INSTITUTE
OF ECONOMIC STUDIES
Faculty of Social Sciences
Charles University

PROFIT SHIFTING OF MULTINATIONAL CORPORATIONS WORLDWIDE

Javier Garcia-Bernardo
Petr Jansky

IES Working Paper 33/2023

Institute of Economic Studies,
Faculty of Social Sciences,
Charles University in Prague

[UK FSV – IES]

Opletalova 26
CZ-110 00, Prague
E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

Institut ekonomických studií
Fakulta sociálních věd
Univerzita Karlova v Praze

Opletalova 26
110 00 Praha 1

E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

Bibliographic information:
Garcia-Bernardo J., Janský P. (2023): " Profit Shifting of Multinational Corporations Worldwide" IES Working Papers 33/2023. IES FSV. Charles University.

This paper can be downloaded at: http://ies.fsv.cuni.cz

Profit Shifting of Multinational Corporations Worldwide

Javier Garcia-Bernardo[1]
Petr Janský[2]

[1]Institute of Economic Studies, Faculty of Social Sciences, Charles University, Prague, Czechia; Department of Methodology & Statistics, Utrecht University, the Netherlands; Centre for Complex Systems Studies, Utrecht University, the Netherlands, E-mail: javier.garcia.bernardo@gmail.com
[2]Institute of Economic Studies, Faculty of Social Sciences, Charles University, Prague, Czechia, E-mail: petr.jansky@fsv.cuni.cz.

December 2023

Abstract:
We exploit the new country-by-country reporting data of multinational corporations, with unparalleled country coverage, to reveal the distributional consequences of profit shifting. We estimate that multinational corporations worldwide shifted over $850 billion in profits in 2017, primarily to countries with effective tax rates below 10%. Countries with lower incomes lose a larger share of their total tax revenue due to profit shifting. We further show that a logarithmic function is better suited for capturing the non-linear relationship between profits and tax rates than linear or quadratic functions. Our findings highlight effective tax rates' importance for profit shifting and tax reforms.

JEL: F23, H25, H26, H32
Keywords: multinational corporation, corporate taxation, profit shifting, effective tax rate, country-by-country reporting, global development

Acknowledgement: We are grateful to Diego d'Andria, Michal Bauer, Jozef Baruník, Sebastian Beer, Katarzyna Bilicka, Julie Chytilová, Kimberly Clausing, Dharmika Dharmapala, Tim Dowd, Martin Gregor, Daniel Haberly, Tomáš Havránek, Martin Hearson, Tomáš Krehlík, Dominika Langenmayer, Jan Luksic, Filip Matejka, Ronen Palan, Miroslav Palanský, Nadine Riedel, Caroline Schimanski, Victor Steenbergen, Francis Weyzig and LudvigWier for excellent comments. We acknowledge support from from the Czech Science Foundation (CORPTAX, 21-05547M) and the International Centre for Tax and Development. This work was supported by the Cooperation Program at Charles University, research area Economics.

The working paper first published: May 2021; this revised version: December 2023.

1 Introduction

Corporate tax avoidance contributes to the view of globalisation as inequitable. Publicised case studies, such as those based on the Panama and Paradise Papers, have detailed how little some large multinational corporations (MNCs) pay in corporate income tax as a result of their profit shifting to low-tax jurisdictions or tax havens. The case studies are not exceptions, with MNCs estimated to shift up to 40% ($600 billion–$1.1 trillion) of their foreign profits to tax havens such as the Netherlands, Switzerland or Bermuda (Clausing, 2016; Tørsløv et al., 2023b). Corporate tax avoidance is problematic because it affects the efficiency and equity of financial markets and societies (Slemrod & Yitzhaki, 2002). For example, large MNCs in the United Kingdom pay lower taxes than domestic firms (Bilicka, 2019). Despite recent growth in research interest in tax havens generally (Alstadsæter et al., 2019; Johannesen & Zucman, 2014; Zucman, 2013) and profit shifting in particular (Clausing, 2020b; de Mooij & Liu, 2020; Garcia-Bernardo, Janský & Tørsløv, 2022; Guvenen et al., 2022; Laffitte & Toubal, 2022; Tørsløv et al., 2023a; Vicard, 2023), we still lack reliable estimates on the origin and destination of profit shifting for many countries worldwide, which is necessary to understand the potential effects of international tax reforms.

In this paper, we exploit a new dataset and develop a novel methodology to address the question of the distributional consequences of profit shifting of MNCs worldwide. Specifically, we answer the following four research questions: (i) What is the scale of profit shifting? (ii) Which tax havens are the largest? (iii) Which MNCs are the most aggressive in profit shifting? (iv) Which countries lose the most relative to their total tax revenues? These intrinsically linked research questions lack definitive answers due to both data-related and methodological challenges. Profit shifting as a form of tax avoidance cannot be directly observed and it is not clear how economists should estimate it. However, the data utilised as well as the choice of function to model the relationship between tax rates and profits have crucial implications for answers to our research questions. In this paper, we address these challenges by using a new country-by-country reporting (CBCR) dataset with vastly improved country coverage and by modelling the extreme non-linearity of that relationship—two contributions that we now outline before proceeding to our main findings.

Our first contribution is to pioneer the use of CBCR by MNCs, alongside several other concurrent studies. These unique data were first made available in 2020 thanks to a new regulation, which emerged from the Base Erosion and Profit Shifting project by OECD, that requires all large MNCs to report profits and taxes in every country, including tax havens and low-income countries. For example, the US CBCR data include 25 African countries, while the frequently used US Bureau of Economic Analysis data only include three. We provide our own estimates of profit shifting for a total of 214 countries using data from 38 headquarter countries, including the major economies of the United States, China and India. While CBCR data include the most reliable country-level information on tax payments and profits of MNCs worldwide, CBCR data aggregate small countries into categories (e.g. "Other Africa"), and might be prone to double-counting of profits due to a lack of clarity in reporting of intercompany dividends and so-called stateless entities. We address the double-counting of profits by developing a method for estimating missing data, disaggregating categories into individual countries, and eliminating double-counting of dividends.

Our second contribution is a methodological one: we propose to model the extremely non-linear relationship between profit location and MNCs' tax rates using a logarithmic function. We build on literature that confirmed the existence of profit shifting, pioneered by Grubert and Mutti (1991) and Hines and Rice (1994). The headline specification of that approach assumes a linear semi-elasticity, which Dowd et al. (2017) show to underestimate profit shifting to low-tax jurisdictions. Dowd et al. (2017) instead introduce a quadratic semi-elasticity, which does constitute an improvement. However, we show that not even the quadratic model is capable of capturing the empirically observed extreme non-linearity in the data: 85% of profit shifted takes place towards countries with tax rates below 10%. In this paper, we therefore introduce a logarithmic model to fully capture the extreme non-linearity of the semi-elasticity of profits to tax rates. Although estimates of the global scale of profit shifting are similar for linear, quadratic and logarithmic functions as well as a simpler misalignment model measuring the difference between locations of profits and economic activity, they differ substantially at the country level: the logarithmic function and the misalignment model point to profits being shifted relatively more to countries with zero or very low effective tax rates. This naturally has implications for the estimated distributional consequences of profit shifting to tax havens.

We apply the logarithmic model to the CBCR data to establish the scale and distribution of profit shifting in many countries worldwide, revealing four main findings that answer the four research questions outlined above. First, MNCs shifted over \$850 billion in profits to tax havens in 2017, which in turn implies \$200–300 billion in revenue losses for other countries. Our total estimates of profit shifting are broadly comparable to existing estimates such as Tørsløv et al. (2023b) and Wier and Zucman (2022), who estimate profit shifting to be \$616 billion in 2015 and \$969 billion in 2019—see Table A25 for a more detailed comparison with Tørsløv et al. (2023b) and Table A13 for a comparison with additional studies. By combining our modelling approach with the extreme non-linearity and exceptionally high coverage of our dataset (214 countries), we arrive at semi-elasticity estimates that are consistent with higher shares of profits in tax havens.

Second, we proceed to estimating which tax havens are the largest. The large majority of shifted profits are shifted to a small group of countries with extremely low effective tax rates (ETRs), defined as the ratio of accrued taxes over profits. We find that the Cayman Islands, Luxembourg, Singapore, Canada, the Netherlands, Switzerland, Hong Kong, Bermuda, Puerto Rico and Ireland are the largest destination of profits. In contrast with the consistent estimates across models of the overall scale, the largest tax havens—as well as the countries affected by them—differ substantially between models. The United Kingdom is seen as a source of profits in the misalignment model, while a recipient of profits (given its low tax rate) in other models. The misalignment and logarithmic model agree that the vast majority of profits in small tax havens (e.g., the Cayman Islands or Luxembourg) are shifted there, while the quadratic and linear models are not able to capture the extent of profit shifting. Moreover, high-income countries capture most of the tax revenue gains due to being destinations of profit shifting.

Third, among headquarter countries reporting on over 20 jurisdictions, MNCs headquartered in the United States, Brazil and Singapore are the most aggressive in terms of profit shifting. In contrast, we find no evidence of profit shifting towards tax havens by MNCs headquartered in South Africa and Malaysia. While a great deal of previous research has been carried out on US-headquartered MNCs due to data availability, our results highlight that they are not necessarily representative of all MNCs and that there are important differences across countries. Consequently, policymakers might negotiate international agreements differently if they know how aggressive their own MNCs are in comparison with other countries' MNCs with respect to profit shifting.

Fourth, we contribute to the ongoing discussion of which countries lose more tax revenue due to profit shifting. CBCR data has much higher country coverage (214 countries) and includes many lower-income countries for the first time. We find that it is precisely these lower-income countries that tend to lose more tax revenue due to profit shifting relative to their total tax revenue, directly contravening one of the goals of the 2030 Agenda for Sustainable Development, namely to: "Strengthen domestic resource mobilization, including through international support to lower-income countries, to improve domestic capacity for tax and other revenue collection". In absolute terms, the United States is estimated to suffer the most from profit shifting while other high-income countries such as Germany and France are estimated to lose up to half of their profit base in this manner.

Overall, our paper's enhanced methodology and data provide a possible resolution to the inconsistency between so-called micro and macro estimates of profit shifting found in existing literature. Specifically, the relatively low (micro) estimates of tax semi-elasticity in earlier studies (Beer, De Mooij et al., 2020; Heckemeyer & Overesch, 2017) could not explain the (macro) estimates of the high shares of profits reported by MNCs in tax havens (Dharmapala, 2019; Zucman, 2015). In this paper, we show that one explanation for the apparent inconsistency is the manner in which the relationship between profits and tax rates has been modelled using mostly linear and, far less frequently, quadratic functions (Dowd et al., 2017; Mutti & Ohrn, 2019). When we instead use a logarithmic function to allow for the relationship's extreme non-linearity, we arrive at high estimates of tax semi-elasticity at low levels of ETRs and, consequently, a very high share of profits in a number of tax havens with low ETRs. While the CBCR data may need to be provided at firm level or for several years to facilitate even more nuanced findings, such as on the incidence or industry heterogeneity of profit shifting worldwide, our improved methodology and dataset do help reconcile the micro and macro estimates.

We structure the rest of the paper as follows. In Section 2, we introduce the new logarithmic model designed to estimate the scale and distribution of profit shifting to tax havens and compare it with existing specifications of the semi-elasticity model. We then describe how we reallocate the shifted profit from tax havens to other countries, as well as including the so-called misalignment model as an alternative to the semi-elasticity model. In Section 3, we discuss the available datasets used to estimate profit shifting, mainly the CBCR data. In Section 4, we show how our methodology improves profit shifting estimation using the US CBCR data, applies the methodology to the OECD CBCR data to obtain global estimates, and describes how profit shifting differs by countries' per capita income. In Section 4, we also summarise several robustness checks and sensitivity analyses with which we show that our findings are robust to changes in the methodology. In Section 5, we conclude the paper.

2 Methodology for estimating profit shifting

In this section we first introduce the traditional methodology for estimating profit shifting using linear and quadratic specifications (Section 2.1). We then detail our logarithmic specification as this paper's preferred way of estimating the scale of profit shifting to tax havens (Section 2.2). We proceed to describe how the shifted profit is reallocated from tax havens to other countries on the basis of economic activity (Section 2.3). Finally, we describe how we apply this logic of shifted profit reallocation to estimate the scale of profit shifting itself using the so-called misalignment model (Section 2.4).

2.1 Semi-elasticity model

MNCs can, and many of them do, engage in shifting profit to tax havens where they seek lower taxation of their profits—a recent review of existing literature is provided by Beer, De Mooij et al. (2020). The profit booked in a jurisdiction i by MNCs (π_i) can be expressed as a sum of the "real unobserved profits" (p_i) and profits shifted into the jurisdiction (S_i) minus the cost of profit shifting incurred by the MNCs (c_i):

$$\pi_i = p_i + S_i - c_i. \tag{1}$$

While various methodologies have been used to estimate profit shifting (e.g. Álvarez-Martínez et al., 2021; Auerbach et al., 2017; Crivelli et al., 2016; Dharmapala and Riedel, 2013; Huizinga and Laeven, 2008; Weichenrieder, 2009), profit shifting is most frequently modelled using the method proposed by Hines and Rice (1994). This method assumes that the cost of profit shifting increases quadratically with the fraction of profit shifted (this assumption and other theory-related issues are discussed in more detail in section A.2). The booked profits (π) are maximised subject to the existence of profit shifting. Subsequently, theoretical profits are identified with the Cobb-Douglas production function, yielding equation 2 for the first-order Taylor expansion and equation 3 for the first-order Taylor expansion around the two values of the Lagrange multiplier where profit shifting becomes zero (it is worth noting that the points where profit shifting becomes zero are far from the most interesting cases: tax havens, see section A.2):

$$\log(\pi_i) = \beta_0 + \beta_1 \log(K_i) + \beta_2 \log(L_i) + \beta_3(\tau_i) + \beta_\chi \chi + \epsilon, \tag{2}$$

$$\log(\pi_i) = \beta_0 + \beta_1 \log(K_i) + \beta_2 \log(L_i) + \beta_3(\tau_i) + \beta_4(\tau_i)^2 + \beta_\chi \chi + \epsilon, \tag{3}$$

where π_i represents profits booked in country i, including both real profit and profit shifted, and K_i and L_i are the capital and labour components of the Cobb-Douglas production function, usually operationalised with total tangible assets and wages. τ_i is either the tax rate of the subsidiary, the difference of tax rates between the subsidiary and the parent, or, less frequently (due to lacking data), between the subsidiary and other subsidiaries, and χ are controls including e.g. GDP per capita and population.

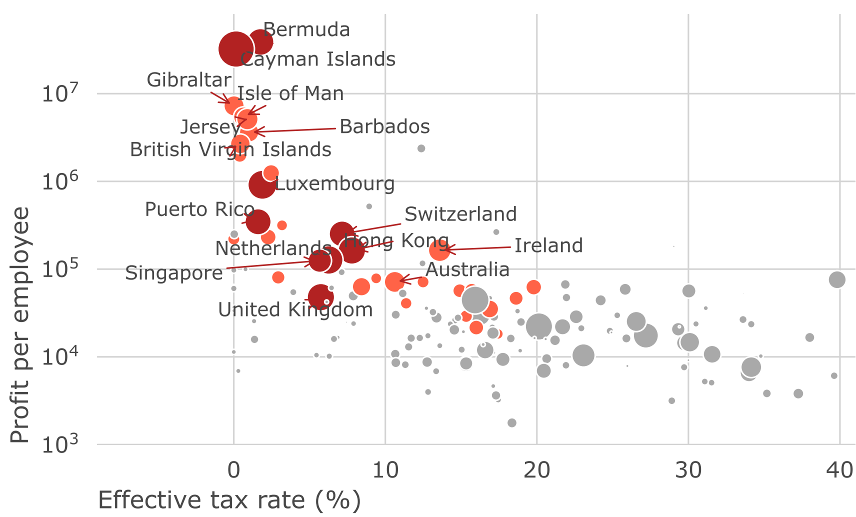
Both equations are currently viewed as traditional methods. However, follow-up studies use equation 2 and its modifications much more than equation 3, even though Hines and Rice, 1994 noted that the results of 3 suggest that the effect is strongest at low tax rates. Recent research has revisited the possibility of significant curvature in the relationship between tax rates and reported profits. In particular, Dowd et al. (2017) apply equation 3 to a panel dataset of US tax returns spanning the 2002–2012 period and find that the effect of tax on profit shifting is not linear, namely that incentive to shift profits from a country with a tax rate of 20% to one with a tax rate of 0% is more than double compared to incentive to shift profits from a country with a tax rate of 20% to one with a tax rate of 10%. Dowd et al. (2017) account for this non-linearity by including a quadratic term.

2.2 Addressing extreme non-linearity: A logarithmic model

In this paper, we argue that the non-linearity of tax semi-elasticity is too extreme to be adequately accounted for using linear or quadratic models. We argue that the assumption of the quadratic relationship between the fraction of profit shifted and the cost of profit shifting, while suitable for the transfer pricing of physical goods where arm-length prices are more readily available, is not suitable for profit shifting strategies based on financial assets such as intellectual property or intra-group lending. In these strategies, the costs of profit shifting are largely fixed and do not differ significantly with profits. As such, the cost as a fraction of profits shifted is high for low fractions of profit shifted and subsequently decreases (Dischinger & Riedel, 2011). Once a tax avoidance structure is in place (e.g. intellectual property located in a tax haven), we assume that the costs do not increase much with each additional dollar of profit shifted through it. Consequently, since they constitute a small share of their overall costs and are typically much lower than the tax avoided through profit shifting, these costs are minor for large MNCs (and only those are included in the CBCR data). By contrast, smaller companies may not find it viable to set up such tax avoidance structures at all and this dichotomy has been observed previously (Davies et al., 2018; Johannesen et al., 2020); indeed, large MNCs tend to be responsible for the bulk of profit shifting (Wier & Erasmus, 2022). Moreover, these costs are comparable regardless of which tax haven profits are shifted to. Firms thus have an incentive to shift profits to tax havens with the lowest effective taxation available, not merely to countries with lower ETRs, and, therefore, models including a logarithmic semi-elasticity would more effectively model profit shifting.

This theoretical prediction is empirically backed by three observations. The first takes into account the extreme non-linearity of the profitability of firms in tax havens. The reported profit per employee is relatively constant around $30,000 to $50,000 per employee in all countries with an ETR over 10%, and exponentially increases as the ETR falls below that level (Fig. 1). The second observation focuses on the empirical results by Dowd et al. (2017). Their discontinuity model yields semi-elasticities for ETRs below 10% which are twice as large as those yielded by their quadratic model, indicating that the extreme non-linearity is not fully captured using a quadratic term. The third observation is derived from our data-driven exploration of the data (see Appendix A.5), where we use symbolic regression to obtain models which best fit the data. All of these models include a term which allows for extreme non-linearity semi-elasticities: a logarithmic term.

