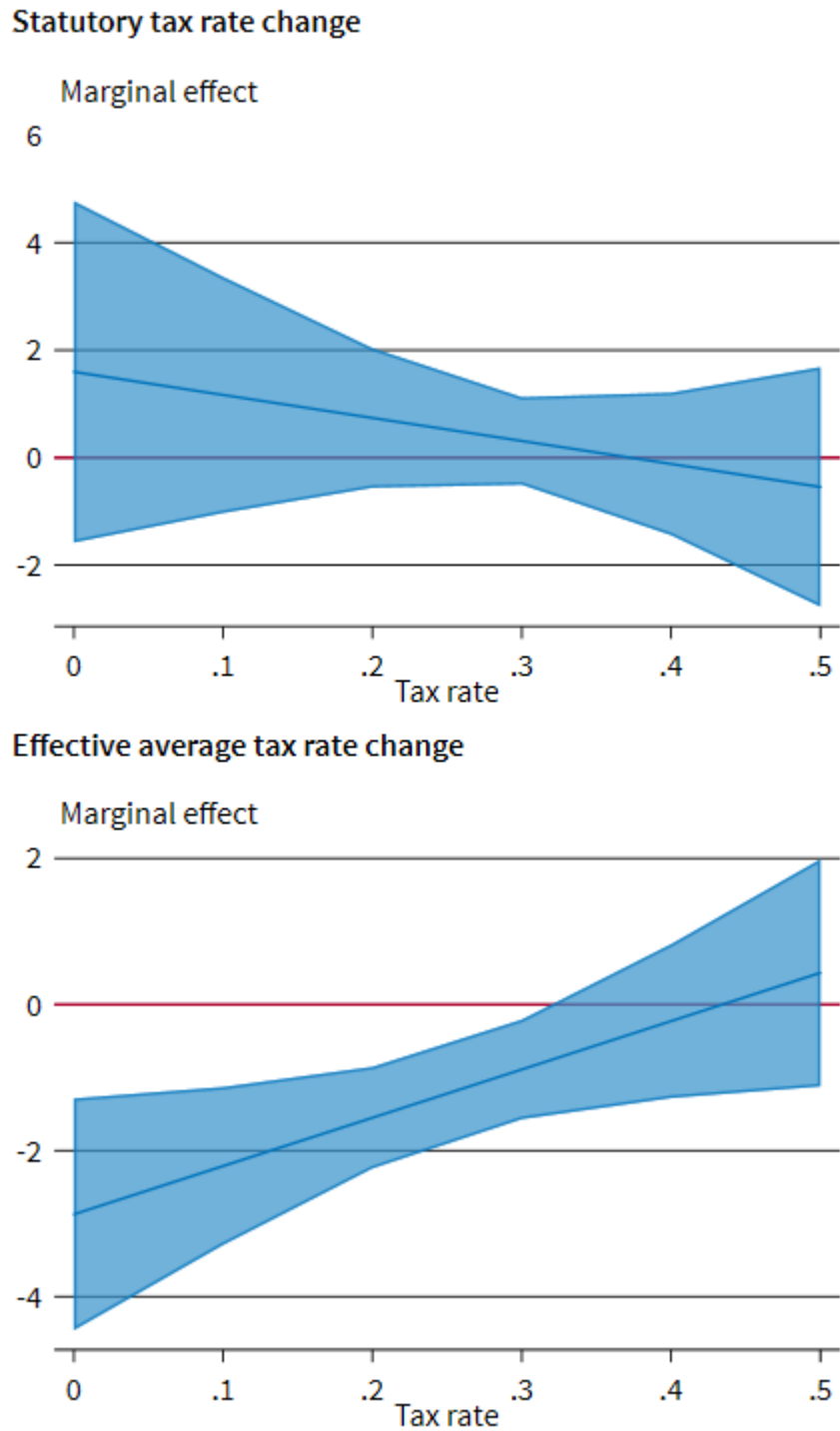
Statutory tax rate change

Effective average tax rate change

Notes: The figures illustrate the average marginal effects of a change in the statutory tax rate (upper figure) and the effective average tax rate (lower figure) on the log of intra-firm revenues for different realizations of the tax rate. Average marginal effects are computed based on the coefficient estimates in Table 2. The shaded areas show 95% confidence intervals.

5.2.3 Including tax haven dummies

In this section, we take a closer look at the importance of tax havens for German MNEs' profit shifting activities. The public exposure of tax avoidance strategies of several well-known corporations over the past years as well as the so-called 'Luxembourg Leaks' have put some countries into the spotlight for the role they play in MNEs' profit shifting activities.

Table 3 shows the regression results when including dummy variables for European and non-European tax havens to our baseline specification (Equation (3)). The results we obtain are quite remarkable. When the two dummy variables are included, the estimate of the tax semi-elasticity of profits reduces by half compared to the baseline specification and is no longer statistically significant. The coefficient estimates of the tax haven dummies, on the other hand, are not only statistically significant at every reasonable level of significance, but also sizeable. Other factors fixed, the profits that large German MNEs report in European tax havens exceed the profits reported in non-havens by more than 60 percent. In non-European tax havens, profits are about 40 percent higher. These findings suggest that tax havens play a key role in the profit shifting activities of large German MNEs. European tax havens seem to be more important than non-European tax havens. In a similar vein, we find that for affiliates located in European (non-European) tax havens, intra-firm revenues are more than two-thirds (two times) higher than for affiliates located in non-havens. This finding suggests that large German MNEs strategically locate inputs in tax havens. The fact that intra-firm revenues are, *ceteris paribus*, higher in non-European tax havens than in European tax havens, although German MNEs report higher profits in European tax havens, fits well with the stylized facts presented in Section 3. Note that the estimated tax semi-elasticity of revenues generated through intra-firm transactions remains statistically significant when the two dummy variables are included. However, its magnitude decreases (in absolute terms) as well.