Figure 1: Profit per employee as a function of the ETR using the OECD data



Notes: Profit per employee as a function of the ETR using the OECD data. Colour indicates the ETR (below or above 10%). Note that the horizontal axis is logarithmic, and as such the effect of effective tax rate on the profitability per employee, which is driven in a large part by profit shifting, is extremely non-linear. The horizontal axis is cut at 40% to increase readability. Only nine countries have a tax rate above 40% (Angola, Guyana, Malawi, Niger, Nigeria, Pakistan, Reunion, Rwanda, Tonga).

We argue that including a logarithmic term enables us to capture the extreme non-linearity better than the inclusion of a quadratic term, and we show this empirically in the results section. In order to model the extreme non-linearity, we propose to modify the equation as follows:

$$\log(\pi_i) = \beta_0 + \beta_1 \log(K_i) + \beta_2 \log(L_i) + \beta_3(\tau_i) + \beta_4 \log(t + \tau_i) + \beta_\chi \chi + \epsilon. \tag{4}$$

where τ is the tax rate faced by the subsidiary which we proxy by ETRs (and t is an offset parameter, which we discuss below). Likewise, three recent influential profit shifting studies all use ETRs to estimate profit shifting in one way or another (Clausing, 2020b; Guvenen et al., 2022; Tørsløv et al., 2023b). ETRs are superior to statutory rates because they are capable of better capturing the actual tax rate faced by MNCs and are more likely to be used by MNCs for profit shifting decision-making. A great deal of existing literature (e.g. Dharmapala, 2014) uses statutory rates, arguing that they are determined by governments and are thus generally exogenous to firms' choices (and mostly for comparability, we present estimates using statutory rates for both data sets in Tables A16 and A17, which show that these models generally perform worse than those with ETRs: for the US data, they have lower R-squared in every case and the BIC values are higher with the exception of the linear model). Such endogeneity might be of importance for the research question of whether MNCs shift profits to countries with low tax rates, of which there is now abundant evidence (Beer, De Mooij et al., 2020). However, once we move on to the scale, destinations and origins of profit shifting, the informativeness about the actual rates MNCs face becomes more important. In particular, statutory rates are not very informative about the taxes MNCs face (e.g. what Dharmapala, 2014 highlighted as some possibility of mismeasurement of actual tax rates), correlate only weakly with various measures of ETRs (Garcia-Bernardo et al., 2021) and do not seem to sufficiently explain the location of profits (e.g. Section A.5). For example, Luxembourg had a statutory rate of 29.22% in 2017, whereas our ETR estimate for the same year is 1% (Table 2) and is in line with ETR estimates from other data sources (Garcia-Bernardo et al., 2023).

In equation 4, t is an offset parameter, included in order to avoid obtaining extremely high differences in the tax semi-elasticity for countries with similar but extremely low tax rates. We obtain the optimal value of the offset (0.0011 for US data and 0.0023 for OECD data) numerically by iterating over the range 0–0.2 and keeping the value that minimises the Bayesian Information Criterion. In section 4.4 we show that our results are highly robust to the choice of the offset, and that including this parameter in the linear and quadratic models does not increase their predictive power. We further include headquarter-country fixed effects to account for differences in profitability and data reporting methods between MNCs headquartered in different countries, and interaction terms between the country fixed effects and $log(t + \tau_i)$, which capture differences in the profit shifting aggressiveness of the MNCs of different reporting countries.

Consistently with literature, we operationalise capital (K) using tangible assets, and labour (L) using wages. A limitation of the operationalisation of the capital component through tangible assets is that tangible assets are affected by profit shifting strategies. For example, US MNCs in

Luxembourg report the second highest value of tangible assets in Europe according to the CBCR data, with a combined value of $223 billion (equal to values reported by US MNCs in the rest of the European Union, excluding tax havens). As a consequence, the use of tangible assets yields conservative estimates of the tax semi-elasticity. Since the data does not include wages, we model them using the product of employees and the average salary in each country, obtained from the International Labour Organization. Missing values in the average salary are estimated using a linear model containing log-GDP and log-Population ($R^2 = 0.91$).

After estimating the tax semi-elasticities using equation 4, we calculate for each pair of countries (headquarter country and jurisdiction of operation) the underlying profits without profit shifting, $\hat{p_i}$. To do this we remove the effect of tax rates by comparing the profits reported in country *i* with profits in a hypothetical scenario where the country's ETR is 25%:

$$\hat{p_i} = \pi_i \cdot \frac{e^{(\beta_3(0.25)+\beta_4 \log{(t+0.25)})}}{e^{(\beta_3(\tau_i)+\beta_4 \log{(t+\tau_i)})}}. \tag{5}$$

This ETR threshold of 25% corresponds roughly to a zero marginal effect of the ETR on profits in the quadratic and logarithmic models, as explored further in the results section. Since MNCs do not appear to shift profits to countries with ETRs above 15%, and our threshold is 25%, $\hat{p_i}$ is almost always larger than π_i. The results are robust to changes in this threshold. A threshold of 20% reduces the estimate of profit shifting using the logarithmic model by 8%, the estimate using the quadratic model by 11% and the estimate using the linear model by 19%. This is expected, since the vast majority of profits are shifted towards countries with extremely low tax rates, which the logarithmic models can account for. In addition, we observe in Orbis that most MNCs indeed have opportunities to shift profits to tax havens. Specifically, 3,804 out of 5,391 (70%) corporate groups, accounting for 89.7% of profits in Orbis, have a subsidiary in one of the following tax havens: Bermuda, Ireland, Luxembourg, Netherlands, Switzerland, Cayman Islands, British Virgin Islands, Hong Kong, and Singapore.

2.3 Reallocating shifted profits

We now proceed to describe how the shifted profit is reallocated from tax havens to other countries and start by discussing how it is linked with the equation 1 above. Profit shifting is calculated as the difference of the booked profits and the estimated profits, assuming that the cost of profit shifting is negligible (as discussed in section 2.2 above):

$$\hat{S_i} = \pi_i - \hat{p_i} \tag{6}$$

Since $\hat{p}_i$ is almost always larger than π_i, S_i does not correspond to profit shifted in or out of the country (i.e. $\sum_i \hat{S}_i) > 0$). For this to happen, we need to redistribute shifted profits to where real economic activity takes place:

$$\Delta P_i = -\hat{S}_i + (\sum_i \hat{S}_i) \cdot R_i, \tag{7}$$

where the change in profits due to profit shifting, ΔP_i , is defined as the profits shifted out of the country, $-\hat{S}_i$ (we reverse its sign since $\hat{S}_i$ measures profits shifted into a country), plus the share of total profit shifted redistributed back to the country.

We define the redistribution formula, R_i, operationalising real economic activity, as

$$R_i = 1/4\frac{L_i}{\sum_i L_i} + 1/4\frac{W_i}{\sum_i W_i} + 1/2\frac{Rev_i}{\sum_i Rev_i}, \tag{8}$$

where 25% of the weight is given to employees (L_i), 25% to wages (W_i) and 50% to unrelated party revenues (Rev_i). We use unrelated party revenues, which are less affected by tax-planning strategies than, for example, tangible assets. This is the same formula used by the misalignment model described in section 2.4. The reallocation of shifted profits to the jurisdictions where economic activity takes place is also used in the impact assessment of the (OECD, 2020) BEPS plan in both pillar one (excess profit allocation) and pillar two (operationalization of the undertaxed payments rule), as well as by Beer, Mooij et al. (2020)—i.e., it is common to use a formulary approach to identify where the economic activity takes place. In the sensitivity analysis, we test that our results are robust to changes in the redistribution formula. The alternative redistribution of using bilateral balance of payments data (Tørsløv et al., 2023b) is not feasible due to the poor coverage of that data for many countries worldwide (Cobham et al., 2021).

After the redistribution, the sum of the change in profits due to profit shifting, $\sum \Delta P_i$, sums to zero.

Finally, tax revenue loss, TRL_i, is the product of the change in the profit base and the ETR (and we use the statutory rate as a robustness check):

$$TRL_i = \Delta P_i \cdot ETR_i \tag{9}$$

2.4 Misalignment model

In addition to various semi-elasticity model specifications, we estimate the scale of profit shifting based on profit misalignment. The misalignment model applies basic arithmetic to the data to observe how well the location of reported profits are aligned with the location of economic activity, typically approximated by a combination of labour (measured using wages and employees), capital (often approximated with tangible assets) and revenue. Profit misalignment is then calculated as the difference between reported profits (π) and estimated theoretical profits (($\hat{p}$)). In our version of this method, and as in equation 8, we calculate $\hat{p}$ giving 25% of the weight to employees, 25% of the weight to wages, and 50% of the weight to unrelated party revenues (eq. 10). Since the majority of profits are shifted towards a small number of tax havens, the exact formula has little impact on the aggregated estimation of profit shifting, although can affect the results for individual countries (which we explore in section 4.4).

$$\hat{p_i} = R_i \cdot \sum_i \pi_i. \tag{10}$$

Profit shifting is again calculated as the difference between booked profits and the estimated profits (eq. 6). In a pure misalignment model, the sum of profit shifting is equal to zero ($\sum \hat{S}_i = 0$ and $\Delta P_i = \hat{S}_i$). We, however, add one extra constraint, similarly to OECD (2020). We set the profit misalignment of all foreign observations (pairs of reporting and investment countries where the reporting and investment countries are different) with a tax rate higher than 25% to zero, since we assumed that an MNC would not shift profits to a country with a tax rate over 25%. This corrects for extreme outliers, such as the high profits of of MNCs in resource-rich countries compared with the economic activity in the countries. In order to ensure that $\sum \Delta P_i = 0$, we redistribute the profits as in section 2.3.

The logarithmic and misalignment models have different advantages. The logarithmic model explicitly models the observed extremely non-linear relationship between profits and tax rates (Fig. 1), and as such provides an estimate on the tax semi-elasticities (which we later visualize in Figures 2 and A16). In contrast, the misalignment model provides a better estimate of the origin and destination countries of profit shifting because it takes into consideration the current distribution of profits. The logarithmic model is agnostic to this fact, and redistributes the profits only as a function of the location of economic activity.

The redistribution of shifted profits works differently in the two methods, as we illustrate in the following example. Assume that $9 million profits are located in the US, $0 million are located in India and $1 million are located in the Cayman Islands. In contrast, the wages and sales in the United States add up to $9 million, $1 million in India and in $0 million in the Cayman Islands. Both the logarithmic and the misalignment models would find that the shifted profit or the total misalignment is approximately $1 million (located in the Cayman Islands), but the redistribution would differ. The logarithmic model would redistribute 90% of those shifted profits to the US and 10% to India. Since the profits in the US are comparable to the economic activity, the misalignment model would redistribute 0% of those profits to the US and 100% to India. Since the misalignment model takes into consideration the degree of profit shifting out of a country—as our example illustrates—the redistribution of profits is more accurate and realistic under the misalignment model than under the logarithmic specification.

3 Data

Our paper exploits the CBCR dataset that became available in July 2020, and is of unprecedented quality. The dataset was created thanks to a CBCR regulation that stems from OECD Base Erosion and Profit Shifting (BEPS) Action 13, and requires all large MNCs to report how much tax they pay in individual countries, including tax havens. The regulation impacts MNCs with consolidated annual group revenue of €750 million and above, headquartered in any country that has adopted the CBCR regulation. The firm-level data is collected by the headquarter country (a template is depicted in Fig. A8), aggregated by country of operations, and published by the OECD. The published data, which we use in this paper, is thus aggregated at the country level for each reporting country — for example, India publishes data on the operations of India-headquartered MNCs in Ghana, Switzerland and many other countries.

To our knowledge, there are now several concurrent research papers using CBCR data from the US (Clausing, 2020b; Cobham et al., 2019; De Mooij et al., 2019; Garcia-Bernardo et al., 2021; Garcia-Bernardo, Janský & Zucman, 2022; Nessa et al., 2022), Italy (Bratta et al., 2021), Germany (Fuest, Hugger et al., 2022) and, most recently, Germany and other countries (Fuest, Greil et al., 2022), and this has been the first paper using the OECD CBCR data.

We use the 2017 OECD CBCR data, which contains data for 38 headquarter countries (see Table A4). The US IRS has been publishing CBCR data approximately one year before it is published by the OECD, which has allowed previous researchers to compare US CBCR with other sources (Clausing, 2020b; Garcia-Bernardo et al., 2021), and established a good correlation between various types of data sources. Moreover, the CBCR data is outstanding in at least three dimensions.

First, one of the most obvious advantages of CBCR data over other data sources is its much more substantial country coverage. This is especially relevant for lower-income countries and for selected parts of the world, for which coverage from other data sources is notoriously limited (Garcia-Bernardo et al., 2021). For example, US CBCR data includes information on taxes and profits for US MNCs in 25 African countries, while the frequently used data from the Bureau of Economic Analysis of the United States Department of Commerce only covers 3. CBCR data includes data on large MNCs' profits and tax payments in, for example, up to 145 (United States) and 198 (Japan) jurisdictions in the full dataset. The exceptional data coverage of up to 214 countries enables us to estimate the scale of profit shifting for lower-income countries. This country coverage is one reason why UNODC and UNCTAD (2020) propose to use this CBCR data for the Sustainable Development Goals indicator of illicit financial flows, likely in a similar way that we implement the profit misalignment method outlined in Section 2.4.

Second, CBCR ensures that profits and taxes are defined consistently with the concepts of corporate profits and taxes. By contrast, this is not the case with, for example, Bureau of Economic Analysis data, where profits are imputed from a combination of net profits, intra-group dividends, interest paid and other variables, as recently discussed by Blouin and Robinson (2020), Clausing

(2020a, 2020b) and Garcia-Bernardo et al. (2021). Consequently, CBCR data excludes double-counting in revenue.

However, a certain extent of double counting in profit due to intercompany dividends, for which we correct, and stateless entities, which we drop from our analysis, is inevitable and confirmed by existing evidence on which we build. Specifically, we correct for double counting in profit in five ways that we briefly summarise here and discuss in more detail in the Appendix A.1. First by excluding stateless entities. Second, some countries such as the Netherlands investigated the extent of double counting in domestic profits and we use their corrections. Third, we remove double counting of US profits, as estimated by Garcia-Bernardo, Janský and Zucman, 2022. Fourth, we remove 10% of profits in tax havens for non-US MNCs (a similar ratio that the one found by Garcia-Bernardo, Janský and Zucman, 2022 for US MNCs). Fifth, we remove certain domestic profits in other countries depending on the relative difference between ETR on domestic and foreign profits. When corrected for double-counting in profits, CBCR data offers the best available information on MNCs' tax payments for many countries, it thus provides us with the first suitable dataset for a high-quality cross-country comparison—until now various proxies for profits were used, for example, by Haberly and Wójcik (2015), Bolwijn et al. (2018) or Damgaard et al. (2019).

Third, CBCR data is provided in two separate datasets, for all subsidiaries ("All Sub-Groups"), as well as for those subsidiaries that had positive profits and so not losses ("Sub-Groups with Positive Profit"). While the data on affiliates with positive profits has lower coverage (Table A4), it allows for more accurate estimates of the ETRs.

3.1 Use of data in the logarithmic and misalignment models

We use different subsets of the data for different parts of the methodology. We estimate ETR as the ratio of accrued taxes over profits, using the data on "sub-groups with positive profits". By using the data with positive profits only, we avoid offsetting firms with losses and firms with profits, and we can thus estimate ETRs more precisely. Since taxes are typically paid by companies earning profits, including companies making losses would overstate ETRs. We use ETRs in two parts of the paper: to calculate profit shifting in the semi-elasticity models, and to calculate tax revenue losses. For the semi-elasticity models we remove outliers—country dyads with tax rates above 50%. This eliminates outliers and allows for a more efficient estimation of the semi-elasticities. To calculate tax revenue losses we use the average ETR in the country, using the average ETR paid by foreign MNCs and the statutory tax rate as robustness checks. The average ETR is weighted by profits booked: $\frac{ETR_i \pi_i}{\sum \pi_i}$. For countries that are only available in the data on all sub-groups but not in the data on sub-groups with positive profit, we used the statutory corporate income tax rate (which was the case for Anguilla, Antigua and Barbuda, Cuba, Djibouti, French Guiana, Guadeloupe, Haiti, Kiribati, Kosovo, Kyrgyz Republic, Sao Tome and Principe, St. Lucia, St. Vincent & Grenadines, Syria, Turkmenistan, Turks and Caicos Islands). The ETRs are reported in Table A11.

First, we estimate the semi-elasticity model (detailed in section 2.1) using data on "sub-groups with positive profits". In addition, we run a robustness check and find no significant differences with the full sample, see section 4.4 for more information. Table A5 shows the summary statistics of the CBCR data for the countries in this sample, distinguishing between domestic and foreign activities of MNCs—domestic ones are those in the reporting (i.e. headquarter) countries, while foreign ones are those in all other countries (i.e. except for the domestic one). For most countries domestic profits and activities are higher than foreign ones. The observed balance between domestic and foreign activities provides useful guidance for when we estimate missing data in Section A.1.

Second, we reallocate profits shifted (equation 8) using the dataset including all sub-groups for the 38 countries that reported some information. Using the complete dataset allow us to more accurately measure information on real economic activities of MNCs regardless of whether the affiliates are profit- or loss-making. Since MNCs prefer to report losses in countries with high taxes while locating their profits in countries with low taxes, excluding loss-making affiliates would exclude an important component of profit shifting (see Figure A9 for a visualisation of this behaviour in the CBCR data, and De Simone et al. (2017) for an empirical confirmation using tax returns data in the United Kingdom). The dataset on all sub-groups is also more suitable for comparison with other datasets (e.g. from the Bureau of Economic Analysis).

Finally, and for the same reasons explained in the previous paragraph, we used data on all sub-groups for the misalignment model. The ETRs (used to calculate tax revenue losses) are still calculated from the data on sub-groups with positive profit. Since the misalignment method is not affected by outliers we keep all observations in the sample.

While we make use of the substantial country coverage and other advantages of CBCR data, we carefully deal with several remaining challenges associated with the new data source, particularly missing data and double counting of profits. We describe how we address the data limitations in detail in Appendix A.1.

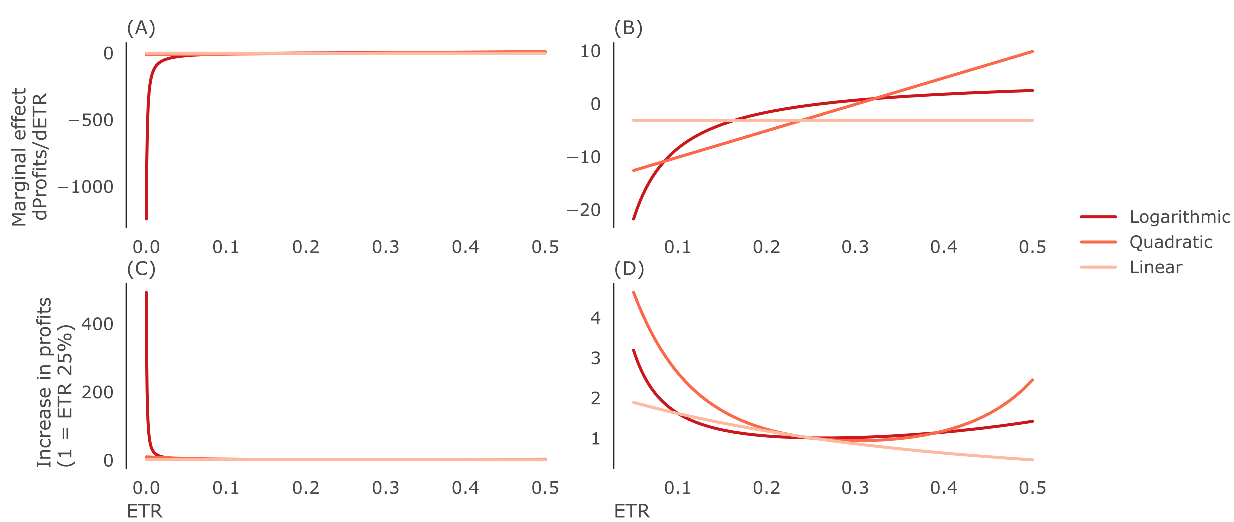
4 Results

The results section is composed of four parts. In the first part we demonstrate the advantage of our methodology using the US CBCR data. In the second part we apply our methodology to the OECD CBCR data, and compare it to estimates generated using other methodologies. In the third part we test whether the scales of profit shifting and associated tax revenue loss are higher or lower in some country groups. In the fourth part, we present a series of robustness tests and sensitivity analyses.

4.1 Estimation of profit shifting (US data): the logarithmic model versus other models

We first test our methodology using only US CBCR data. Restricting our analysis to US data allows us to compare with previous analysis, including one of the best-regarded papers on profit shifting using tax semi-elasticities, Dowd et al., 2017. The results of our regressions (Table 1) shows that the logarithmic model fits the data better than any other model. This not only involves a higher R-square and lower Bayesian information criteria, but also a better disaggregation of the origin and destination of profits shifted. Fig. 2 shows a graphical interpretation of the coefficients. The logarithmic model is capable of accounting for extreme ratios of profit shifted in small countries with low ETRs, while at the same time avoiding the overestimation of profit shifted in countries with tax rates above 15%. For a country with a tax rate of 15% (e.g. Australia), the logarithmic model estimates that 16% of the profits are shifted in, while the quadratic and linear models estimate that number to be 40 and 26% respectively. Importantly, the logarithmic model and the misalignment model clearly identify that the majority of profits in small countries with extremely low tax rates are shifted there. This effect is less pronounced for the quadratic model, and especially so for the linear model (Table 2). For an ETR of 1.7% (e.g. Bermuda), the logarithmic and quadratic model estimates that 91% and 86% of the booked profits have been shifted into the country (and 98.5% with the misalignment method below), while the linear model estimates that only 52% have.

Figure 2: Comparison of tax semi-elasticity estimates using the 2017 US data



Notes: Graphical representation of Table 1 for the logarithmic, quadratic, linear models. (A, B) Marginal effect of ETR on profits. (C,D) Relative increase in profits due to profit shifting, compared with a country with an ETR of 25%. Plots B and D are close-ups of plots A and C respectively, constraining ETRs between 5 and 50%. Note that the marginal effects for the logarithmic model decreases (becomes more negative) faster than other models as the ETR approaches 0%.

Table 1: Comparison of tax semi-elasticity estimates using the 2017 US data

	Log	Quad	Log+Quad	Linear
ETR	5.1998***	-15.1545***	8.4752	-3.1654***
	(1.4324)	(3.0356)	(5.2472)	(1.0062)
ETR^2		24.9745***	-5.0609	
		(6.0246)	(7.7973)	
log(0.0011 + ETR)	-1.3813***		-1.5210***	
	(0.1959)		(0.2915)	
log(Tangible assets)	0.5456***	0.6745***	0.5412***	0.7595***
	(0.0751)	(0.0815)	(0.0756)	(0.0861)
log(Wages)	0.2481***	0.1163	0.2541***	0.0442
	(0.0885)	(0.0977)	(0.0893)	(0.1049)
log(Population)	0.1638*	0.1094	0.1602*	0.0200
	(0.0859)	(0.0983)	(0.0863)	(0.1046)
log(GDP per capita)	0.1664	0.2132	0.1638	0.2347
	(0.1316)	(0.1510)	(0.1322)	(0.1646)
N	91	91	91	91
R-squared	0.8850	0.8481	0.8856	0.8170
R-squared Adj.	0.8768	0.8372	0.8759	0.8062
BIC	230.48	255.83	234.53	268.26

Notes: Comparison of semi-elasticities for the logarithmic (Log), quadratic (Quad), the combination of the two (Log+Quad) and linear (Linear) models using the 2017 US CBCR data. The dependent variable for all models is profits booked in country in logarithm. (We include the combination of the two (Log+Quad) models in this and other regression tables as a robustness check to test whether the Log model was not better because it was more complex; the results show that adding a Quad term to the Log model does not improve the model.)

Figure 2 shows a U-shaped relationship in the effect of ETRs on profits. The semi-elasticity is negative until the ETR reaches approximately 25%, thereafter becoming positive. This is due to high profits in countries rich in natural resources, such as Angola, the United Arab Emirates, Qatar, Norway and Nigeria. These countries levy resource taxes while carrying out activities that produce vast amounts of profit in relation to the labour and capital costs. In order to correct for this in our estimates of profit shifting, we assume a tax semi-elasticity of zero if the ETR is higher than 25%. This approach is also used in the Impact Assessment of the BEPS plan OECD, 2020.

Next, we redistribute the profits shifted according to equation 8 to calculate global profit shifting. The logarithmic model yields an estimate of $364 billion of profit shifted, comparable to the $323 billion of profit shifted found by the misalignment strategy (Figure 3). Since our objective in this section is to compare the different methodologies and not to present the scale of profit shifted for individual countries, we do not try to disaggregate categories, such as “Other Europe”, into individual countries, as detailed in section A.1 and as applied in section 4.2. The destination

Table 2: Percentage of profits shifted into countries with at least $10 bn reported using the 2017 US data

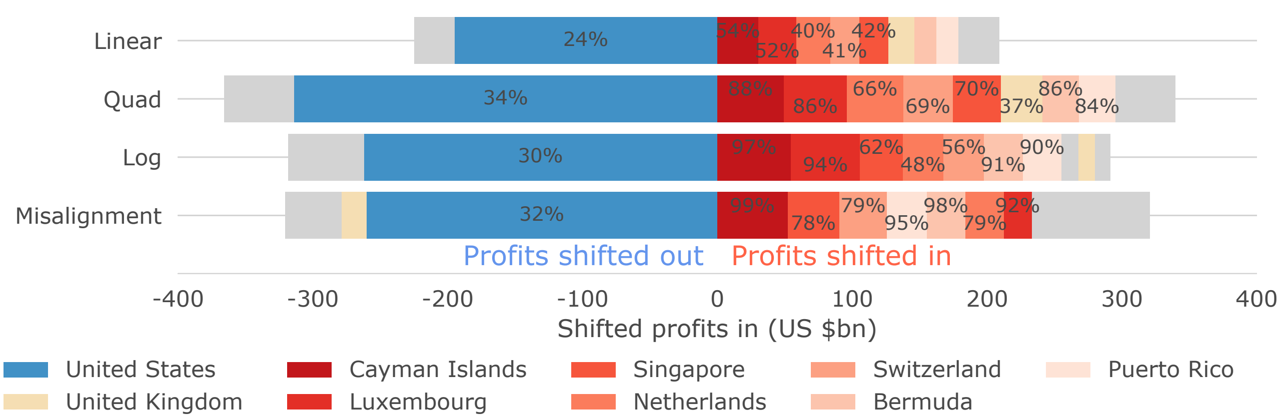
Country	ETR	Profits (+)	Profits (all)	Misal.	Log	Quad	Linear
Jersey	0.1%	$12.8 bn	$10.5 bn	97.3%	99.4%	89.0%	54.5%
Cayman Islands	0.6%	$56.1 bn	$52.7 bn	98.8%	97.6%	88.3%	53.9%
Other Europe	0.8%	$13.6 bn	$0.0 bn	-	96.5%	87.9%	53.6%
Luxembourg	1.0%	$54.4 bn	$22.4 bn	92.0%	95.2%	87.5%	53.2%
Puerto Rico	1.6%	$31.7 bn	$30.9 bn	94.9%	91.8%	86.4%	52.3%
Bermuda	1.7%	$31.9 bn	$29.2 bn	98.5%	91.4%	86.2%	52.2%
Other America	2.4%	$12.2 bn	$-0.1 bn	-	86.4%	84.7%	51.1%
Singapore	5.0%	$51.1 bn	$49.2 bn	78.2%	68.6%	78.4%	46.9%
Switzerland	6.1%	$53.3 bn	$44.4 bn	79.4%	61.3%	75.3%	45.0%
Netherlands	7.5%	$63.0 bn	$36.0 bn	79.2%	51.9%	70.7%	42.4%
United Kingdom	11.6%	$81.7 bn	$18.1 bn	-	29.8%	55.2%	34.5%
Hong Kong	12.3%	$12.2 bn	$11.1 bn	48.0%	26.8%	52.3%	33.1%
Ireland	13.8%	$30.8 bn	$26.5 bn	54.3%	20.9%	45.8%	29.9%
Canada	15.2%	$40.1 bn	$31.7 bn	7.5%	15.8%	39.2%	26.6%
Australia	15.3%	$18.1 bn	$14.8 bn	27.8%	15.6%	38.9%	26.4%
Japan	20.5%	$25.5 bn	$24.9 bn	44.9%	3.8%	15.6%	13.2%
China	23.0%	$28.5 bn	$26.8 bn	-	1.1%	6.1%	6.1%
Germany	24.9%	$19.8 bn	$6.8 bn	-	-	0.3%	0.4%
Brazil	25.5%	$12.0 bn	$5.9 bn	-	-	-	-
Nicaragua	26.7%	$17.7 bn	$0.1 bn	-	-	-	-
India	33.0%	$13.7 bn	$11.8 bn	-	3.3%	-	-
United States	42.8%	$602.8 bn	$542.8 bn	-	16.9%	27.0%	-

Notes: Profit shifted into countries estimated using a variety of models and the US CBCR data. The table shows the percentage of profits shifted for the misalignment (Misal.) model using data on all sub-groups, and—using data on affiliates with positive profits—logarithmic (Log), quadratic (Quad), and linear (Linear) models. The column "profits (+)" indicates the profits of affiliates with positive profits, the column "profits (all)" indicates the profits of all affiliates.

of shifted profits is similar between models (Figure 3 and A10). The majority of these profits are in a small group of tax havens. The large majority of profits shifted, are shifted to the top 10 countries shown in Table 2. Moreover, over 75% of the profits booked in those 10 countries are artificially shifted there. The Cayman Islands, Luxembourg, the Netherlands, Switzerland, Singapore, Bermuda and Puerto Rico are the largest destinations. However, several differences may be observed. Profit shifted to Luxembourg is more than two times larger in the logarithmic rather than misalignment model, because of the presence of many companies with losses and different data used for the two models. Compared with the $22 billion of profits found in Luxembourg in the data on "All Sub-Groups" (used for the misalignment model), there is $54 billion of profits in the data "Sub-Groups with positive profits". Similarly, while the "Other Europe", "Other Asia&Oceania"

and "Other America" groups appear as profit destinations in the logarithmic model, they appear as places of profit origin in the misalignment. This is due to the higher granularity of the data with "All Sub-Groups" used for the misalignment model. There, "Isle of Man", "Barbados", "Gibraltar", "Macao" and "the British Virgin Islands" appear as standalone countries, with $22 billion booked into those countries.

Figure 3: Profits shifted in and out of countries using the US data



Notes: Profits shifted in and out of countries using the US data, estimated with with the linear, quadratic (Quad), logarithmic (Log) and misalignment models. MNCs shift profits from countries with negative shifted profits to countries with positive shifted profits. The largest origins of the profits are visualised in blue, and the largest destinations in red. All other countries are visualised together in grey. The annotations indicate the percentage of profit shifted out of the country (compared to estimated profits) or into the country (compared to booked profits).

The origin of shifted profits is, however, considerably different across the models. We observe that 72% of the employees, wages and sales of US MNCs are located in the United States and the ETR of the United States is 43%. This together implies that no profits are shifted into the US, and approximately 72% of the global shifted profits are redistributed back to the United States in the models relying on semi-elasticity. In the misalignment model a similar level of profits are shifted out of the USAsince 48% of the profits are already reported there. In addition to the US, the UK also seems to lose out in the misalignment model, but not in the other models (Fig. 3). In the tax semi-elasticity models, the low ETR of the UK (12%) implies that profits are expected to be shifted into the country. In the misalignment model profits are found to be shifted out of the country, since the profits reported in the UK (1.5% of the total) are lower than their share of the economy (3.3% of the total). The low aggregated profits recorded in the UK are a consequence of MNCs reporting zero or negative profits (Bilicka, 2019).

Overall, while we consider the logarithmic specification to be more accurate with respect to estimating the global scale of profit shifting, the misalignment method might provide more accurate estimates of the redistribution of these shifted profits. The misalignment method takes into consideration the current distribution of profits, and in this respect provides a more accurate way of redistributing profits, as we have discussed at the end of the methodology section 2. The location of profits and economic activity is often more balanced (i.e. less misaligned) in countries with high per capita income (Fig. A10 in the Appendix). The logarithmic model is agnostic to this fact, and redistributes the profits only as a function of the location of economic activity. As a consequence, the misalignment model typically redistributes more profits back to lower-income countries.

4.2 Estimation of profit shifting (OECD data)

Having shown that the logarithmic model is superior to both the quadratic and linear models, we apply it to the OECD CBCR data. We use the same methodology as in the previous section, but add fixed effects for the reporting countries to correct for differences in profitability due to the location of headquarters, and add an interaction between the reporting country and either $\log(t + ETR)$, ETR^2 or ETR in our logarithmic, quadratic and linear models.

Table 3 shows the estimates of tax semi-elasticity using the OECD data (with an interpretation of the coefficients given visually in Figure A16). The US is used as the reference group for country comparisons. We again observe that the logarithmic model fits the data better than the quadratic and linear specifications. The logarithmic model estimates that over 40% of profit shifting takes places towards countries with an ETR below 1% (Table 4). The quadratic and linear models are not able to capture this fully (Table 4). The misalignment model yields similar results to the logarithmic model, reinforcing the accuracy of the logarithmic model.

The location of MNCs' headquarters have been shown both theoretically and empirically to be an important consideration in the profit shifting carried out by MNCs (Bilicka, 2019; Dischinger et al., 2014). A significant number of existing studies observed profit shifting in the case of US headquartered MNCs (Clausing, 2020b; Dowd et al., 2017; Guvenen et al., 2022). For example, the ETR paid on foreign profits by US MNCs in sectors other than oil has fallen by half since the late 1990s and nearly half of this decline is estimated to be the outcome of the rise of profit shifting to tax havens (Wright & Zucman, 2018).

The introduction of the interaction term between the country fixed-effect and $\log(ETR)$, ETR^2 or ETR allows us to understand the aggressiveness of each country's MNCs with respect to profit shifting. We find that MNCs from Singapore, Brazil and the United States are the most aggressive (the magnitude of the interaction is more negative). This is in contrast with a recent paper by Bilicka (2019) that studies headquarter location heterogeneity for MNCs active in the United Kingdom and finds US MNCs to have a similar size of the estimated profit ratio gap as French and German MNCs. Furthermore, we find that the difference is statistically significant for all countries (Table 3). In fact, the relationship completely disappears for South Africa and Malaysia (Fig. A17). Japan is an interesting case to study due to its historically perceived distinct attitude towards tax planning (Izawa, 2019). Our results show that profit shifting by Japanese MNCs are similar to other MNCs.