Table 3: Including dummy variables for tax havens

Dependent Variable	log(profits)		log(revenues related)	
	(1)	**(2)**	**(3)**	**(4)**
Statutory tax rate	0.532		1.254**	
	(0.274)		(0.453)	
Effective tax rate		−0.249		−0.867**
		(0.184)		(0.325)
European tax havens	0.665***	0.630***	0.774***	0.690***
	(0.080)	(0.078)	(0.126)	(0.124)
Non-European tax havens	0.414***	0.371***	1.104***	1.004***
	(0.091)	(0.091)	(0.158)	(0.151)
No. of observations	9410	9275	8338	8246
Adjusted R^2	0.800	0.801	0.723	0.725

Notes: Results are based on OLS regression. Coefficients of control variables are omitted to conserve space. All specifications include corporate group fixed effects. Standard errors shown in parentheses are clustered at the corporate group level. */**/*** indicate significance at the 5%/1%/0.1% level.

5.2.4 Effect heterogeneity

It is often argued that a high reliance on intangible assets facilitates profit shifting. In the BEPS project, for instance, the OECD highlights the importance of intangible assets for MNEs' tax avoidance activities (OECD, 2017). Also, Griffith et al. (2014) as well as Dischinger and Riedel (2011) provide evidence that the location of MNEs' intellectual property is sensitive to the level of taxation. For that reason, we check whether the estimated tax semi-elasticities of profits and intra-firm revenues vary with the share of intangible assets in total assets. To this end, we split our sample into four subsamples based on the quartiles of this share and re-estimate Equation (3) for each subsample. Since the CbC reports do not contain information about intangible assets, we compute the ratio based on Orbis data and merge this information with the CbC data.[14] The results are shown in Table 4. Overall, the findings do not indicate that the extent of profit shifting by German MNEs is related to the share of intangible assets. The coefficient estimates of the dummy variables for both European and non-European tax havens vary only little across the four subsamples. The only exception is the third quartile, where the coefficient estimate of the dummy for non-European tax havens is not statistically significant.

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[14] Note that information about the share of intangible assets is missing for 133 of the 333 MNEs included in our sample. The total number of observations therefore decreases to 9830.

Another common claim is that larger firms are more prone to engage in profit shifting than smaller firms. The reason is that tax planning and profit shifting activities involve significant fixed costs, which large firms can bear more easily. These costs may include staffing costs, costs of legal advice, and costs of setting up companies abroad. Davies et al. (2018), Desai et al. (2006), Langenmayr and Liu (2020), as well as Wier and Reynolds (2018) provide evidence for a positive relationship between firm size and profit shifting activities. Taking up on this, we check whether the estimates of the tax semi-elasticity of profits vary with firm size. As a proxy for firm size, we use the consolidated revenue of the MNE group. As before, we split our sample into four subsamples based on the quartiles of the firm size indicator and re-estimate our empirical model for each subsample. Table 5 reports the results. The findings we obtain support the notion that the extent of profit shifting is positively related to firm size. The larger an MNE, the higher are the profits reported in European tax havens. The profits reported in European tax havens by the smallest 25 percent of MNEs in our sample exceed the profits reported in non-tax havens by about 45 percent. For the largest 25 percent of German MNEs in our sample, this effect grows to over 80 percent. Moreover, we find that only the largest 50 percent of MNEs in our sample appear to use non-European tax havens to shift profits. For the smaller half, the coefficient estimate for the dummy for non-European tax havens is statistically insignificant. For intra-firm revenues, though, there is no clear pattern.

Table 4: Semi-elasticities by intangible asset shares

Dependent Variable	log(profits)							
	1st quartile		2nd quartile		3rd quartile		4th quartile	
Statutory tax rate	0.477		0.993		1.174		−0.000	
	(0.765)		(0.584)		(0.731)		(0.646)	
Effective tax rate		0.527		−0.420		−0.920*		−0.039
		(0.487)		(0.415)		(0.397)		(0.464)
European tax havens	0.722**	0.730***	0.722***	0.661**	0.725***	0.628**	0.758***	0.722***
	(0.217)	(0.206)	(0.204)	(0.191)	(0.186	(0.183)	(0.185)	(0.192)
Non-European tax havens	0.469*	0.451*	0.696**	0.579*	0.276	0.132	0.605***	0.657***
	(0.210)	(0.210)	(0.213)	(0.218)	(0.217)	(0.214)	(0.161)	(0.147)
Dependent Variable	**log(revenues related)**							
	1st quartile		2nd quartile		3rd quartile		4th quartile	
Statutory tax rate	−0.269		2.222		1.742		1.780	
	(0.972)		(1.316)		(1.235)		(0.941)	
Effective tax rate		−1.062		−0.453		−1.605		−0.731
		(0.949)		(0.960)		(0.868)		(0.437)
European tax havens	0.264	0.226	1.087**	0.993*	1.108***	0.979***	1.210***	1.050***
	(0.281)	(0.276)	(0.402)	(0.392)	(0.217)	(0.222)	(0.286)	(0.273)
Non-European tax havens	1.254**	1.211**	1.856***	1.683***	1.198*	1.010*	1.053***	0.923***
	(0.418)	(0.405)	(0.465)	(0.459)	(0.448)	(0.397)	(0.232)	(0.210)

Notes: Results are based on OLS regression. Coefficients of control variables are omitted to conserve space. All specifications include corporate group fixed effects. Standard errors shown in parentheses are clustered at the corporate group level. */**/*** indicate significance at the 5%/1%/0.1% level.