Table 3: Comparison of tax semi-elasticity estimates using the OECD data

	Logarithmic	Quadratic	Log*FE + Quad	Log + Quad*FE	Linear
ETR	0.9313	-8.5950***	1.5638	0.6666	-3.7698***
	(0.7316)	(2.0412)	(1.8934)	(2.0052)	(0.3623)
ETR^2		13.0086***	-1.1865	-1.2082	
		(3.9734)	(3.2164)	(3.5384)	
log(0.0023 + ETR)	-0.7626***		-0.7817***	-0.4012***	
	(0.0788)		(0.0848)	(0.0930)	
Australia:tax	0.3816***	4.2074***	0.3807***	2.7669**	1.6438***
	(0.0471)	(1.2526)	(0.0484)	(1.2730)	(0.4634)
Bermuda:tax	0.2434***	-0.9764	0.2439***	-1.3191	-0.9521***
	(0.0259)	(1.0674)	(0.0262)	(1.1076)	(0.3177)
Brazil:tax	-0.0517	-1.5007	-0.0505	-2.8834*	-2.0144***
	(0.0341)	(1.5443)	(0.0346)	(1.4777)	(0.3989)
Switzerland:tax	0.4475***	2.7625***	0.4485***	2.7460***	2.9171***
	(0.0244)	(0.3537)	(0.0235)	(0.3293)	(0.1867)
China:tax	0.4961***	3.3578***	0.4957***	2.5759***	1.8940***
	(0.0192)	(0.6916)	(0.0196)	(0.6705)	(0.1017)
Germany:tax	0.2750***	0.8763***	0.2765***	0.7850***	1.3159***
	(0.0294)	(0.2102)	(0.0291)	(0.2001)	(0.1539)
Denmark:tax	0.6250***	8.0680***	0.6245***	7.5109***	3.6067***
	(0.0350)	(0.7957)	(0.0351)	(0.7826)	(0.1935)
Spain:tax	0.5907***	3.9825***	0.5889***	2.8803***	2.4847***
	(0.0235)	(0.8224)	(0.0257)	(0.7778)	(0.1168)
France:tax	0.4934***	3.0331***	0.4952***	2.4200***	3.5035***
	(0.0721)	(0.4119)	(0.0734)	(0.4265)	(0.1727)
Indonesia:tax	0.5351***	0.7934	0.5397***	2.4612	1.9278**
	(0.0453)	(1.5095)	(0.0481)	(1.5396)	(0.7508)
India:tax	0.1467***	-3.3621***	0.1489***	-2.8247***	-1.5550***
	(0.0416)	(0.8267)	(0.0415)	(0.9031)	(0.3596)
Italy:tax	0.2978***	3.3342**	0.2930***	0.4478	0.4584**
	(0.0352)	(1.6581)	(0.0425)	(1.4797)	(0.1807)
Japan:tax	0.2457***	-1.7402*	0.2462***	-2.1359**	-0.6353**
	(0.0315)	(1.0264)	(0.0311)	(1.0368)	(0.2695)
Luxembourg:tax	0.4013***	11.3447***	0.4014***	9.5510***	1.7322***
	(0.0385)	(2.3111)	(0.0387)	(2.3102)	(0.2663)
Mexico:tax	0.4254***	3.0125*	0.4268***	3.3186**	1.9125**
	(0.0843)	(1.6854)	(0.0837)	(1.6929)	(0.8231)
Malaysia:tax	0.6954***	19.4704***	0.6960***	19.3316***	4.0391**
	(0.0805)	(7.2946)	(0.0801)	(7.3789)	(1.5871)
Singapore:tax	-0.4671***	-6.1132***	-0.4660***	-5.6146***	-4.2840***
	(0.0361)	(0.7610)	(0.0352)	(0.7757)	(0.3474)
South Africa:tax	0.7822***	12.0999***	0.7831***	12.2542***	5.0063***
	(0.0497)	(1.4844)	(0.0491)	(1.5910)	(0.3831)
log(Tangible assets)	0.3379***	0.3389***	0.3381***	0.3416***	0.3395***
	(0.0454)	(0.0439)	(0.0453)	(0.0440)	(0.0455)
log(wages)	0.1847***	0.1623***	0.1847***	0.1744***	0.1544***
	(0.0462)	(0.0455)	(0.0464)	(0.0465)	(0.0472)
log(Population)	0.1668**	0.1588**	0.1661**	0.1596**	0.1396*
	(0.0768)	(0.0776)	(0.0776)	(0.0773)	(0.0748)
log(GDPpc)	0.3505***	0.3686***	0.3503***	0.3618***	0.3679***
	(0.0957)	(0.0940)	(0.0960)	(0.0918)	(0.0970)
N	1430	1430	1430	1430	1430
R-squared	0.7314	0.7142	0.7314	0.7196	0.7115
R-squared Adj.	0.7178	0.6997	0.7176	0.7051	0.6971
BIC	5267.72	5356.36	5274.88	5336.68	5362.54

Notes: Regression table for the OECD data. Clustered standard errors are shown in parenthesis. Country:tax represents the interaction effect between the country and $\log(0.0023 + ETR)$, ETR^2 and ETR for our three specifications (logarithmic, quadratic and linear). The intercept and country fixed effects are not shown and are generally negative and significant at the 0.1% significance level; since the treatment group is the US, this indicates the higher profitability of US MNCs. Only countries reporting in over 20 partner jurisdictions are shown.

Table 4: Share of profit shifted into countries, grouped by the effective tax rates

ETR	Misalignment	Logarithmic	Quadratic	Linear
Below 5%	40.0%	40.6%	33.5%	31.6%
5-10%	30.0%	43.1%	40.6%	39.8%
10-15%	15.4%	11.8%	16.4%	17.2%
15-25%	9.7%	2.7%	4.1%	6.1%
Above 25%	4.9%	1.7%	5.4%	5.3%

Notes: Share of profit shifted into countries, grouped by the average foreign ETR in the country. The quadratic and linear models are not able to account for the large share of profits shifted into countries with ETRs below 1%. Since profit shifting is estimated at the bilateral level (reporting:partner) for the semi-elastictiy methods, a country can (rarely) have an average ETR above 25% and an ETR below 25% for some of those reporting:partner relationships.

Next, we calculate the extent of profit shifting for all models. We reach an estimate of $862 billion shifted for the logarithmic model and a 95% confidence interval of $838–1,022 billion for the misalignment model, of which we use the median, $867 billion (Table A12 and Fig. 4).[1] We compare the results obtained using both methodologies in Figure A10 in the Appendix. In general, there is a good correlation between the origin and the destination of profit shifted, albeit with some outliers (the United Kingdom, Brazil, Malaysia, China), with the United Kingdom previously discussed in section 4.1. Our total estimates are comparable to existing estimates such as Tørsløv et al. (2023b) and Wier and Zucman (2022), who estimate profit shifting to be $616 billion in 2015 and $969 billion in 2019, albeit using a smaller sample of countries ((see Figure A25 for a detailed comparison)). Our findings imply that revenue losses total approximately $200–300 billion. This is comparable with recent leading estimates of revenue losses which range from $100 to $300 billion, as compared in Table A13. Furthermore, it is important to keep in mind that some aspects of our methodological approach are conservative. For example, we aggregate at the country level and as such offset profits shifted in with profits shifted out. The estimated scale of profit shifting and tax revenue loss would be higher if we would not net gains and loses.

In addition to outlining the overall scale of the practice, Figure 4 provides an overview of the origins and destinations of profit shifting. Using both the logarithmic model and misalignment methods, we estimate that the Cayman Islands and the Netherlands have 94–96% and 34–47% of their respective booked profits shifted in from other countries, while also ranking among countries most benefiting from profit shifting in absolute terms. The US is estimated to suffer the most from profit shifting in absolute terms according to most of the methods, while France is affected to a substantially greater degree relative to estimated profits, with an estimate ranging from 47% (misalignment method) to 27% (logarithmic model). Table 5 and 6 shows the largest destinations

[1]Note that the sum of the median misalignment for each country is different from the median of the total misalignment. We use the median misalignment for each country which adds up to a positive misalignment of $841 billion and negative of 854B.

Table 5: Top destinations of profit shifting

Country	ETR (%)	Misalignment P (all groups)	PS (B)	PS (%)	Logarithmic P (groups>0)	PS (B)	PS (%)
United Kingdom	7.3	260,194	6,041	2.3	441,372	190,160	43.1
Cayman Islands	0.2	136,292	130,276	95.6	159,811	149,000	93.2
Luxembourg	1.8	48,845	41,520	85.0	116,346	83,360	71.6
Singapore	5.3	121,237	59,602	49.2	151,568	79,058	52.2
Canada	12.9	162,820	51,011	31.3	215,831	59,342	27.5
Netherlands	6.0	114,845	54,029	47.0	172,608	59,256	34.3
Switzerland	8.1	107,476	47,639	44.3	136,177	32,231	23.7
Hong Kong	7.8	91,630	46,727	51.0	86,695	8,567	9.9
Bermuda	1.8	58,903	55,853	96.0	43,618	35,089	80.4
Puerto Rico	1.6	36,570	33,815	92.5	38,546	31,090	80.7
Ireland	10.6	51,363	24,163	47.0	65,284	18,124	27.8
Malaysia	18.7	44,027	19,628	44.6	50,721	-4,513	-8.9
Sweden	10.9	52,014	18,785	36.1	61,060	7,729	12.7
Australia	19.7	111,334	17,055	15.3	126,229	-9,854	-7.8
China	25.9	583,000	15,511	2.7	683,371	-139,394	-20.4
Jersey	0.9	16,493	15,329	92.9	15,989	14,529	90.9
Norway	26.5	41,225	15,037	36.5	47,853	-5,859	-12.2
Gibraltar	0.0	12,373	12,248	99.0	5,511	5,082	92.2
Isle of Man	0.6	11,624	11,486	98.8	8,639	7,954	92.1
British Virgin Islands	0.4	12,480	11,100	88.9	13,759	7,868	57.2
Barbados	1.0	10,540	10,441	99.1	6,842	4,776	69.8

Notes: The table shows the top destinations of profit shifting (PS (B)) for misalignment and logarithmic models and as a percentage of the total profits booked in the jurisdiction (PS (%)). All countries with at least $10 bn shifted are included. The total profits for all groups ((P (all groups)) and groups with positive profits (P (groups>0) are shown for comparison. The full table can be found in Tables A7 and A9 for misalignment and logarithmic models, respectively.

and sources of profit shifting respectively.[2] Figure A11 in the Appendix shows profit shifting at the country level for all countries, 214 countries for the log and 210 for the misalignment model, and for the misalignment model we show results in Table A7 and we visualise the uncertainty in Figure A12.

4.3 Profit shifting and tax revenue loss by income groups

The analysis presented above compares different methodology approaches and establishes the largest origins and destinations of profits in absolute terms. In this section, we focus on the

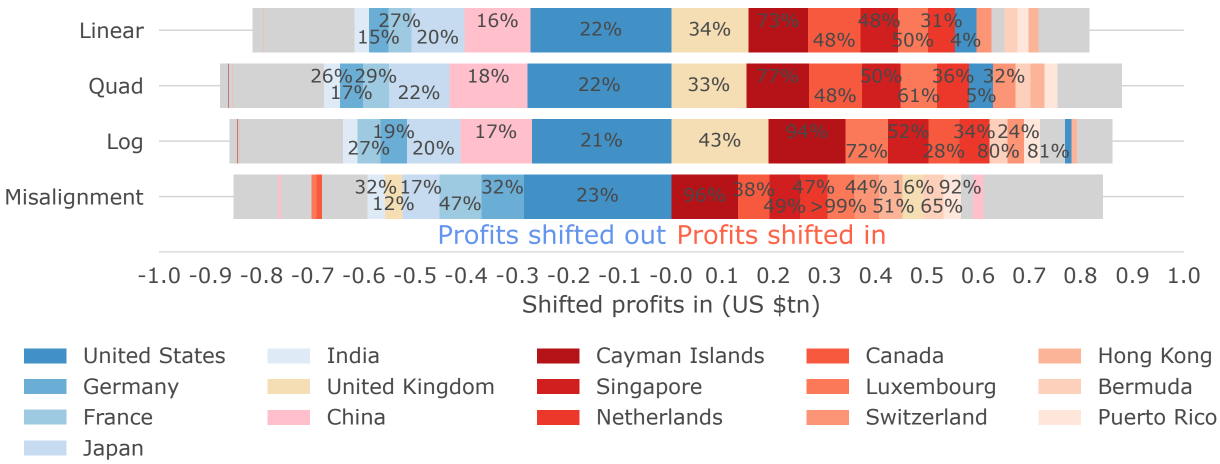
[2]Perhaps surprising is the inclusion of Canada as one of the top destinations. This is mostly driven by Canadian MNCs shifting profits towards the headquarters. However, this may be explained by the relatively low ETR of 12.9% observed in the data, and the characteristics of its tax system (Capurso, 2016; van't Riet & Lejour, 2014).

Table 6: Top sources of profit shifting

Country	ETR (%)	Misalignment P (all groups)	PS (B)	PS (%)	Logarithmic P (groups>0)	PS (B)	PS (%)
Sorted by total profit shifted (average of the two models)							
United States	29.6	954,310	287,971	23.2	997,467	259,263	20.6
Japan	27.4	346,261	71,961	17.2	414,662	104,218	20.1
Germany	18.3	175,971	82,717	32.0	223,988	51,277	18.6
France	25.0	92,626	82,377	47.1	122,962	45,784	27.1
China	25.9	583,000	-15,511	-2.7	683,371	139,404	16.9
India	41.7	70,523	33,269	32.1	88,394	28,086	24.1
Mexico	33.9	56,136	19,479	25.8	49,351	17,762	26.5
South Korea	23.0	102,984	441	0.4	130,052	26,236	16.8
Italy	21.1	54,621	13,024	19.3	71,412	9,984	12.3
Spain	14.8	63,375	7,923	11.1	72,889	10,976	13.1
Brazil	22.7	80,658	14,666	15.4	113,266	-5,332	-4.9
Taiwan	13.1	58,112	-7,240	-14.2	15,269	10,320	40.3
Sorted by percentage of total profits shifted (average of the two models)							
Kenya	37.3	714	1,412	66.4	727	509	41.2
Greece	23.9	2,485	3,266	56.8	2,013	1,599	44.3
Colombia	34.0	5,258	8,241	61.0	5,052	3,143	38.3
Nigeria	47.8	10,061	5,627	35.9	1,269	2,129	62.6
Iran	11.1	4,968	940	15.9	487	1,504	75.5
Saudi Arabia	17.8	10,737	3,826	26.3	3,304	3,362	50.4
France	25.0	92,626	82,377	47.1	122,962	45,784	27.1
Romania	14.8	5,500	4,232	43.5	6,223	1,893	23.3
Philippines	20.5	13,304	5,276	28.4	7,714	4,261	35.6
Pakistan	41.9	4,501	1,603	26.3	2,285	1,379	37.6
Egypt	27.2	6,514	2,079	24.2	2,963	1,444	32.8
India	41.7	70,523	33,269	32.1	88,394	28,086	24.1
Ukraine	12.8	2,277	1,015	30.8	1,985	590	22.9
Poland	16.6	20,457	9,799	32.4	23,370	6,286	21.2
Germany	18.3	175,971	82,717	32.0	223,988	51,277	18.6
Kazakhstan	25.3	11,566	657	5.4	2,466	1,676	40.5
Russia	22.9	35,355	3,514	9.0	18,552	9,032	32.7
Turkey	17.1	18,641	1,432	7.1	9,695	4,909	33.6
Taiwan	13.1	58,112	-7,240	-14.2	15,269	10,320	40.3

Notes: The table shows the top sources of profit shifting (PS (B)) for misalignment and logarithmic models and as a percentage of the total profits in the jurisdiction (PS (%)). Note that the total profits is the sum of the profits booked and the profits shifted. All countries with at least \$10 bn shifted out (top table) or \$1bn and 20% of the total profits (bottom table) are included. The total profits for all groups ((P (all groups)) and groups with positive profits (P (groups>0) are shown for comparison. The full table can be found in Tables A8 and A10 for misalignment and logarithmic models, respectively.

Figure 4: Profits shifted in and out of countries using the OECD data



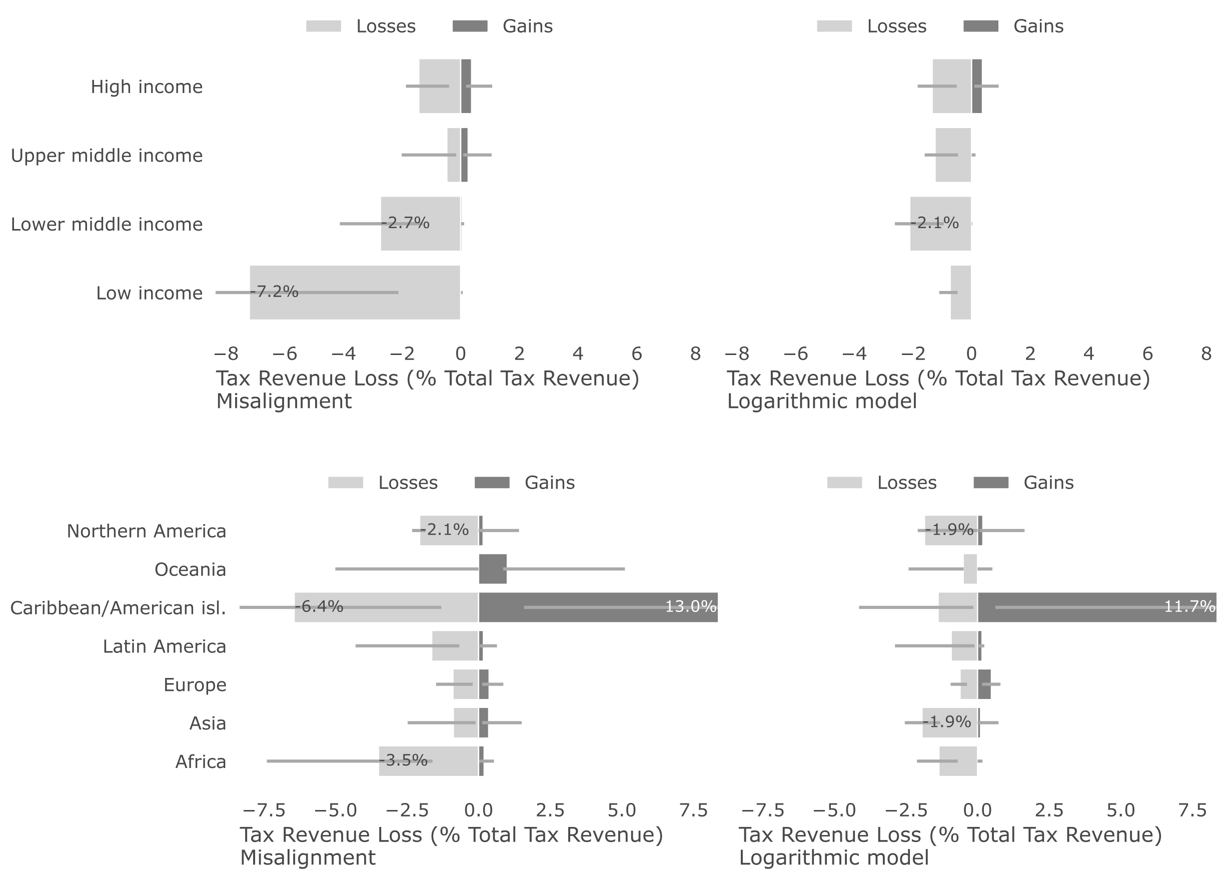
Notes: Profits shifted in and out of countries using the OECD CBCR data, estimated with the linear quadratic (Quad), logarithmic (Log) and misalignment models. MNCs shift profits from countries with negative shifted profits to countries with positive shifted profits. The largest origins of the profits are visualised in blue, and the largest destinations in red. All other countries are visualised together in grey. The annotations indicate the percentage of profit shifted out of the country (compared to estimated profits) or into the country (compared to booked profits). Tables 5 and 6 show the top sources and destinations.

distribution effects of profit shifting, and find that lower-income countries tend to lose more tax revenue relative to their total tax revenue (i.e. total tax revenue collected by government, from across all types of taxes), which is in line with some of the earlier estimates (e.g., Crivelli et al. (2016) and Fuest et al. (2011).