Table 5: Semi-elasticities by firm size

Dependent Variable	log(profits)							
	1st quartile		2nd quartile		3rd quartile		4th quartile	
Statutory tax rate	−0.535		0.849		0.926		0.950	
	(0.525)		(0.480)		(0.571)		(0.494)	
Effective tax rate		0.015		−0.359		−0.306		−0.271
		(0.359)		(0.303)		(0.324)		(0.365)
European tax havens	0.433**	0.452**	0.584***	0.540***	0.780***	0.738***	0.872***	0.815***
	(0.139)	(0.137)	(0.153)	(0.147)	(0.149)	(0.148)	(0.152)	(0.162)
Non-European tax havens	0.345	0.373	0.228	0.141	0.662***	0.605***	0.476**	0.418**
	(0.215)	(0.214)	(0.210)	(0.212)	(0.170)	(0.175)	(0.139)	(0.133)
Dependent Variable	**log(revenues related)**							
	1st quartile		2nd quartile		3rd quartile		4th quartile	
Statutory tax rate	1.765*		1.699		0.658		1.198	
	(0.890)		(1.024)		(0.836)		(0.651)	
Effective tax rate		−0.666		−1.413		−0.101		−1.072**
		(0.795)		(0.797)		(0.453)		(0.371)
European tax havens	0.192	0.074	0.807**	0.725*	1.060***	1.025***	1.155***	1.050***
	(0.242)	(0.240)	(0.295)	(0.283)	(0.206)	(0.204)	(0.189	(0.180)
Non-European tax havens	0.898**	0.704**	1.277***	1.139***	1.287***	1.232***	0.962***	0.907**
	(0.280)	(0.256)	(0.349)	(0.325)	(0.300)	(0.296)	(0.254)	(0.259)

Notes: Results are based on OLS regression. Coefficients of control variables are omitted to conserve space. All specifications include corporate group fixed effects. Standard errors shown in parentheses are clustered at the corporate group level. */**/*** indicate significance at the 5%/1%/0.1% level.

6. Calculating the amount of shifted profits

Based on the results of the specification including tax haven dummies (cf. Column (1) of Table 3), we can derive a rough estimate of the total amount of profits shifted to tax havens by large German MNEs. Our estimates suggest that in 2016 and 2017 combined, large German MNEs shifted approximately EUR 18.3 billion to tax havens. This equals almost 40 percent of the total profits the MNEs in our sample reported in tax havens, which was EUR 47.3 billion (Column (1) of Table 6).

To estimate how much profit was shifted out of Germany vis-à-vis other non-haven countries, we re-allocate the shifted profits to Germany and other non-haven countries based on the distribution of tangible assets. Our estimates suggest that in 2016 and 2017, EUR 10.7 billion of profits were shifted out of Germany, which corresponds to 4.3 percent of reported profits (Columns (2) and (3) of Table 6). The amount of profits shifted out of other non-haven countries was somewhat smaller; it was equal to EUR 7.6 billion or 3 percent of the profits reported in those countries. Note that these numbers are for the years 2016 and 2017 combined. Translated into yearly averages, large domestic MNEs shift EUR 5.4 billion in profits out of Germany annually. Multiplied with a statutory tax rate of 30 percent this implies annual revenue losses for Germany of EUR 1.6 billion.

Table 6: Profit shifting by large German MNEs in 2016 and 2017 combined

	Reported profits (bn. EUR)	Shifted profits (bn. EUR)	Shifted profits / reported profits
Germany	247.6	−10.7	−4.3%
Other non-havens	250.4	−7.6	−3.0%
European tax havens	41.4	+16.6	+40.1%
Non-European tax havens	5.9	+1.7	+28.8%
Sum	545.3	0	---

One should keep in mind that the estimates presented in Table 6 exclude profits shifted by German subsidiaries of foreign MNEs and by domestic MNEs with revenues below EUR 750 million. To obtain a rough estimate of the total amount of profits shifted to tax havens out of Germany, we make some simple extrapolations.

In 2016 and 2017 combined, the total amount of corporate profits reported in Germany was about EUR 1,044.4 billion.[15] This figure includes the profits reported by domestic MNEs, domestic non-MNEs, and German subsidiaries of foreign MNEs. Unfortunately, the contribution of each firm type to the EUR 1,044.4 billion of total profits is unknown. However, what is known is the aggregate gross operating surplus for each of the three firm types. If we assume that each firm type's contribution to the EUR 1,044.4 billion of total profits matches the relative contributions to gross operating surplus, we obtain an estimate of the annual profits of domestic MNEs (including those MNEs covered by the CbC data and those who are not covered) of EUR 654.5 billion, and for German subsidiaries of foreign MNEs of EUR 233.9 billion EUR.[16] If domestic MNEs with revenues below the EUR 750 million threshold shifted just as much of their profits to tax havens as MNEs covered by the CbC data, another EUR 17.4 billion would be added to our estimate of EUR 10.7 billion, yielding EUR 28.1 billion. This probably overestimates profits shifted by these firms because smaller companies tend to engage less in profit shifting than larger ones (cf. Section 5.2.4). If we further assume that German subsidiaries of foreign MNEs shift the same share of their profits out of Germany and to tax havens as German MNEs with their domestic activities (4.3 percent), profits shifted by foreign MNEs in the two years under consideration would amount to another EUR 10.1 billion. This leads to an estimate of overall corporate profits shifted out of Germany of EUR 38.2 billion for 2016 and 2017 combined or EUR 19.1 billion on average *per year*. Given the statutory tax rate of 30 percent, this implies an annual revenue loss of EUR 5.7 billion. These numbers are summarized in Table 7.