We first focus on profit shifting. While countries from all income groups lose similarly relative to their GDP, profit shifting takes place predominantly to high-income countries (Figure A18). This is expected, since the majority of tax havens are included in this group (see, e.g., Cobham et al. (2015) and Tørsløv et al. (2023b)). Although we present results for both the misalignment and the logarithmic model, we argue that the results of the misalignment model might be more accurate for two reasons. First, we use all available data in the misalignment model, imputing missing data. As previously mentioned, countries often do not report on small countries, but group them together into categories (e.g. “Other Africa”). For example, only Germany, Japan and India report operations on Gambia (three, two and two MNCs respectively), while the remaining reporting countries with operations in the country group Gambia with other African countries. For the logarithmic model this leads to an underestimation of the losses of lower-income countries. For the misalignment model, we estimate the expected employees and revenue of all country pairs, and use this information to correct the amount of profit shifted more accurately (Section 2.4). While this only increases total profit shifted by 30%, it is key to estimating profit shifting in lower-income countries accurately. A second, closely related, reason in favour of the misalignment model is its observation that profits are less aligned with economic activity in lower-income countries (discussed in Section 4.1).

We continue by looking at tax revenue loss (the product of profits shifted and the ETR) as a function of the total tax revenue in each income group and region (Figure 5). In general, we find that lower-income-countries – those in Africa and Latin America—tend to lose more tax revenue relative to their total tax revenue. Countries with low and middle per capita incomes (Figure 5), are thus the largest profit-shifting losers. MNCs shift an equivalent of 7.19% (95% CI; 2.12–17.42) of their total tax revenue out of low-income countries, while receiving influxes equivalent to 0.02% (0.01–0.07). On the other hand, high-income countries lose an equivalent of 1.43% (0.40–1.87), while gaining 0.37% (0.18–1.07). These low tax revenue gains for high-income countries contrast with the high volume of profits shifted in those countries (Figure A18). Furthermore, losses for lower-middle-income countries (1.29–4.11) are also significantly higher than those of higher-income countries, while upper-middle-income countries exhibit only moderate loses (0.15-2.01).

Figure 5: Tax revenue loss as a percentage of total tax revenue



Notes: Tax revenue loss as a percentage of total tax revenue for countries in different income groups (top row) and different geographical regions (bottom row), as estimated by the misalignment (left side of graph) and logarithmic (right side of graph) models. Confidence intervals show 95% intervals, calculated via bootstrapping.

When analysing each country separately (Figure A19), we once again find that lower-income countries lose significantly more tax revenue than high- and upper-middle-income countries. Similar results are found for comparisons of tax revenue losses with corporate income tax revenue (Figure A20) and GDP (Figure A21). There are, however, differences within lower-income countries. In general, African countries tend to lose the higher share of their tax revenue to profit shifting (Figure A22). Overall, our analysis shows that only a small number of countries gain any tax revenue. Profit shifting is thus a phenomenon where the majority of countries lose, and especially so lower-income countries.

With this finding on lower-income countries we contribute to the ongoing discussion of which countries lose more to profit shifting. Few existing studies identify how countries in various income groups are distinctly affected by profit shifting, and the nature of these differences varies across the studies. On the one hand, the theoretical case for such countries' higher vulnerability is strong (Hearson, 2018), and several studies indicate that low- and lower-middle-income countries (which we label as lower-income countries) are more vulnerable to profit shifting by MNCs than countries at higher levels of income (Fuest et al., 2011; Johannesen et al., 2020). On the other hand, Janský and Palanský (2019) compare five sets of country-level estimates—Clausing (2016), Cobham and Janský (2018, 2019) and Tørsløv et al. (2023b) and their own estimates—and four of the five do not suggest that lower-income countries are disproportionately affected by profit shifting. These five studies rely on data from a different number of countries (25, 102, 34, 37, 79), which are all small in comparison with our results for up to 214 countries.

4.4 Robustness checks and sensitivity analyses

We address the data and methodology limitations of this paper by testing the consistency of the main results to our methodological choices. In total, we carry out 10 robustness checks and sensitivity analyses. We briefly summarise them here. Overall, these robustness checks and sensitivity analyses show how our results are robust to changes in the methodology and data.

First of all, we discuss the main sensitivity analyses of our methodology that are not related to the data. (i) We use a variety of models based on linear, quadratic and logarithmic semi-elasticities, as well as the misalignment method. The scale of profit shifting is estimated to be similar across all models—\$817 (linear), \$880 (quadratic), \$862 (logarithmic), and \$867 (misalignment) billions (Sections 4.1 and 4.2). (ii) We test the robustness of the 25% ETR threshold in equation 5. Reducing the threshold to 20% would reduce our estimate of profit shifting by the logarithmic model by 6%. Increasing the threshold to 30% would increase the estimate of profit shifting by 8%. (iii) We compare our results to those of Tørsløv et al. (2023b) and Wier and Zucman (2022), observing a high correlation with a much increased country sample (Figure A25). (iv) We compare the tax revenue loss with other benchmarks, corporate tax revenue (Figure A20) and GDP (Figure A21). We find that lower-income countries lose comparatively the most in all specifications, as discussed above in section 4.3.

We further test the consistency of the main results to other methodological choices in three additional ways: (v) We analyse the sensitivity of our results to the offset in the logarithmic model, showing a robust estimation of the coefficients for a wide range of offsets (Figure A26). (vi) We compare the logarithmic specification with other specifications that can accommodate extreme non-linearities, including $1/(\tau + ETR)^1$, $1/(\tau + ETR)^2$, $1/(\tau + ETR)^3$ and $coth(\tau + ETR)$). The logarithmic specification allows for higher non-linearities, and exhibits a higher R2 and lowest Bayesian Information Criteria (see Table A14 and Figs. A27 and A28). (vii) We test a different redistribution formula. For this, we first regressed the share of profits booked in a country against the shares of employees, capital, sales and wages (Table A15). We then used the coefficients as our new redistribution formula, after normalising them to sum to one. Profit shifting is reduced by 9%, with a similar distribution of the origin and destination of profits (Figure A30).

Additional robustness checks and sensitivity analyses focus on the data itself and, in particular, on missing data imputation. In accordance with the design of the individual methods, this missing data imputation does not affect our preferred semi-elasticity methods of estimating the scale of profit shifting, but only influences the measures of misalignment and the subsequent redistribution of the shifted profit for all methods: (viii) We estimate missing data using 1,000 bootstrapped data samples (Section A.1) to show the consistency of our results in relation to variations in data coverage. In the main results we use the median of the samples. The confidence intervals are included in Figure A12. (ix) We compare the location of employees and revenue according to our missing data model with the information in the original data as well as GDP, showing how our method addresses the limitations of these two alternatives (Figure A13). (x) Finally, we compare our missing data imputation method with other models, including with penalised linear regression (Appendix A.1.2), showing that our method has higher predictive power.

5 Conclusion

Exploiting the combination of a new methodology and a new dataset, we establish that MNCs shifted around $900 billion in profits to tax havens in 2017. Our results show that existing linear and quadratic models underestimate profit shifting to countries with extremely low tax rates while simultaneously overestimating it for countries with moderate rates. However, the new logarithmic model as well as the misalignment model are able to capture this behaviour accurately. Using these two preferred models, we show that 40–41% and 70–83% of profit shifted is shifted to countries with an ETR below 1% and 10%, respectively. Overall, our findings are consistent with the hypothesis that MNCs exploit the combination of globalisation and the sovereignty of individual countries, in particular tax havens, to avoid paying taxes at the expense of countries worldwide regardless of income level.

Our findings provide two key insights. First, the extremely non-linear relationship between the location of profits and tax rates has implications for both research and policy. In research, we show that accurately accounting for this relationship affects the estimated scale and distribution of profit shifting. In policy, this modelling choice can significantly influence the assessment of international tax reform, as may be the case with the global minimum tax rate agreement reached in 2021, so-called Pillar Two. While this assessment assumes that profit shifting incentives decrease in linear fashion as the minimum ETR increases, we show in this paper that this linearity assumption is unlikely to hold. Our findings indicate the importance of the specific value of the minimum ETR, which is 15% in the case of Pillar Two.

Our second key insight is based on our finding that lower-income countries tend to lose more tax revenue relative to total tax revenue due to profit shifting. This could nudge their governments into using confidential tax return data for more detailed analyses—as South Africa recently did, thus learning that profit shifting is highly concentrated among a few large MNCs (Wier & Erasmus, 2022). In policy, our results indicate that the current international tax system may be hindering the achievement of one of the goals of the 2030 Agenda for Sustainable Development: to strengthen domestic resource mobilisation (FACTI, 2021; UN, 2015). This supports the arguments of lower-income countries that they should be represented on an equal footing at reform discussions and that such reforms should be geared towards creating a level playing field in the corporate taxation of MNCs.

The findings presented in this paper open up additional avenues for future research. We see two such research directions as especially fruitful. The first is obtaining more accurate estimates as new CBCR data become available in the future. For example, the guidelines to report intra-company dividends have been updated and the 2020 data, which should be published no later than in 2024, will thus contain no double counting. The second research avenue is obtaining more accurate estimates of tax semi-elasticity using firm-level data. An increasing number of MNCs (e.g. Vodafone and Shell) are voluntarily publishing their own CBCR data, and more are likely to do so in the future, either of their own accord or due to government pressure. For example, in 2021 the European Union approved a regulation whereby companies will be required to publish parts of their CBCR data, to be available from around 2025. If firm-level CBCR data become available for a large number of MNCs, it would enable us to understand even more accurately the extent of profit shifting, as well as which MNCs are responsible for the bulk of profit shifting worldwide.

References

Alstadsæter, A., Johannesen, N. & Zucman, G. (2019). Tax Evasion and Inequality. *American Economic Review*, *109*(6), 2073–2103.

Álvarez-Martínez, M. T., Barrios, S., d'Andria, D., Gesualdo, M., Nicodème, G. & Pycroft, J. (2021). How large is the corporate tax base erosion and profit shifting? A general equilibrium approach. *Economic Systems Research*, 1–32.

Auerbach, A. J., Devereux, M. P., Keen, M. & Vella, J. (2017). International tax planning under the destination-based cash flow tax. *National Tax Journal*, *70*(4), 783–802.

Bajgar, M., Berlingieri, G., Calligaris, S., Criscuolo, C. & Timmis, J. (2018). *To Use or Not to Use (and How to Use): Coverage and Representativeness of Orbis Data*. Paris: OECD.

Beer, S., De Mooij, R. & Liu, L. (2020). International corporate tax avoidance: A review of the channels, magnitudes, and blind spots. *Journal of Economic Surveys*, *34*(3), 660–688.

Beer, S., Mooij, R., Hebous, S., Keen, M. & Liu, L. (2020). Exploring Residual Profit Allocation. *IMF Working Papers*, *20*.

Bilicka, K. A. (2019). Comparing UK Tax Returns of Foreign Multinationals to Matched Domestic Firms. *American Economic Review*, *109*(8), 2921–2953.

Blouin, J. & Robinson, L. A. (2020). *Double counting accounting: How much profit of multinational enterprises is really in tax havens?* (SSRN Scholarly Paper No. ID 3491451). Social Science Research Network. Rochester, NY.

Bolwijn, R., Casella, B. & Rigo, D. (2018). Establishing the baseline: Estimating the fiscal contribution of multinational enterprises. *Transnational Corporations*, *25*(3), 111–142.

Bratta, B., Santomartino, V. & Acciari, P. (2021). Assessing profit shifting using Country-by-Country Reports: A non-linear response to tax rate differentials. *Ministry of Economy and Finance, Department of Finance*.

Breiman, L. (2001). Random Forests. *Machine Learning*, *45*(1), 5–32.

Capurso, C. (2016). Burgers, doughnuts, and expatriations: An analysis of the tax inversion epidemic and a solution presented through the lens of the Burger King-Tim Hortons merger. *Wm. & Mary Bus. L. Rev.*, *7*, 579.

Clausing, K. (2016). The Effect of Profit Shifting on the Corporate Tax Base in the United States and Beyond. *National Tax Journal*, *69*(4), 905–934.

Clausing, K. (2020a). Five Lessons on Profit Shifting from the US Country by Country Data. *Tax Notes International and Tax Notes Federal*.

Clausing, K. (2020b). Profit Shifting Before and After the Tax Cuts and Jobs Act. *National Tax Journal*.

Cobham, A., Faccio, T. & FitzGerald, V. (2019). Global inequalities in taxing rights: An early evaluation of the OECD tax reform proposals.

Cobham, A., Garcia-Bernardo, J., Janský, P. & Palanský, M. (2021, July). *Statistical Measurement of Illicit Financial Flows in Sustainable Development Goals: Tax Avoidance by Multinational Corporations* (No. 2021/24). Charles University Prague, Faculty of Social Sciences, Institute of Economic Studies.

Cobham, A. & Janský, P. (2018). Global distribution of revenue loss from corporate tax avoidance: Re-estimation and country results. *Journal of International Development*, *30*(2), 206–232.

Cobham, A. & Janský, P. (2019). Measuring Misalignment: The Location of US Multinationals' Economic Activity versus the Location of their Profits. *Development Policy Review*, 1–38.

Cobham, A., Janský, P. & Meinzer, M. (2015). The Financial Secrecy Index: Shedding New Light on the Geography of Secrecy. *Economic Geography*, *91*(3), 281–303.

Crivelli, E., de Mooij, R. & Keen, M. (2016). Base Erosion, Profit Shifting and Developing Countries. *FinanzArchiv: Public Finance Analysis*, *72*(3), 268–301.

Damgaard, J., Elkjaer, T. & Johannesen, N. (2019). What Is Real and What Is Not in the Global FDI Network? *IMF Working Paper*, *2019*(274), 1–51.

Davies, R. B., Martin, J., Parenti, M. & Toubal, F. (2018). Knocking on Tax Haven's Door: Multinational Firms and Transfer Pricing. *The Review of Economics and Statistics*, *100*(1), 120–134.

De Mooij, R., Liu, L. & Prihardini, D. (2019). An Assessment of Global Formula Apportionment. *IMF Working Paper*, *2019*(213), 1–41.

De Simone, L., Klassen, K. J. & Seidman, J. K. (2017). Unprofitable Affiliates and Income Shifting Behavior. *The Accounting Review*, *92*(3), 113–136.

de Mooij, R. & Liu, L. (2020). At a Cost: The Real Effects of Transfer Pricing Regulations. *IMF Economic Review*, *68*(1), 268–306.

Dharmapala, D. (2014). What do we know about base erosion and profit shifting? A review of the empirical literature. *Fiscal Studies*, *35*(4), 421–448.

Dharmapala, D. (2019). Profit Shifting in a Globalized World. *AEA Papers and Proceedings*, *109*, 488–492.

Dharmapala, D. & Riedel, N. (2013). Earnings shocks and tax-motivated income-shifting: Evidence from European multinationals. *Journal of Public Economics*, *97*, 95–107.

Dischinger, M. & Riedel, N. (2011). Corporate taxes and the location of intangible assets within multinational firms. *Journal of Public Economics*, *95*(7), 691–707.

Dischinger, M., Knoll, B. & Riedel, N. (2014). The role of headquarters in multinational profit shifting strategies. *International Tax and Public Finance*, *21*(2), 248–271.

Dowd, T., Landefeld, P. & Moore, A. (2017). Profit shifting of U.S. multinationals. *Journal of Public Economics*, *148*, 1–13.

FACTI. (2021). *FACTI Panel Report*.

Friedman, J. H. (2001). Greedy function approximation: A gradient boosting machine. *Annals of statistics*, 1189–1232.

Fuest, C., Greil, S., Hugger, F. & Neumeier, F. (2022). Global Profit Shifting of Multi-national Companies: Evidence from CbCR Micro Data.

Fuest, C., Hebous, S. & Riedel, N. (2011). International debt shifting and multinational firms in developing economies. *Economics letters*, *113*(2), 135–138.

Fuest, C., Hugger, F. & Neumeier, F. (2022). Corporate profit shifting and the role of tax havens: Evidence from German country-by-country reporting data. *Journal of Economic Behavior & Organization*, *194*, 454–477.

Garcia-Bernardo, J., Janský, P. & Tørsløv, T. (2021). Multinational corporations and tax havens: Evidence from country-by-country reporting. *International Tax and Public Finance*, *28*(6), 1519–1561.

Garcia-Bernardo, J., Janský, P. & Tørsløv, T. (2022). Decomposing Multinational Corporations' Declining Effective Tax Rates. *IMF Economic Review*, *70*(2), 338–381.

Garcia-Bernardo, J., Janský, P. & Tørsløv, T. (2023). Effective tax rates of multinational corporations: Country-level estimates. *PLOS ONE*, *18*(11), e0293552.

Garcia-Bernardo, J., Janský, P. & Zucman, G. (2022). Did the Tax Cuts and Jobs Act Reduce Profit Shifting by US Multinational Companies? *National Bureau of Economic Research Working Paper*, *2022*(30086).

Garcia-Bernardo, J. & Takes, F. W. (2018). The effects of data quality on the analysis of corporate board interlock networks. *Information Systems*, *78*, 164–172.

Grubert, H. & Mutti, J. (1991). Taxes, tariffs and transfer pricing in multinational corporate decision making. *The Review of Economics and Statistics*, 285–293.

Guvenen, F., Mataloni, J., Raymond J, Rassier, D. G. & Ruhl, K. J. (2022). Offshore Profit Shifting and Aggregate Measurement: Balance of Payments, Foreign Investment, Productivity, and the Labor Share. *American Economic Review*.

Haberly, D. & Wójcik, D. (2015). Tax havens and the production of offshore FDI: An empirical analysis. *Journal of Economic Geography*, *15*(1), 75–101.

Hearson, M. (2018). When do developing countries negotiate away their corporate tax base? *Journal of International Development*, *30*(2), 233–255.

Heckemeyer, J. H. & Overesch, M. (2017). Multinationals' profit response to tax differentials: Effect size and shifting channels. *Canadian Journal of Economics*, *50*(4), 965–994.

Hines, J. R. & Rice, E. M. (1994). Fiscal Paradise: Foreign Tax Havens and American Business. *Quarterly Journal of Economics*, *109*(1), 149–82.

Horst, T. & Curatolo, A. (2020). Assessing the Double Count of Pretax Profit In the IRS Summary Of CbC Data for Fiscal 2017. *Tax Notes International*, *98*(4), 427–32.

Huizinga, H. & Laeven, L. (2008). International profit shifting within multinationals: A multi-country perspective. *Journal of Public Economics*, *92*(5), 1164–1182.

Izawa, R. (2019). Who, me? Tax Planning and Japanese Multinational Enterprises, 1887–2019. *Working Paper Series (Faculty of Economics, Shiga University)*, (291).

Janský, P. & Palanský, M. (2019). Estimating the scale of profit shifting and tax revenue losses related to foreign direct investment. *International Tax and Public Finance*, *26*(5), 1048–1103.

Johannesen, N., Tørsløv, T. & Wier, L. (2020). Are less developed countries more exposed to multinational tax avoidance? Method and evidence from micro-data. *The World Bank Economic Review*, *34*(3), 790–809.

Johannesen, N. & Zucman, G. (2014). The End of Bank Secrecy? An Evaluation of the G20 Tax Haven Crackdown. *American Economic Journal: Economic Policy*, *6*(1), 65–91.

Johansson, A., Skeie, O. B., Sorbe, S. & Menon, C. (2017). Tax planning by multinational firms: Firm-level evidence from a cross-country database. *OECD Economics Department Working Papers*, *2017*(1355), 64.

Ke, G., Meng, Q., Finley, T., Wang, T., Chen, W., Ma, W., Ye, Q. & Liu, T.-Y. (2017). Lightgbm: A highly efficient gradient boosting decision tree. *Advances in neural information processing systems*, *30*, 3146–3154.

Keen, M. J., Perry, V., d Mooij, R., Matheson, T., Schatan, R., Mullins, P. & Crivelli, E. (2014). *Spillovers in international corporate taxation*. IMF.

Laffitte, S. & Toubal, F. (2022). Multinationals' Sales and Profit Shifting in Tax Havens. *American Economic Journal: Economic Policy*, *14*(4), 371–96.

Mutti, J. & Ohrn, E. (2019). Taxes and the location of US business activity abroad. *National Tax Journal*, *72*(1), 165–192.

Nessa, M., Persson, A. V., Song, J. Z., Towery, E. & Vernon, M. (2022). The Effect of US Country-by-Country Reporting on US Multinationals' Tax-Motivated Income Shifting and Real Activities.

OECD. (2019, June). *Country-by-Country Reporting XML Schema: User Guide for Tax Administrations*.

OECD. (2020). *Tax Challenges Arising from Digitalisation – Economic Impact Assessment*. Paris.

Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., Thirion, B., Grisel, O., Blondel, M., Prettenhofer, P., Weiss, R., Dubourg, V. et al. (2011). Scikit-Learn: Machine Learning in Python. *the Journal of machine Learning research*, *12*, 2825–2830.

Phillips, R., Petersen, H. & Palan, R. (2020). Group subsidiaries, tax minimization and offshore financial centres: Mapping organizational structures to establish the 'in-betweener'advantage. *Journal of International Business Policy*, 1–22.

Reurink, A. & Garcia-Bernardo, J. (2020). Competing for capitals: The great fragmentation of the firm and varieties of FDI attraction profiles in the European Union. *Review of International Political Economy*, *0*(0), 1–34.

Schmidt, M. & Lipson, H. (2009). Distilling Free-Form Natural Laws from Experimental Data. *Science*, *324*(5923), 81–85.

Slemrod, J. & Yitzhaki, S. (2002). Tax avoidance, evasion, and administration. *Handbook of public economics* (pp. 1423–1470). Elsevier.

Sullivan, M. (2023). Five Years of CbC Reporting Yields Disappointing Results. *Tax Notes International*, *2023*(180), 1207.

Tax Justice Network. (2021). *The State of Tax Justice 2021*. Tax Justice Network. London, UK.

Tørsløv, T., Wier, L. & Zucman, G. (2023a). Externalities in international tax enforcement: Theory and evidence. *American Economic Journal: Economic Policy*, *15*(2), 497–525.

Tørsløv, T., Wier, L. & Zucman, G. (2023b). The Missing Profits of Nations. *The Review of Economic Studies*, *90*(3), 1499–1534.

UN. (2015). Transforming our world: The 2030 Agenda for Sustainable Development. *Division for Sustainable Development Goals: New York, NY, USA*.

UNODC & UNCTAD. (2020). *Conceptual Framework for the Statistical Measurement of Illicit Financial Flows*.

van't Riet, M. & Lejour, A. (2014). Potential Benefits of Tax Inversion Remain (Huge): With the model and full country rankings. *CPB Netherlands Bureau for Economic Policy Analysis Backround Document*.

Vicard, V. (2023). Profit Shifting, Returns on Foreign Direct Investments and Investment Income Imbalances. *IMF Economic Review*, *71*(2), 369–414.

Weichenrieder, A. J. (2009). Profit shifting in the EU: Evidence from Germany. *International Tax and Public Finance*, *16*(3), 281–297.

Wier, L. & Erasmus, H. (2022). The Dominant Role of Large Firms in Profit Shifting. *IMF Economic Review*.

Wier, L. S. & Zucman, G. (2022). Global profit shifting, 1975-2019. *National Bureau of Economic Research working paper*, *2022*(30673).

Wright, T. & Zucman, G. (2018). The Exorbitant Tax Privilege. *National Bureau of Economic Research Working Paper*, *24983*.

Zucman, G. (2013). The missing wealth of nations: Are Europe and the US net debtors or net creditors? *The Quarterly Journal of Economics*, *128*(3), 1321–1364.

Zucman, G. (2015). *The hidden wealth of nations: The scourge of tax havens*. University of Chicago Press.

A Appendix

A.1 Additional data corrections

A.1.1 Data limitations and corrections: imputing missing data

While the substantial country coverage, as well as the other advantages of CBCR data, open new avenues for research, several challenges associated with the new data source remain (we summarise them and the discussed advantages in Table A1). First, a certain extent of double counting in profit due to intercompany dividends is inevitable—MNCs are instructed not to double count intercompany dividends in revenue, but not instructed to do so explicitly in profit. Some countries (e.g. the Netherlands and Sweden) have published associated notes together with their data, showing that domestic operations of MNCs may be considerably affected by this. We correct for double counting in the following ways. First by excluding stateless entities.[3]. Second, some countries such as Sweden, the Netherlands, Italy and the United Kingdom investigated the extent of double counting in domestic profits. These range from 16% in the Netherlands to 51% in Sweden and the United Kingdom. We include such corrections. Third, by exploiting the fact that multiple data sets are available for US MNCs and remove double counting of US profits—54% of US domestic profits (as estimated by Garcia-Bernardo, Janský and Zucman, 2022 using the methodology of (Horst & Curatolo, 2020)) and 10% of profits in tax havens. Fourth, by removing 10% of profits in tax havens for non-US MNCs. Fifth, by removing 35% of domestic profits in all other countries, except Slovenia, Latvia, and Luxembourg, where the ETR on domestic profits is higher than foreign profits, and Belgium, Singapore, Isle of Man and Bermuda, where we remove 50% since the ETR on domestic profits is much lower than of foreign profits. As a result, we see a higher correlation between the ETRs paid by domestic and foreign companies (Fig. A1).

Second, while the availability of CBCR data constitutes a significant step forward, and partially corrects this issue, the data is still not complete and is not systematically disaggregated by jurisdiction. The CBCR regulation has been implemented by approximately 100 countries so far—only 38 of them agreed to share their data publicly in aggregated and anonymised form; moreover, some have chosen to aggregate data to a far greater extent than others (Table A6), with the US and Japan (145 and 198 jurisdictions, respectively) leading the way (Table A4). Figure A2 shows how many reporting countries report on selected countries often considered tax havens and it captures well the heterogeneity in countries' decisions to aggregate the data.

In the remainder of this section, we deal empirically with three issues related to data completeness: the lack of completeness in the data of reporting countries; the varying combinations of countries in the aggregated country categories; and the lack of reporting by some countries.

[3]Stateless entities include not only entities whose stateless status results from a mismatch between the legislation of two jurisdictions (e.g. the case of Apple Sales International in Ireland), but includes also flow-through entity (tax-transparent entities). The latter are not considered separate legal entities from their owners, and whose profits are taxed at the level of the owner.

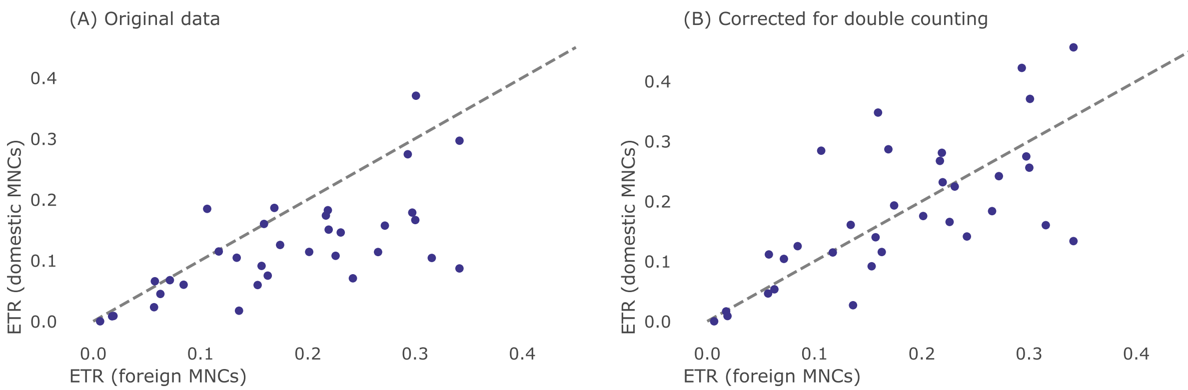


Figure A1: Domestic and foreign ETRs before and after correction for double counting

Table A1: Summary of selected advantages and disadvantages of CBCR data

Selected advantages
Includes data on large MNCs' profits and tax payments in over 150 jurisdictions for at least 5 headquarter countries. Does not include double counting in revenue. Enables to use data on large MNCs and those with positive profit only (the latter estimates ETRs more precisely).
Selected disadvantages
Might include some double counting in profit due to intercompany dividends or stateless entities (which we drop). Includes a sample of large MNCs for 2017 for some countries in aggregated and anonymised form (which we address).

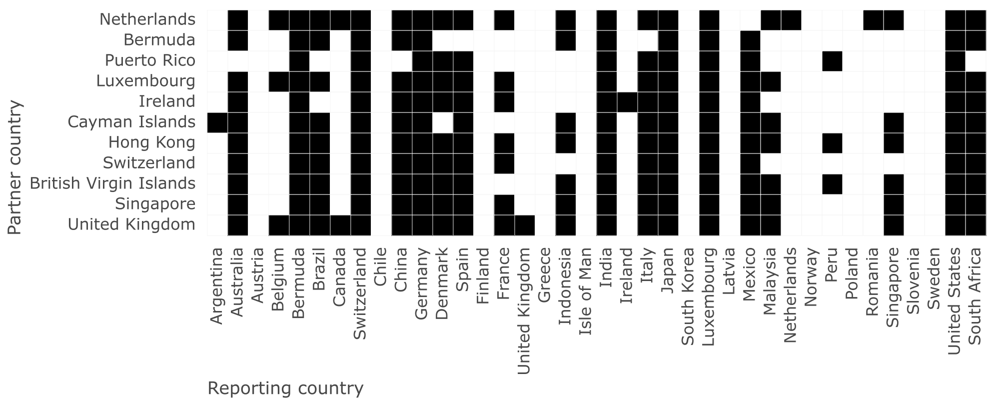
Notes: The table summarises some of the most important advantages and disadvantages of CBCR data from the point of view of using them to estimate profit shifting of multinational corporations worldwide.

Other limitations of the CBCR data (e.g. revenue unavailable according to the location of the final customer) are discussed by the OECD, which published the data with an "Important disclaimer regarding the limitations of the country-by-country report statistics", and by Garcia-Bernardo et al. (2021), Clausing (2020b) or Sullivan (2023).

The first limitation concerns the lack of completeness in the data of reporting countries. We address this limitation by comparing the number of companies in Orbis, a frequently used database covering over 300 million public and private firms worldwide, with the number of companies observed in CBCR (Table A6). Orbis has good coverage regarding the number and consolidated revenue of large MNCs (Garcia-Bernardo & Takes, 2018), but poor information at the subsidiary level (Bajgar et al., 2018; Garcia-Bernardo et al., 2021; Phillips et al., 2020). We find a good correlation between the Orbis and CBCR data Table A6, which indicates that CBCR data is complete in 2017.

The second limitation concerns the combination of countries in aggregated categories—for example, Chile and the British Virgin Islands may be grouped together in "Other Americas". The aggregation criterion is different for different countries. While India and South Africa do not seem

Figure A2: Country availability in the 2017 OECD data



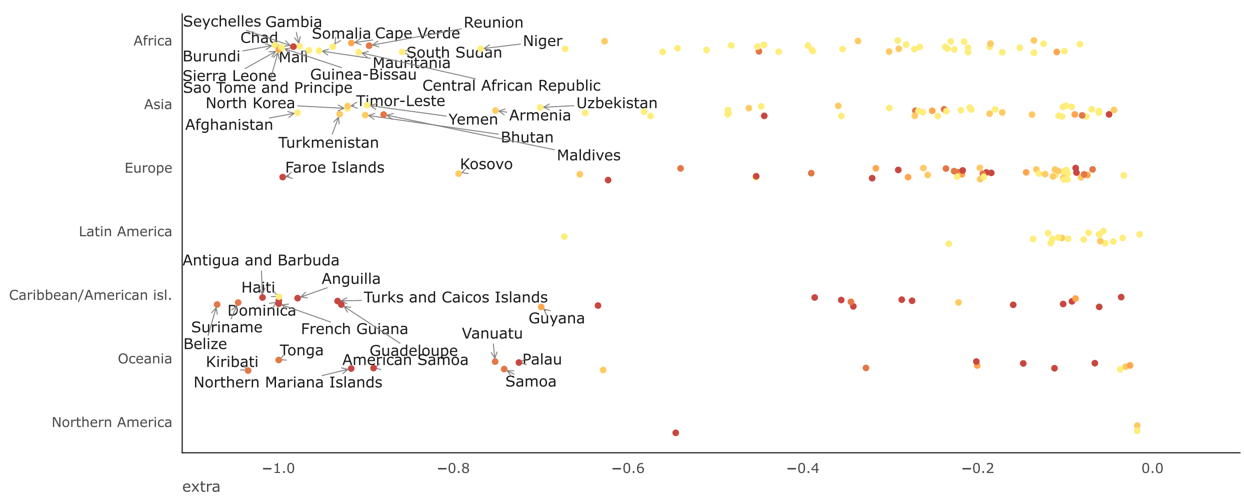
Notes: Country availability in the 2017 OECD CBCR data. Reporting countries (horizontal axis) reporting on selected countries often considered tax havens (vertical axes) are depicted with black squares. While every MNC reports on its activities in every jurisdiction, it is decided by each country whether it enables publication of its CBCR data through the OECD and how aggregated the published data are. This figure depicts the heterogeneity in countries' decisions. Only countries that decided to share some data and report on at lest one of the major tax havens are on the horizontal axis (reporting country). The figure depicts whether the reporting country allows the OECD to publish the country-level data for each of the selected partner countries (major tax havens) on the vertical axis. For example, the United States enables publication of information for all of those tax havens, while Austria or Norway or Poland for none of them (and therefore not shown in the table).

to aggregate data, the US aggregates countries with a low number of reporting MNCs. This is problematic, as aggregation affects particularly lower-income countries and low tax jurisdictions. For instance, only three countries report information on Gambia, and only seven countries report on the Isle of Man. The other countries aggregate information on Gambia and the Isle of Man in larger categories such as Other Africa and Other Europe. If we decided to ignore this grouped data, we would be missing a significant part of the operations in those countries, leading to an underestimation of the extent of profit shifting. This is acknowledged by the Economic Analysis and Impact Assessment of the OECD OECD, 2020, who impute missing sales by extrapolating using a gravity model using data available in the CBCR, Orbis, and the OECD's Activity of Multinational Enterprises database, as well as foreign direct investment and GDP data.

We address these biases by modelling the location of employees and sales for each pair of countries using a Histogram-based Gradient Boosting Regression Tree, a type of gradient boosting based on decision trees that frequently outperforms other machine learning algorithms, while offering some interpretability on the most relevant features (Friedman, 2001; Ke et al., 2017). Specifically, we use the Python implementation in scikit-learn (Pedregosa et al., 2011). Another of its advantages is that it offers native support for missing values, and as such is able to use a large range of features without data imputation. We train the location of profits, employees, sales and tangible assets using variables from the gravity dataset of CEPII, imports and exports from UN Comtrade, and foreign direct investment from the World Bank, as well as from other sources detailed in Table E1 in Appendix A.1.2. We obtain a mean out-of-sample R-square of 0.74, 0.56, 0.57 and 0.44 respectively for employees, sales, profits and tangible assets.

We use the model to estimate the total number of employees, unrelated party sales and tangible assets for each pair of countries in the world. For reporting countries, we then adjust the estimated values so their sum corresponds to the aggregated sum in CBCR. We demonstrate our approach using the following model scenario: French MNCs have 10,000 employees in Other America, and Other America comprises Paraguay and Suriname—we can establish this by checking which countries are missing from the CBCR data of France. If our model estimates 6,000 employees in Paraguay and 5,000 employees in Suriname, we multiply the employees of those countries by 10,000 and divide by 11,000. In the next step, we compare for each country the sums of those estimated values with the sums of the values observed in the CBCR data. We then use the lowest of the two ratios (estimated vs. reported employees and sales) to adjust the profits shifted in order to correct for the combination of small countries in aggregated groups. We cap this ratio at 10—that is, if the model expects that the OECD data is less than 10 per cent complete, we consider it to be 10 per cent complete. While the estimation of missing economic activity increases total shifted profits by approximately 30 per cent, it is key with respect to accounting for missing data in countries underrepresented in the sample—typically lower-income countries. Without this step, we would redistribute too few profits to those countries. Figure A3 shows the available information on CBCR, displaying how data coverage is especially worrisome in the case of lower-income countries.

Figure A3: Available information on CBCR



Notes: Colour denotes increasing GDP per capita. Countries with availability below 20% are annotated. All countries with availability below 10% are placed to the left of the 10% horizontal line.

The third limitation concerns the lack of reporting by some countries, including Russia, which excludes MNCs headquartered in those countries from the sample—but we do have the operations in those countries of MNCs headquartered in reporting countries. This limitation is partially addressed in the previous step, where financial information for all pairs of countries is estimated, even for non-reporting countries. However, the information on domestic activities of MNCs is important, especially for large countries. This is addressed by estimating the number of domestic employees, revenue and tangible assets for all non-reporting countries. We do so by using a linear model based on the number of expected companies in each country, its GDP, population, the average ETRs and the total consolidated banking claims on an immediate counterparty basis (Table B4 of the BIS data) (R-square 0.97, 0.93 and 0.88 respectively; see also Figures A14 and A15).