Table 7: Profit shifting out of Germany in 2016 and 2017 combined

	Profits reported in Germany (bn. EUR)	Shifted profits (bn. EUR)	Impact on tax revenue
Large German MNEs	247.6	−10.7	−3.2
Smaller German MNEs	406.9	−17.4	−5.2
Foreign MNEs in Germany	233.9	−10.1	−3.0
German non-MNEs	156.0	---	---
Sum	1044.4	−38.2	−11.4

[15] Source: German Federal Statistical Office, Sector Accounts.

[16] The remaining EUR 156.0 billion in corporate profits come from German non-MNEs.

In a recent paper, Tørsløv et al. (2018) estimate the amount of corporate profit shifting by combining national accounts data with information from the OECD's foreign affiliates statistics and balance of payments data. They do so on a global scale as well as for individual countries. The data they use are for the year 2015. For Germany, Tørsløv et al. (2018) estimate that the amount of profits shifted out of the country to tax havens equals USD 55 billion (EUR 50 billion), which is notably higher than our estimate of EUR 19.1 billion per year.

Another important finding in Tørsløv et al. (2018) is that the profits reported in tax havens would fall by 60 percent if all countries adopted the same effective corporate tax rate. If we divide our estimate of EUR 18.3 billion of profits large German MNEs shifted to tax havens by the EUR 47.3 billion of total profits they report in tax havens, we obtain approximately 40 percent, which is also notably smaller.

It is important to interpret profit shifting estimates in the light of the counterfactuals implied by the estimation methods used. These counterfactuals tell us how profits would be distributed globally in the absence of profit shifting. In our estimates documented in Table 7, the counterfactual is a world where the global distribution of profits is determined by the control variables in our regressions, which include firm-level indicators of 'real' economic activity – employment, tangible assets, sales to third parties – and host country variables like GDP and population.

To illustrate the importance of the assumed counterfactual, consider a similar, but simpler approach: a world where profits are distributed in the same way as factors of production, that is, employment and tangible assets. If the counterfactual distribution of profits of the large German MNEs covered by the CbC data would correspond to the distribution of employment and tangible assets (with equal weights on both indicators), we would find that profit shifting out of Germany to tax havens would be roughly EUR 10 billion per year – almost twice as much as the estimate reported in Table 7. Profit shifting of foreign subsidiaries of German MNEs out of other non-haven countries would equal EUR 3.4 billion, which is close to our estimate (Table 6). In Tørsløv et al. (2018), the counterfactual is that the profit-to-payroll ratio of foreign MNEs' tax haven subsidiaries is the same as that of local firms – an assumption that can be called into question.

From a policy perspective, the counterfactual of no profit shifting is less relevant than the impact of a change in tax rate differentials which could be achieved through reforms of the international tax system. In the context of the BEPS project, the

OECD/G20 currently discusses the introduction of a global effective minimum tax rate for MNEs. The idea is to allow the headquarters country of an MNE to tax foreign profits if the effective average tax rate for these profits is below a certain threshold. The introduction of such a rule would lead to an increase in the effective tax rate on profits reported in low-tax jurisdictions. To get an idea about the consequences of such a reform on the allocation of profits, we calculate the absolute change in profits reported in tax havens in response to a 1 pp increase in tax havens' effective tax rates using the estimates presented in Tables 1 and 2. The results are reported in Table 8.[17]

Not surprisingly, the implied absolute change in profits is notably larger when we base our estimation on the quadratic specification. The reason is the distinct non-linear relationship between the effective average tax rate and the estimated tax (semi-)elasticity of profits (cf. Section 5.2.2.). Based on the results of the quadratic specification, a 1 pp increase in the effective tax rate would be associated with an annual reduction in profits reported in tax havens by about EUR 4.4 billion. This corresponds to roughly 18.6 percent of the average annual profits German MNEs report in non-havens (cf. Table 6).

Table 8: Estimated absolute change in profits reported in tax havens

Specification	Annual change in profits in response to a 1pp tax rate hike (in million EUR p.a.)
Linear specification	2,005
Quadratic specification	4,445

Notes: The change in profits is calculated based on the coefficient estimates of the effective average tax rate presented in Tables 1 and 2.

7. Profit shifting regressions based on Orbis data

To check whether using (incomplete) Orbis data yields different results for the tax semi-elasticity of corporate profits than the CbC data, we re-estimate the linear specification, the quadratic specification, and the specification including tax haven dummies based on Orbis data. To this end, we collect information on unconsolidated profits, taxes paid, tangible assets, employment, and revenues of the entities of German

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[17] We use the estimated tax semi-elasticities reported in Tables 1 and 2 to predict the change in profits for each tax haven country separately and then sum up the predicted changes.

MNEs covered in the CbC data from the Orbis database.[18] We then aggregate this information at the level of the subsidiaries' residence countries for each MNE so that the data are at the same level of aggregation as the CbC data.[19] Our empirical approach thus perfectly resembles the one outlined in Section 5.1. Table 9 shows the results.

Table 9: Results based on Orbis data

Dependent Variable	log(profits)					
	(1)	(2)	(3)	(4)	(5)	(6)
Statutory tax rate	−1.165	−1.692			−0.667	
	(0.600)	(2.402)			(0.610)	
Statutory tax rate squared		1.124				
		(4.993)				
Effective tax rate			0.034	−10.623***		1.419**
			(0.467)	(2.164)		(0.459)
Effective tax rate squared				25.690***		
				(4.876)		
European tax havens					0.772***	1.069***
					(0.163)	(0.162)
Non-European tax havens					---	---
					(---)	(---)
No. of observations	3349	3349	3316	3316	3349	3316
F statistic (joint sign. tax variables)	---	1.93	---	14.59***	---	---
Adjusted R^2	0.791	0.791	0.791	0.795	0.794	0.796

Notes: Results are based on OLS regression. Coefficients of control variables are omitted to conserve space. All specifications include corporate group fixed effects. Standard errors shown in parentheses are clustered at the corporate group level. */**/*** indicate significance at the 5%/1%/0.1% level.

What is striking is that we lose almost two-thirds of our observations when using Orbis data. The reason is a drastic reduction in the number of countries included in the sample. While the CbC data document activities of German MNEs in 193 countries, our Orbis sample only covers 46 countries (see also Section 4).[20]

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[18] Note that Orbis data do not contain information about intra-firm revenues, which is why we use the log of total revenues as a control variable instead. However, the estimates we obtain based on CbC data remain unaffected when replacing the revenues generated through sales to third parties by total revenues.

[19] Note that Huizinga and Leven (2008) use the same approach to estimate the extent of profit shifting by MNEs.

[20] Note that a large fraction of the 157 countries for which information is lacking are actually covered in Orbis, but the realizations of the variables included in our empirical model are missing.

The estimates we obtain based on Orbis data present a very different picture than the results based on CbC data. The linear specification yields an estimate for the coefficient of the statutory tax rate of notable size and with a p-value just above the 5 percent level of significance (p = 0.053). According to this estimate, a one pp increase in the statutory tax rate is associated with a 1.2 percent decrease in profits. However, the quadratic specification yields coefficient estimates for the statutory tax rate that are statistically insignificant both individually and jointly. For the effective average tax rate, we obtain an insignificant coefficient estimate in the linear specification, but individually and jointly significant estimates in the quadratic specification. The resulting marginal effects show an odd pattern, though (cf. Figure 9). For low-tax jurisdictions, we observe an unreasonably large reaction to an increase in the effective average tax rate. In countries with an effective average tax rate of 10 percent (which roughly corresponds to the 10th percentile), a 1 pp hike in the tax rate is associated with a reduction in profits by about 5 percent. Once the effective average tax rate exceeds a level of roughly 20 percent (which is close to the sample median), the tax semi-elasticity becomes significantly positive. Only the coefficient estimate of the dummy variable for European tax havens remains relatively stable.[21]

But how come that in the baseline specification, the coefficient estimate of the statutory tax rate turns out to be (almost) statistically significant and of notable size when using Orbis data, while it is insignificant and close to zero when using CbC data? It is likely that this is related to the poor coverage of the Orbis data. In Section 4, we discussed different reasons for the poor coverage, including (i) an incomplete coverage of countries, (ii) an incomplete list of subsidiaries, and (iii) missing values in the variables of interest. The first reason implies that the results based on Orbis data may be subject to a sample selection bias. The other two reasons imply that the dependent (and some of the independent) variables included in our empirical model are measured with an error when using Orbis data, which may lead to biased estimates as well. To check the relevance of these two explanations, we perform two tests. First, we re-estimate our baseline specification using the CbC data, but only include those 46 countries to our sample that are also covered in the Orbis data. If the differences in results are due to a sample selection bias, then restricting our CbC sample to these countries should produce similar coefficient estimates as in Table 9. However, when

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[21] We do not obtain a coefficient estimate for the dummy for non-European tax havens since the countries labelled as such are not covered by the Orbis data.

doing so, we obtain a coefficient estimate for the statutory tax rate that is statistically insignificant at every reasonable level of significance. In contrast, the coefficient estimate of the effective average tax rate grows to −1.3 (in absolute terms) and is significant even at the 0.1 percent level. These findings indicate that the omission of countries not covered by the Orbis data does not explain the different results based on the two data sets.

In the second test, we try to assess whether the measurement error in the dependent variable, that is, the sum of profits made by an MNE in a country, may explain the different results. The existence of a measurement error implies that the error term of Equation (1) comprises two components when using Orbis data:

$$(4)\ \varepsilon_{ict} = \vartheta_{ict} + e_{ict}$$

where e_{ict} is the measurement error and ϑ_{ict} is the idiosyncratic component of the composite error term. Under the standard assumption that $E(e|X) = E(e) = 0$, OLS will yield unbiased coefficient estimates. In our application, though, this assumption is violated for two reasons. First, the measurement error is – apart from a few exceptions (see Section 4) – strictly negative as Orbis underreports aggregate MNE profits in the host countries. This violation implies that $E(e) \neq 0$; however, it does not necessarily lead to biased coefficient estimates for the explanatory variables.[22] Second, we find that coverage of the Orbis data is inversely related to the statutory tax rate, implying that $E(e|X) \neq E(e)$. The coefficient of correlation between the statutory tax rate on the one hand and the ratio of profits reported in Orbis to profits reported in the CbC data on the other hand is −0.54, which is sizeable. The negative relationship implies that the extent of underreporting tends to be larger in countries with high statutory tax rates which, in turn, leads to a downward bias in the OLS estimate of the statutory tax rate's (negative) coefficient. Given the large size of the correlation coefficient, it is not surprising that the bias turns out to be so severe. Our findings thus clearly indicate that the results of profit shifting regressions based on unconsolidated Orbis data should be interpreted with great caution.

One reason for the fact that the extent of underreporting of profits in Orbis tends to be larger in high-tax countries could be the different treatment of profits by PEs in the

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[22] Using Monte Carlo simulations, Millimet and Parmeter (2019) show that strictly negative or positive measurement errors (which the authors refers to as 'one-sided measurement errors') mainly affect the estimate of the intercept, but not the estimates of the control variables' coefficients, at least as long as the measurement error is not correlated with the explanatory variables.

two data sets. In the CbC data, profits of PEs are reported in the country where the PE is situated, while in Orbis, they are reported in the residence country of its direct parent company (cf. Section 4). Consequently, if German MNEs rely to a large extent on legally dependent PEs to run their operations in high-tax jurisdictions, while their legally independent subsidiaries are situated in low-tax jurisdictions, then the ratio of profits reported in Orbis to the profits reported in CbC would indeed be inversely related to the statutory tax rate.