Importantly, in the logarithmic model, we only use the fixes to the second and third limitations to redistribute profits back to the home countries, but not to calculate profit shifted. We do this since we do not have accurate estimates of ETR for MNCs of non-reporting countries. Instead, we divide the total profit shifted by the share of GDP of the countries of the sample (83%). This is a similar figure to the available economic activity estimated in the CBCR data using the fixes to the second and third limitation (94%). Using the GDP in the logarithmic model may be a conservative strategy, since we are assuming that the MNCs of non-reporting countries (e.g., the Cayman Islands, the British Virgin Islands) are similar to those of reporting countries.

Finally, we assess our results' sensitivity to the estimation of missing information. To do so, we train the models 1,000 times using bootstrapped samples of the data (i.e. the gradient boosting ensemble to address the second limitation and the linear regression to address the third limitation) and record the impact in our results. Since the sampling randomly removes information, samples without important dyads (e.g. USA-Netherlands, or China–Hong Kong) will be more affected. This thus offers a conservative strategy that allows us to partially understand how our results depend on methodological choices. In the end, we use median values as our preferred point estimates.

The difference between the observed and estimated location of employees and sales is visualised in Figure A13. In comparison with the observed location of the economy, the estimated location is more balanced, giving less weight to reporting countries, and affecting especially Asian and African countries—see the largest outliers in Figure A13. Our estimated location of the economy matches closely the share of GDP for richer countries, while departs for developing countries (Figure A13B). This is expected given the lower presence of large MNCs in developing countries.

In addition to those limitations discussed above, we briefly refer to other limitations identified in the use of the data and discussed by the OECD, which published the data with an "Important disclaimer regarding the limitations of the country-by-country report statistics", an updated version of which has been published in July 2021.

A.1.2 Modelling missing employees and revenues

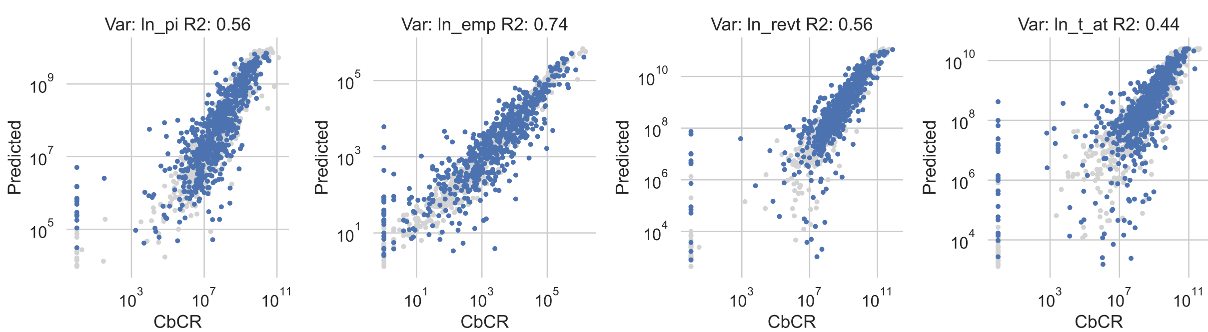
We train the location of profits, employees and sales using variables from the gravity dataset of CEPII, the World Bank data (WBD), the United Nations data (UN), the International Monetary Fund (IMF), the UN COMTRADE database (COMTRADE), Linkedin, the Tax Justice Network financial secrecy and corporate tax haven indexes (TJN), the Bank of International Settlements (BIS), the International Labour Organization (ILO), the World Health Organization (WHO), and the

Government Revenue Dataset (UNU-WIDER GRD). A complete list of variables can be found at the end of this Annex.

We used these variables to predict the location of employees and revenues. We tested several models, and Histogram-based Gradient Boosting Regression Tree—a type of gradient boosting based on decision trees which frequently outperforms other machine learning algorithms while offering some interpretability on the most relevant variables (Friedman, 2001; Ke et al., 2017)—was shown to perform the best. A sample of the prediction power of the algorithm is visualized in Figure A4, and a comparison with Lasso regression in Figure A5. Since Lasso does not have native support for missing values, these are imputed using the sklearn function IterativeImputer, which provides with an strategy for imputing missing values by modeling each variable as a function of other variables in a round-robin fashion.

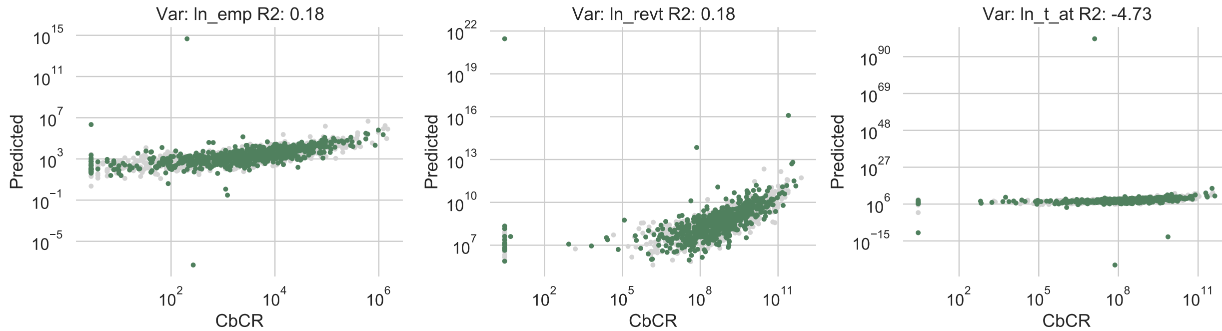
Finally, we investigated which variables were more important in the estimation using permutation feature importance (Breiman, 2001). The permutation feature importance is defined as the decrease in the R-square of the model when the values of a variable are randomly shuffled. We permutated the values of the original data (i.e., not of the 1000 bootstrap samples) 100 times to get a confidence interval, which is visualized in Figure A6. For the estimation of profits (ln_pi, not used in the paper), we find that outward FDI and Portfolio Investment are the most important variables. For the estimation of employees (ln_emp) and sales (ln_revt), outward FDI and Exports are the most important predictors. Importantly, we are not trying to rationalise the variables chosen by the algorithm, just to create an accurate model to impute missing values.

Figure A4: The prediction power of the algorithm, in-sample and out-of sample estimations



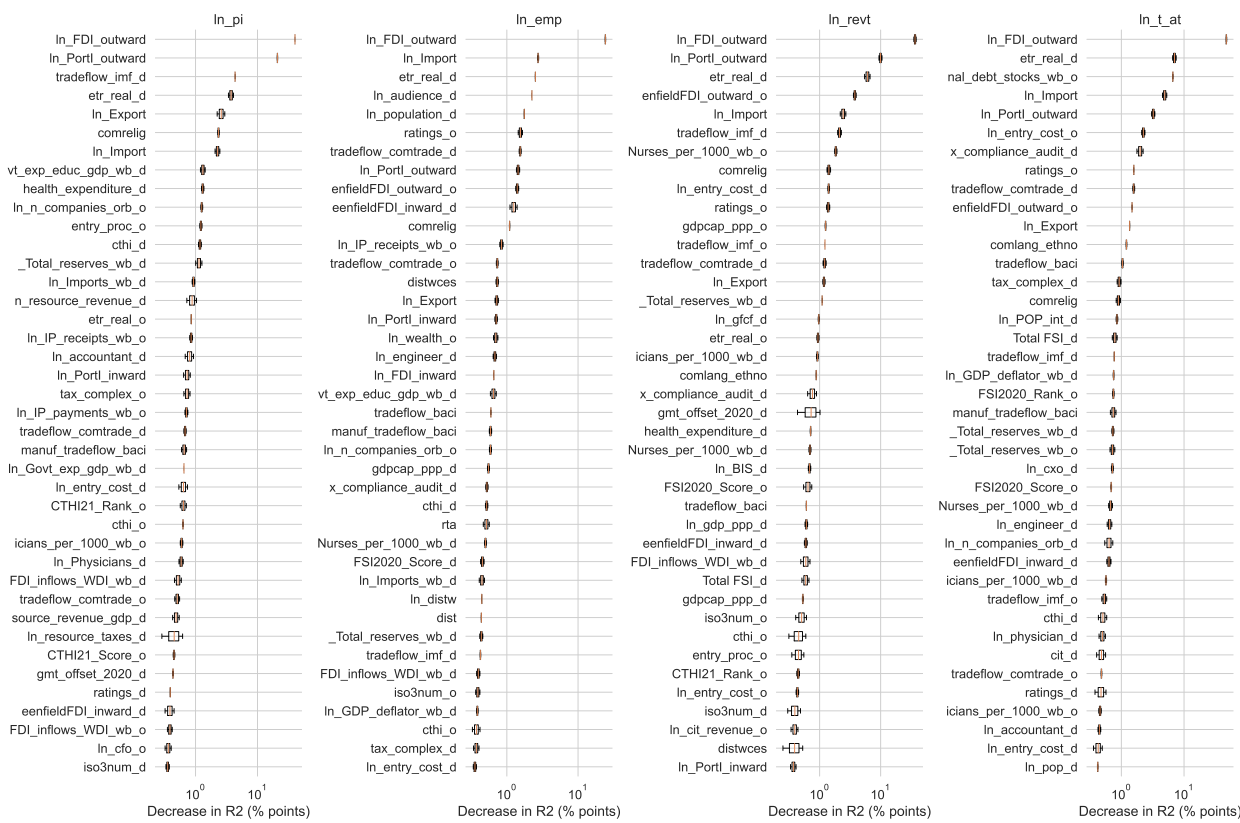
Notes: The boosting model was fit on 60% of the sample and tested in the other 40%. In-sample estimations are depicted in light grey, while out-of sample estimations of employees, unrelated party sales and tangible assets are visualised in blue. Note that this is one split of the data. The cross-validated r-squares are displayed in the main text. The parameters (learning_rate=0.105; 0.168; 0.073; 0.042 respectively, l2_regularization=158.5; 100; 63.1; 39.8 respectively and min_samples_leaf=20 for all) were set using cross-validation.

Figure A5: A comparison with a Lasso regression



Notes: A penalised linear regression model was fit on 60% of the sample and tested in the other 40%. In-sample estimations are depicted in light grey, while out-of sample estimations of employees, unrelated party sales and tangible assets are visualised in blue. Note that this is one split of the data. The penalty parameter (alpha=1.0 for all) was set using cross-validation.

Figure A6: Permutation Importance of each variable for the prediction of profits and sales



Notes: Permutation Importance of each variable for the prediction of profits (ln_pi, not used in the paper), (ln_emp), and sales (ln_revt).

A.1.3 Modelling missing employees and revenues: A complete list of variables

Table A2: Variables used in the imputation of missing data

Variable	Description	Source
iso3	ISO-3 code	
revt, emp, pi, txc	Revenue, employees, profits and cash taxes	CBCR
Bilateral Variables		
ln_Import	Log of total imports from origin to destination	COMTRADE
ln_Export	Log of total exports from origin to destination	COMTRADE
ln_FDI_inward	Log of total FDI from orogin to destination	IMF CDIS
ln_FDDI_outward	Log of total FDI from destination to origin	IMF CDIS
ln_PortI_inward	Log of total portfolio investment from orogin to destination	IMF CPIS
ln_PortI_outward	Log of total portfolio investment from destination to origin	IMF CPIS
ln_dClaims	Log of total banking claims (derived from partners)	BIS Table A6.2
ln_dLiabilities	Log of total banking liabilities (derived from partners)	BIS Table A6.2
ln_distw	Ln of distance between countries	CEPII GravData
tdiff	Time zones difference (hours)	CEPII GravData
transition_legalchange	Dummy, 1 if common legal origin changed since transition	CEPII GravData
eu_to_acp	Dummy, EU/member exporting to an ACP country (a preferential trade agreement on imports)	CEPII GravData
acp_to_eu	Dummy, ACP country exporting to an EU/member (a preferential trade agreement on imports)	CEPII GravData
col45	Dummy, colonial relationship post 1945	CEPII GravData
col_fr	Dummy, origin of colonial relationship post 1945	CEPII GravData
col_to	Dummy, destination of colonial relationship post 1945	CEPII GravData
colony	Dummy, colonial relationship (ever)	CEPII GravData
comcol	Dummy, common colonizer post 1945	CEPII GravData
comcur	Dummy, common currency	CEPII GravData
comlang_ethno	Dummy, common language (>9% population)	CEPII GravData
comlang_off	Dummy, common official language	CEPII GravData
comleg_posttrans	Dummy, common legal origins after transition	CEPII GravData
comleg_pretrans	Dummy, common legal origins before transition	CEPII GravData
comrelig	Religious proximity index	CEPII GravData
contig	Dummy, contiguity	CEPII GravData
curcol	Dummy, current colonial relationship	CEPII GravData
cursib	Dummy, current sibling relationship (common colonizer)	CEPII GravData

sibling	Dummy, ever sibling relationship (common colonizer)	CEPII GravData
fta_wto	Dummy, regional trade agreement (WTO)	CEPII GravData
gsp	Dummy if donator in Generalized System of Preferences	CEPII GravData
heg_o	Dummy, 1 if origin is current of former hegemon of destination	CEPII GravData
heg_d	Dummy, 1 if destination is current of former hegemon of origin	CEPII GravData
gsp_d_d	Dummy, 1 if origin is donator in Generalized System of Preferences	CEPII GravData
gsp_o_d	Dummy, 1 if destination is donator in Generalized System of Preferences	CEPII GravData
Unilateral variables: Included for the reporting and partner countries		
Legislative/historical/Geographical		
entry_proc	Start-up procedures to register a business (Number)	CEPII GravData
entry_time	Time required to start a business (days)	CEPII GravData
entry_tp	Days+Procedures to start a business	CEPII GravData
gatt	GATT member	CEPII GravData
EU28	Dummy, country belonging go the EU-28	
OECD	Dummy, country belonging go the OECD	
Ukt	Dummy, UK-territory	
region_tjn	Region	TJN
ln_area	Log of area in sq. kms	CEPII GravData
ln_entry_cost	Log of cost of business start-up procedures (log of % GNI per capita)	CEPII GravData
english	Official language 1 in the CEPII GeoDist dataset	CEPII GeoDist
governance	First PCA component of the six dimensions of the Worldwide Governance Indicators project	WBD
Socio-economic		
Nurses_per_1000	Nurses per 1000 inhabitants	WBD
Physicians_per_1000	Doctors per 1000 inhabitants	WBD
ln_Nurses	Log of number of nurses	
ln_physician	Log of number of doctos	
ln_pop	Population (source CEPII)	CEPII GravData
ln_population	Population (source WBD)	WBD
ln_POP_int	Population (manually completed)	WBD, UN, CIA
ln_GDP_int	GDP (manually completed)	WBD, UN, CIA
ln_gdp_d	GDP	CEPII GravData
ln_gdpcap_d	GDP per capita	CEPII GravData

ln_gdppc_d	GDP per capita	ln_GDP_int - ln_POP_int
ln_Health_expenditure_gdp	Log of health expenditure (% of gdp)	WBD
ln_uhnwi	Log10 of the number of high net worth individuals (adults with wealth above 50 millions)	Global Wealth Report 2018 by Credit Suisse
ratings	Trading Economic credit rating, composed from the credit ratings by Moody's, S&P, Fitch and DBRS	Feb. 2019 tradingeconomics.com
ln_n_companies_orb	Log of number of MNCs with a turnover higher than 750M in Orbis	Orbis
ln_GreenfieldFDI_inward	Total greenfield FDI into the country	UNCTAD
ln_GreenfieldFDI_outward	Total greenfield FDI out of the country	UNCTAD
ln_BIS	Log of total consolidated banking claims on an immediate counterparty basis	BIS (Table B4)
ln_ExternalDebtStocks	Log of External Debt Stock	WBD
ln_consumption	Log10 of final consumption expenditure by households and non-profit institutions serving households (constant 2010 USD)	Mean 2014-2018 NE.CON.PRVT.KD
ln_gfcf	Log10 of gross fixed capital formation (constant 2010 USD)	Mean 2014-2018 NE.GDI.FTOT.KD
ln_FDI_Inflows_WDI_d	Log of total FDI inflows	WBD
ln_imports_wbd	Log of total imports in the country	WBD
ln_ip_payments_wbd	Log of IP payments in the country	WBD
ln_ip_receipts_wbd	Lof of IP receipts in the country	WBD
ln_exports_wbd	Log of total exports in the ocuntry	WBD
ln_month_wage	Log of monthly wage	ILO
ln_govt_exp_educ_sgdp_wb	Log of government expenditure in education (%GDP)	WBD
ln_who_gvt_health_expenditure	Log og public expenditure in health care	WHO
ln_cit_revenue	Log of government revenue from corporate income tax	UNU - WIDER GRD
ln_resource_revenue	Log of government revnue from resource taxes and fees	UNU - WIDER GRD
ln_resource_taxes	Log of government revnue from resource taxes	UNU - WIDER GRD
ln_resource_revenue_gdp	Log of government revnue from resource taxes and fees (% GDP)	UNU - WIDER GRD
ln_total_taxes_revenue	Log of total government revenue from taxes	UNU - WIDER GRD
Secrecy and tax		
Total FSI	Financial Secrecy Score	TJN
cit	Statutory Corporate Income tax rates	Mean 2014 - 2018, (Janský & Palanský, 2019)
cthi	Corporate Tax Haven Score	TJN
etr_real	Effective tax rate, capped at 0.6 and using CIT for missing and negative values.	CBCR weighted average

ln_cit	Log of cit	KPMG, EY, PwC
ln_etr_real	Log of etr_real	CBCR weighted average
tax_complex	Time to prepare and pay taxes (hours)	Mean 2014 - 2018, IC.TAX.DURS (WBD)
ln_accountant_d	Log of number of accountants	Linkedin (Garcia-Bernardo and Stausholm, Forthcoming)
ln_all_tax	Log of number of all tax professionals	Linkedin (GB&S)
ln_audience	Log of number of linkedin users	Linkedin (GB&S)
ln_banker	Log of number of bankers	Linkedin (GB&S)
ln_ceo	Log of number of CEOs	Linkedin (GB&S)
ln_cfo	Log of number of CFOs	Linkedin (GB&S)
ln_coo	Log of number of COOs	Linkedin (GB&S)
ln_cxo	Log of number of Chief Executives	Linkedin (GB&S)
ln_engineer	Log of number of engineers in country	Linkedin (GB&S)
ln_finance	Log of number of finance workers	Linkedin (GB&S)
ln_other_corporate	Log of number of corporate tax professionals	Linkedin (GB&S)
ln_wealth	Log of number of wealth managers	Linkedin (GB&S)
ln_transfer_pricing	Log of number of transfer pricing specialists	Linkedin (GB&S)
ln_tax_compliance_audit	Log of number of tax compliance experts and auditors	Linkedin (GB&S)

A.2 Additional theory discussion

Profit shifting is most frequently modelled using the method proposed by Hines and Rice (1994). In this section we show why the assumptions of that model are not consistent with our empirical observation of modern profit shifting behaviour.