Figure 9: Marginal effect of a tax rate change on profits – Orbis data

Statutory tax rate change
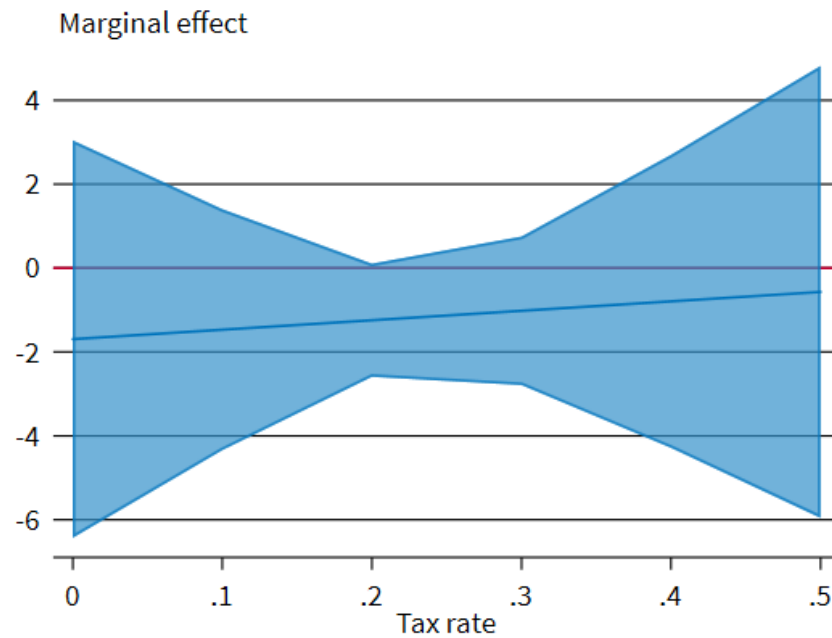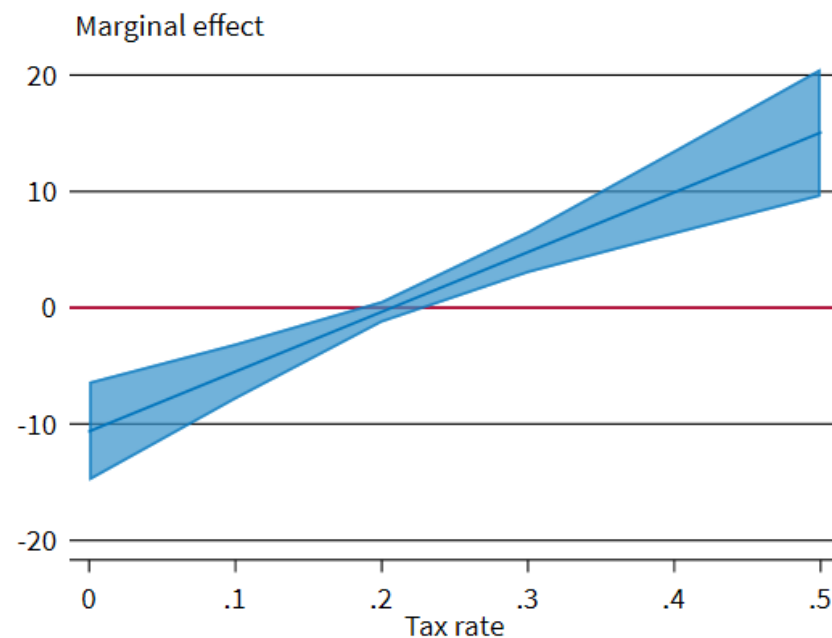
Effective average tax rate change

Notes: The figures illustrate the average marginal effects of a change in the statutory tax rate (upper figure) and the effective average tax rate (lower figure) on the log of profits for different realizations of the tax rate. Average marginal effects are computed based on the coefficient estimates in Table 8. The shaded areas show 95% confidence intervals.

8.   Conclusions

This paper studies profit shifting of German multinational enterprises (MNEs) using newly available data from country-by-country reports for the years 2016 and 2017. We show that economic activities of German MNEs in tax havens are much more profitable than in non-havens. In addition, there is a strong negative correlation between effective average tax rates and revenues from intra-firm trade of goods and services. These findings support the view that German MNEs exploit opportunities to shift profits to tax havens. However, compared to the profits in non-haven countries, profits reported in tax havens are small – they only account for 9 percent of global profits. According to our estimates, roughly 40 percent of the profits reported in tax havens are a result of tax-induced profit shifting. Large MNEs are more tax sensitive and are therefore responsible for most of the profit shifting. In total, profit shifting by large German MNEs gives rise to an annual tax revenue loss for German tax authorities of EUR 1.6 billion. Note that this excludes losses from profit shifting by German MNEs with revenues below EUR 750 million and by the German subsidiaries of foreign MNEs. Adding estimates of profit shifting by firms not covered by the CbC data leads to an overall estimate for the German tax revenue loss due to corporate profit shifting to tax havens of EUR 5.7 billion per year.

In a recent paper, Tørsløv et al. (2018) report that globally, MNEs shift 40 percent of their foreign profits to tax haven countries. While we do find evidence for profit shifting, the volume we estimate based on our sample of large German MNEs is much smaller than the figure reported by Tørsløv et al. (2018). Our findings suggest that annually, EUR 3.8 billion out of EUR 125 billion of total foreign profits of German MNEs are shifted to tax havens, yielding a share of approximately 3 percent.

In general, estimates of the extent of profit shifting in the literature for both German MNEs and MNEs from other countries tend to be higher. This may be a result of different methods or data sources used, but it may also reveal that German MNEs are less prone to shift profits than MNEs from other countries. That, in turn, may reflect tighter anti-tax avoidance policies in Germany and important host countries of German foreign investment, or differences in profit shifting opportunities due to firm characteristics such as the importance of immaterial assets.

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Appendix A: Tax haven definitions

Table A1: List of tax havens

Kategorie	Länder
European tax havens	Cyprus, Gibraltar, Ireland, Lichtenstein, Luxembourg, Malta, Netherlands, Switzerland
Non-European tax havens	Antigua and Barbuda, Bahamas, Bahrain, Barbados, Belize, Bermuda, British Virgin Islands, Cayman Islands, Cook Islands, Curacao, Grenada, Guernsey, Hong Kong, Isle of Man, Jersey, Liberia, Montserrat, Panama, Sankt Kitts and Nevis, Saint Vincent and the Grenadines, Singapore, Sint Maarten, Turks and Caicos Islands, Vanuatu

Sources: IMF (2019), Menkhoff and Miethe (2019).

Appendix B: Descriptive statistics

Table B1: Descriptive statistics for the CbC sample

Variable	Complete sample			European tax havens			Non-European tax havens		
	Obs.	Mean	Std.-dev.	Obs.	Mean	Std.-dev.	Obs.	Mean	Std.-dev.
log(profits)	9,465	14.689	2.668	717	15.239	2.653	362	14.527	2.465
profits (in mio. EUR)	9,465	57.614	474.721	717	57.713	225.572	362	16.374	40.049
log(revenues related)	8,375	15.058	3.463	647	15.502	3.505	338	15.300	3.232
Revenues related (in mio. EUR)	9,465	203.314	2386.049	717	128.828	483.385	362	123.187	759.483
Statutory tax rate	9,410	0.245	0.075	717	0.214	0.057	358	0.163	0.050
Effective average tax rate	9,275	0.194	0.095	717	0.104	0.020	345	0.110	0.053
Statutory tax rate (differential)	9,397	−0.044	0.081	717	−0.075	0.061	358	−0.133	0.063
Effective avg. tax rate (differential)	9,262	0.033	0.098	717	−0.054	0.029	345	−0.050	0.059
log(assets)	9,465	15.369	3.187	717	15.222	3.347	362	14.505	2.794
Assets (in mio. EUR)	9,465	284.269	3405.950	717	146.795	1,152.1	362	31.379	133.283
log(employment)	9,465	4.933	2.076	717	4.518	1.870	362	4.028	1.706
Employment	9,465	1338.222	7617.984	717	429.255	1042.490	362	223.563	515.143
log(revenues unrelated)	9,465	17.048	2.894	717	17.235	2.790	362	16.584	2.728
Revenues unrelated (in mio. Euro)	9,465	444.482	3004.052	717	234.484	538.327	362	170.745	727.942
Corruption perception index	9,465	0.598	0.192	717	0.807	0.072	362	0.764	0.136
log(GDP per capita)	9,465	10.267	0.706	717	10.993	0.252	362	10.941	0.586
log(population)	9,465	3.314	1.597	717	1.859	1.180	362	1.519	1.012

Table B2: Descriptive statistics for the Orbis sample

Variable	Complete sample			European tax havens			Non-European tax havens		
	Obs.	Mean	Std.-dev.	Obs.	Mean	Std.-dev.	Obs.	Mean	Std.-dev.
log(profits)	3,751	15.022	2.430	165	15.734	2.155	0	---	---
profits (in mio. EUR)	3,751	67.420	387.582	165	93.477	357.133	0	---	---
Statutory tax rate	3,751	0.227	0.062	165	0.216	0.065	0	---	---
Effective average tax rate	3,713	0.198	0.073	164	0.067	0.048	0	---	---
Statutory tax rate (differential)	3,702	−0.032	0.069	162	−0.049	0.069	0	---	---
Effective avg. tax rate (differential)	3,664	−0.034	0.094	161	−0.168	0.068	0	---	---
log(assets)	3,751	14.728	3.159	165	14.021	3.220	0	---	---
Assets (in mio. EUR)	3,751	120.999	839.083	165	22.910	162.800	0	---	---
log(employment)	3,751	5.146	2.018	165	4.612	1.522	0	---	---
Employment	3,751	1377.312	7032.780	165	265.885	407.344	0	---	---
log(revenues)	3,751	17.896	2.158	165	17.996	1.928	0	---	---
Revenues (in mio. Euro)	3,751	3902.572	198749.20	165	283.711	708.017	0	---	---
Corruption perception index	3,751	0.620	0.169	165	0.793	0.046	0	---	---
log(GDP per capita)	3,751	10.416	0.421	165	11.058	0.281	0	---	---
log(population)	3,751	3.103	1.432	165	1.766	1.273	0	---	---

Appendix C: List of countries

Table C1: Complete list of countries covered by CbC reports vs. Orbis

Country (ISO Code)	Coverage of profits	Coverage of assets	Coverage of employment	Coverage of number of entities	Country (ISO Code)	Coverage of profits	Coverage of assets	Coverage of employment	Coverage of number of entities
AD	0	---	---	0	KZ	0	0	0	0
AE	0	0	0	0	LA	0	0	0	0
AF	0	---	0	0	LB	0	0	0	0
AG	---	---	---	0	LI	0	0	0	0
AL	0	0	0	0	LK	0	0	0	0
AM	0	0	0	0	LR	0	0	0	0
AO	0	0	0	0	LS	0	0	0	0
AR	0	0	0	0	LT	77.7	29.4	48.6	27.3
AT	45.4	27.8	63.0	67.3	LU	37.6	2.7	33.4	17.3
AU	28.6	19.4	77.3	18.6	LV	108.5	23.9	61.9	47.5
AW	0	0	0	0	LY	---	0	0	0
AZ	0	0	0	0	MA	0	0	0	0
BA	53.9	37.9	59.0	69.7	MC	0	0	0	0
BB	0	0	0	0	MD	0	0	0	0
BD	0	0	0	0	ME	101.6	94.5	57.2	66.7
BE	64.0	43.0	71.9	56.6	MG	0	0	0	0
BF	0	0	0	0	MH	0	0	---	0
BG	65.9	55.3	96.4	59.6	MK	83.9	87.2	107.2	37.5
BH	0	0	0	0	ML	0	0	0	0
BI	0	0	0	0	MM	0	0	0	0
BJ	0	0	0	0	MN	0	0	0	0
BM	0	0	0	0	MO	0	0	0	0
BN	0	0	0	0	MQ	0	0	0	0

BO	0	0	0	0	MR	0	0	0	0
BR	26.5	4.3	2.6	5.7	MT	0.0	0.0	0.8	2.7
BS	0	0	0	0	MU	0	0	0	0
BW	0	0	0	0	MW	---	0	0	0
BY	0	0	0	0	MX	0.5	0.2	0.3	0.3
BZ	0	0	0	0	MY	0	0	0	0
CA	0	0	0	0	MZ	---	0	0	0
CD	0	0	0	0	NA	0	0	0	0
CF	0	0	0	0	NC	0	0	0	0
CG	0	0	0	0	NE	0	0	0	0
CH	0	0	0	0	NG	0	0	0	0
CI	0	0	0	0	NI	0	0	0	0
CL	0	0	0	0	NL	47.9	7.9	16.4	29.3
CM	0	0	0	0	NO	96.8	134.7	106.2	75.9
CN	51.5	18.9	44.1	21.6	NP	0	0	0	0
CO	0	0.002	0.01	1.1	NZ	0	0	0	0
CR	0	0	0	0	OM	0	0	0	0
CU	---	0	0	0	PA	0	0	0	0
CV	0	0	0	0	PE	10.2	0.6	4.7	1.6
CW	0	0	0	0	PF	0	0	0	0
CY	0	0	0	0	PG	0	0	0	0
CZ	51.5	46.6	64.2	76.0	PH	0	0	0	0
DE	62.0	19.6	43.7	39.5	PK	0	0	0	0
DK	59.5	31.0	56.0	44.1	PL	42.8	24.1	45.8	50.0
DO	0	0	0	0	PR	0	0	0	0
DZ	0	0	0	0	PS	---	0	0	0
EC	0	0	0	0	PT	68.4	26.4	57.4	70.7
EE	43.6	34.6	42.9	46.7	PY	0	0	0	0
EG	0	0	0	0	QA	0	0	0	0
ES	44.4	45.1	67.5	62.9	RE	0	0	0	0

ET	0	0	0	0	RO	77.9	64.0	66.5	61.4
FI	99.1	18.7	57.3	44.4	RS	105.3	55.6	80.1	73.4
FJ	0	0	0	0	RU	101.0	36.5	67.0	64.1
FM	0	0	0	0	RW	0	0	0	0
FR	91.2	20.3	72.2	54.9	SA	0	0	0	0
GA	---	0	0	0	SB	0	0	0	0
GB	73.0	49.7	103.3	74.2	SE	10.1	56.3	54.5	52.5
GE	0	0	0	0	SG	0	0	0	0
GF	---	---	0	0	SI	79.1	39.5	70.4	65.9
GG	0	0	0	0	SK	47.1	34.9	36.8	47.5
GH	0	0	0	0	SL	0	0	0	0
GI	0	---	---	0	SM	0	0	0	0
GM	0	0	0	0	SN	0	0	0	0
GN	0	0	0	0	SV	0	0	0	0
GP	0	0	0	0	SX	---	0	0	0
GQ	0	0	0	0	SY	0	0	0	0
GR	14.3	4.3	17.8	34.2	SZ	0	0	0	0
GT	0	0	0	0	TD	0	0	0	0
GW	0	0	0	0	TG	0	0	0	0
HK	0	0	0	0	TH	0	0	0	0
HN	0	0	0	0	TJ	---	0	0	0
HR	84.5	64.8	85.6	64.9	TL	0	0	---	0
HT	---	0	0	0	TM	---	0	0	0
HU	36.0	45.8	53.1	39.8	TN	0	0	0	0
ID	0	0	0	0	TO	---	---	---	0
IE	65.8	2.1	67.6	111.4	TR	0.6	0.2	0.9	0.8
IL	0	0	0	0	TT	0	0	0	0
IM	0	---	---	0	TW	38.0	6.7	48.7	1.4
IN	0.1	0.9	1.0	4.7	TZ	0	0	0	0
IQ	0	0	0	0	UA	77.1	37.9	77.0	35.3

IR	0	0	0	0	UG	0	0	0	0
IS	56.5	51.5	86.9	75.0	US	0	0	0	0
IT	41.0	23.3	51.9	72.3	UY	0	0	0	0
JE	0	0	0	0	UZ	0	0	0	0
JM	---	0	0	0	VE	0	0	0	0
JO	0	0	0	0	VG	0	0	0	0
JP	1.5	0.6	1.8	3.5	VI	0	0	0	0
KE	0	0	0	0	VN	0	0	0	0
KG	---	---	---	0	WS	0	---	---	0
KH	0	0	0	0	XK	0	0	0	0
KP	0	0	0	0	ZA	0	0	0	0
KR	48.8	7.8	52.9	30.3	ZM	0	0	0	0
KW	0	0	0	0	ZW	0	0	0	0
KY	0	0	0	0					

Notes: The table shows the coverage of CbC data by Orbis (in %). The figures represent the ratio of the respective variable's realization in Orbis to its realization in the CbC data. "---" indicates that the variable is zero in the CbC data.