The Hines and Rice (1994) model method assumes that the cost of profit shifting in country i, $Cost_i$, increases quadratically with the profit shifted (S_i). This assumption implies that low levels of profit shifting are practically cost-free, while the cost quadratically increases as the intensity of profit shifting increases. The relationship is normalized by $\alpha/2$.

$$Cost_i = \frac{\alpha}{2}\frac{S_i^2}{p_i} \tag{11}$$

The profits booked in a country (π_i) are defined by the sum of real profits (p_i) and profits shifted minus the cost of profit shifting:

$$\pi_i = p_i + S_i - Cost_i \tag{12}$$

Hines and Rice (1994) maximize the after-tax profits ($(1-\tau_i)\cdot\pi_i$) subject to the existence of profit shifting, finding that the relationship between profits shifted and tax rates is:

$$S_i = p_i\left(\frac{1-\tau_i-\lambda}{\alpha(1-\tau_i)}\right), \tag{13}$$

Substituting equation 13 in equation 14 and 11, we obtain:

$$\pi_i = p_i + p_i\left(\frac{1-\tau_i-\lambda}{\alpha(1-\tau_i)}\right) - p_i\frac{\alpha}{2}\left(\frac{1-\tau_i-\lambda}{\alpha(1-\tau_i)}\right)^2 = p_i\cdot\left(1+\frac{\alpha}{2\alpha}-\frac{\lambda^2}{2\alpha(1-\tau_i)^2}\right) \tag{14}$$

where λ is the Lagrange multiplier and τ_i is the tax rate in the country.

While this method has been widely used (Beer, Mooij et al., 2020), the assumptions of the model are inadequate to study modern profit shifting. First, the Taylor expansion of equation 14 is taken around the point where no profit shifting takes place (i.e., where $\lambda^2 = (1-\tau_i)^2$, which simplifies equation 14 to $\pi_i = p_i$). This simplifies

$$\log(\pi_i) = \log(p_i) + \log\left(1+\frac{1}{2a}-\frac{\lambda^2}{2a(1-\tau_i)^2}\right) \tag{15}$$

around $\tau_i = (1-\lambda)$ into

$$\log(\pi_i) \sim \log(p_i) + \left(\frac{1-\lambda}{\alpha\lambda}-\frac{\tau_i}{\alpha\lambda}\right), \tag{16}$$

and around $(1-\tau_i)^2 = \lambda^2$ into

$$\log(\pi_i) \sim \log(p_i) + \left(\frac{1}{1\alpha} - \frac{\lambda^2}{2\alpha(1-\tau)^2}\right). \tag{17}$$

Subsequently, theoretical profits (p_i) are identified with the Cobb-Douglas production function, yielding equations 18 and 19 from equations 16 and 17:

$$\log(\pi_i) = \beta_0 + \beta_1 \log(K_i) + \beta_2 \log(L_i) + \beta_3(\tau_i) + \beta_\chi \chi + \epsilon, \tag{18}$$

$$\log(\pi_i) = \beta_0 + \beta_1 \log(K_i) + \beta_2 \log(L_i) + \beta_3(\tau_i) + \beta_4(\tau_i)^2 + \beta_\chi \chi + \epsilon, \tag{19}$$

where π_i represents profits booked in country i, and K_i and L_i are the capital and labour components of the Cobb-Douglas production function, usually operationalised with total tangible assets and wages. τ_i is either the tax rate of the subsidiary, the difference of tax rates between the subsidiary and the parent, or, less frequently (due to lacking data), between the subsidiary and other subsidiaries, and χ are controls including e.g. GDP per capita and population.

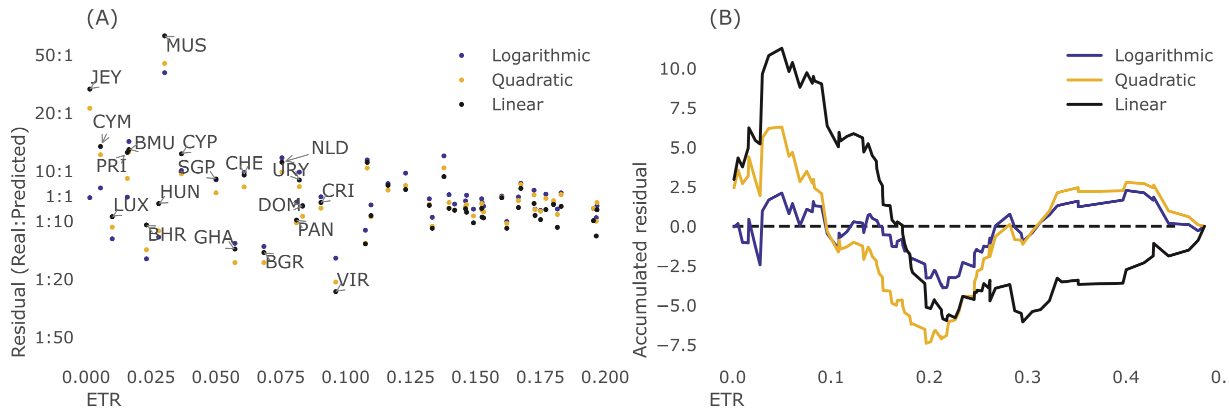
These two equations are convenient but are only valid around the point where no profit shifting is present ($\pi_i = p_i$). Extending these approximations far from that point is not adequate. While, as Hines and Rice (1994) put it, "it is helpful to transform the second term on the right side [of eq. 15] into a linear function of tax rates", the response of profit shifting on the tax rate is, as we show in the main text and below, highly non-linear. As a result, these simplifications (both in the linear and the quadratic forms) are not able to model profit shifting correctly (Fig. A7).

For both the linear (eq. 18) and quadratic (eq. 19) models, profit shifting is undervalued for countries with a tax rate below 10% and overvalued for other countries (Fig. A7)—the residuals are typically positive for countries with an ETR below 10% for both the linear and quadratic model (Fig. A7). The residuals are only corrected once the logarithmic term is reintroduced, with the cumulative residual fluctuating only slightly (Fig. A7).

The second assumption that requires careful consideration is the choice of the cost function (Eq. 11). Profit shifting strategies based on intangibles require high costs to set up, and low functioning costs—the opposite of what it is assumed in equation 11.

The inadequacy of equation 11 to model the cost of profit shifting in the 21st century can also be shown by estimating α (normalization constant) and λ (the Lagrange multiplier). We start with the estimates in the literature of the semi-elasticity of the tax rate (which is equivalent to $-\frac{1}{\alpha\lambda}$), at around 1 (Beer, De Mooij et al., 2020) or around 4, as implied in this

Figure A7: Residuals of the regressions



Notes: (A) Residuals ($\log\left(\frac{bookedprofits}{predictedprofits}\right)$) and (B) Cumulative sum of residuals for the linear (green), quadratic (orange) and logarithmic (blue) models, as a function of the ETR in the country.

		Semi-elasticity: 1			Semi-elasticity: 4		
		Tax rate			Tax rate		
		0	0.2	0.4	0	0.2	0.4
	95%	0.26	0.28	0.32	0.14	0.16	0.18
Profits shifted	50%	1.62	1.72	1.89	1.21	1.25	1.32
	25%	3.79	3.95	4.19	3.23	3.29	3.37

Table A3: Values of α depending on the tax rate (τ_i), the semi-elasticity, and the fraction of profit shifted ($S_i/(S_i + p_i)$)

paper. Furthermore, we can estimate (using the logarithmic or the misalignment models) that the share of profits shifted ($S_i/(S_i + p_i)$) in countries with no corporate income tax rate is around 90–99%, and 30–50% in countries with moderate tax rates. This allows us to plug S_i/p_i in equation 13, keeping only τ_i, α and λ. Using the relationship of our parameters of interest (α and λ) and the semi-elasticity on the one hand and the share of profit shifting on the other, we can calculate the value of α for different values of the profits shifted ($S_i/(S_i + p_i)$), the semi-elasticity and τ_i (Table A3). This exercise allows us to estimate α to be around 0.14–4.19.

For a tax haven with no corporate income tax rate and 95% of the profits shifted in ($S_i = 0.95(S_i + p_i)$), equation 11 becomes

$$Cost_i = \frac{\alpha}{2}\frac{S_i^2}{0.05S_i/0.95} = \frac{\alpha}{2}19S_i > \frac{0.14}{2}19S_i > 1.33S_i \tag{20}$$

$$Cost_i = \frac{\alpha}{2} 19 S_i > \frac{0.14}{2} 19 S_i > 1.33 S_i \tag{21}$$

Using the most conservative value of alpha (0.14), as in equation 21, we would estimate that the cost of profit shifting is at least 33% higher than the amount of profits shifted for tax havens. This points to a mismatch between the quadratic cost function proposed by (Hines & Rice, 1994) and profit shifting in the 21st century.

A.3 Supplementary Figures

Figure A8: Template for the country-by-country report by the OECD

Name of the MNE group:
Fiscal year concerned:
Currency:

Tax Jurisdiction	Revenues			Profit (Loss) Before Income Tax	Income Tax Paid (on cash basis)	Income Tax Accrued – Current Year	Stated capital	Accumulated earnings	Number of Employees	Tangible Assets other than Cash and Cash Equivalents
	Unrelated Party	Related Party	Total							

Name of the MNE group:
Fiscal year concerned:

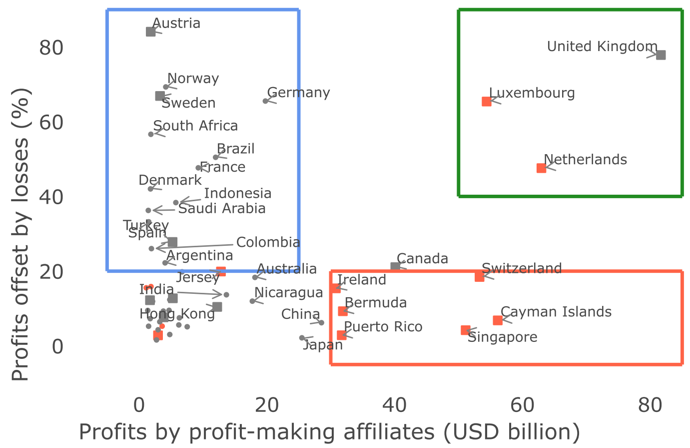
Tax Jurisdiction	Constituent Entities resident in the Tax Jurisdiction	Tax Jurisdiction of organisation or incorporation if different from Tax Jurisdiction of Residence	Main business activity(ies)												
			Research and Development	Holding/managing intellectual property	Purchasing or Procurement	Manufacturing or Production	Sales, Marketing or Distribution	Administrative, Management or Support Services	Provision of services to unrelated parties	Internal Group Finance	Regulated Financial Services	Insurance	Holding shares or other equity instruments	Dormant	Other[2]
	1.														
	2.														
	3.														
	2.														
	3.														

Name of the MNE group:
Fiscal year concerned:

Please include any further brief information or explanation you consider necessary or that would facilitate the understanding of the compulsory information provided in the country-by-country report.

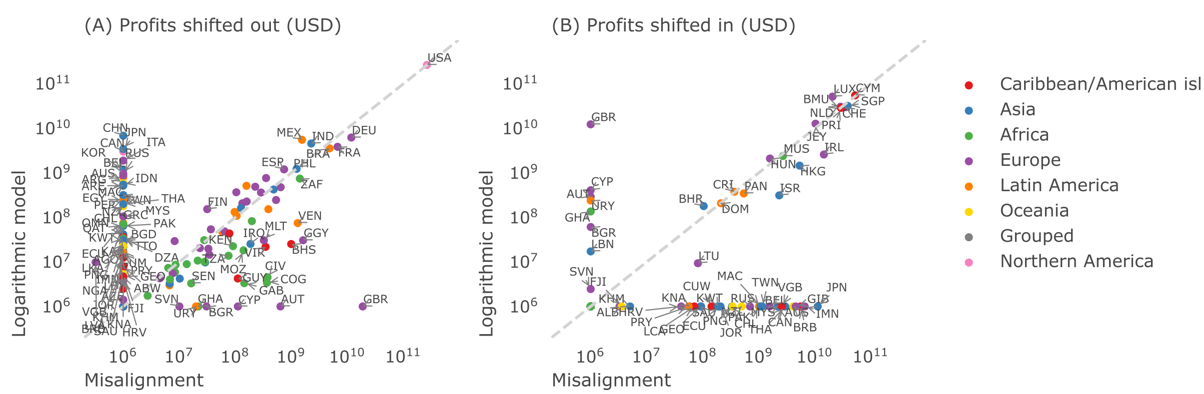
Notes: This figure includes pictures of a three-part template for CBCR by OECD (2019): (i) overview of allocation of income, taxes and business activities by tax jurisdiction; (ii) list of all the constituent entities of the MNC group included in each aggregation per tax jurisdiction; and (iii) additional information. Source: OECD (2019)

Figure A9: Loss-making affiliates as a profit shifting strategy



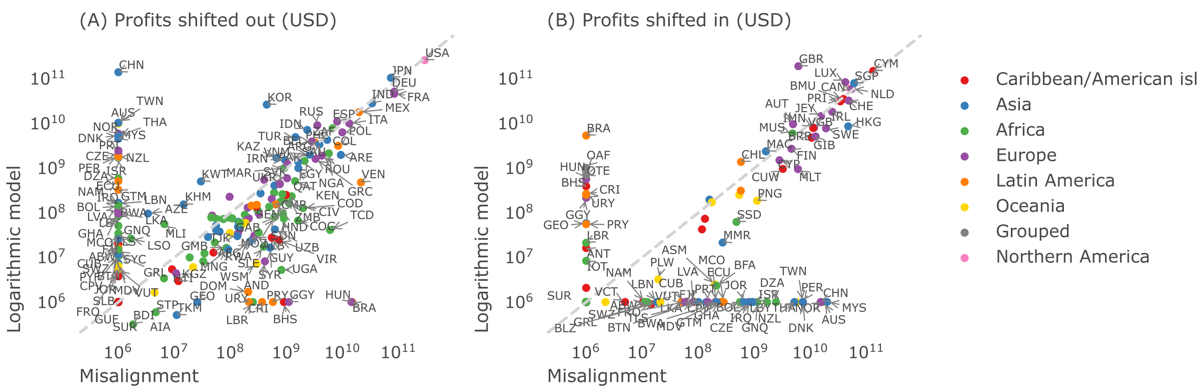
Notes: Loss-making affiliates as a profit shifting strategy, using US data. The total profits made by profit-making affiliates is plotted against the percentage of profits offset by losses. Three types of countries are highlighted with boxes in line with Reurink and Garcia-Bernardo (2020). In red are "profit centers", reporting very high profits not offset by losses. In green are "coordination centers" (or conduits), reporting very high profits offset by losses. In blue are origin countries, reporting profits offset by losses. Only countries reporting at least $10 billion profits are reported, the USA (profits of US 1,310 and offset ratio of 10% is excluded). Countries in red exhibit profitabilities above $100,000 per employee.

Figure A10: Comparison of profit shifting in and out for the misalignment and the logarithmic models using the US data



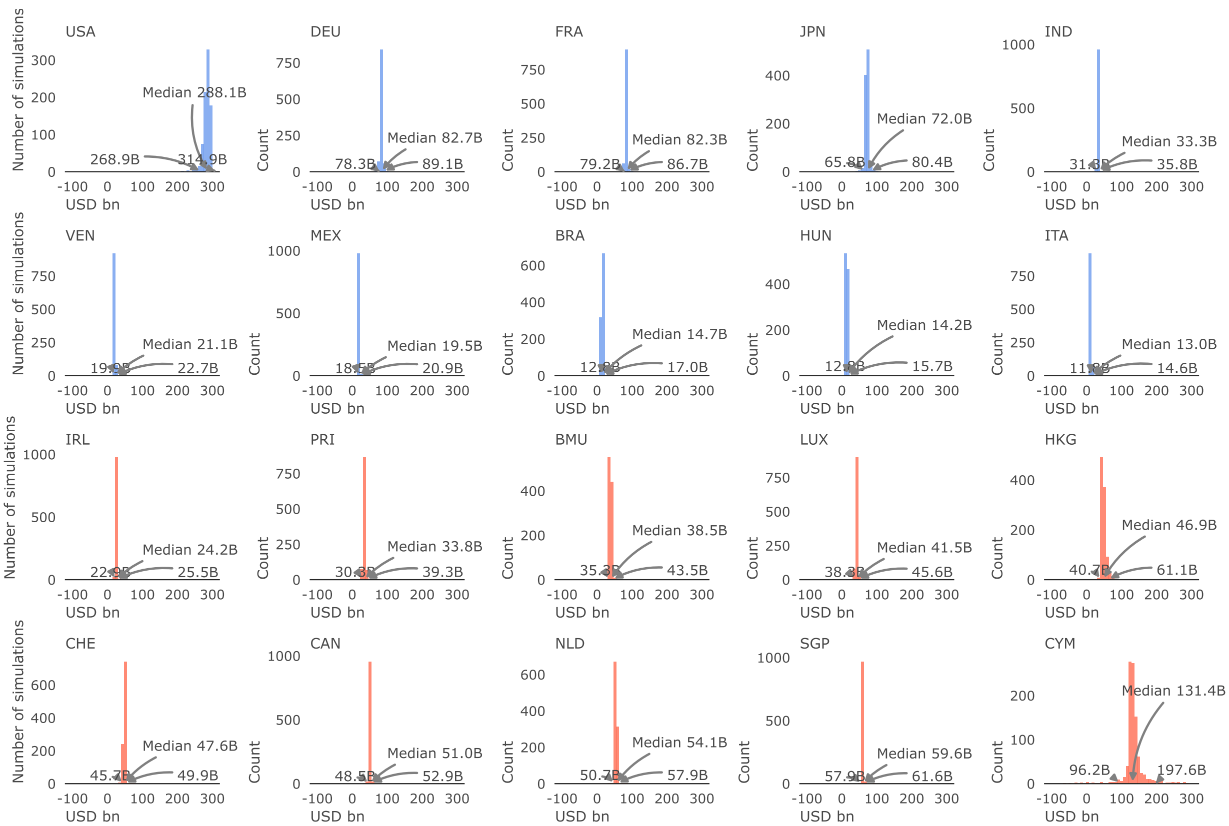
Notes: Comparison of profits shifted out (A) and profits shifted in (B) for the misalignment and the logarithmic models for the US data. Each dot represents a country, coloured by region. Note that profit shifting out of African countries is higher in the misalignment model.

Figure A11: Comparison of profit shifting in and out for the misalignment and the logarithmic models using the OECD data



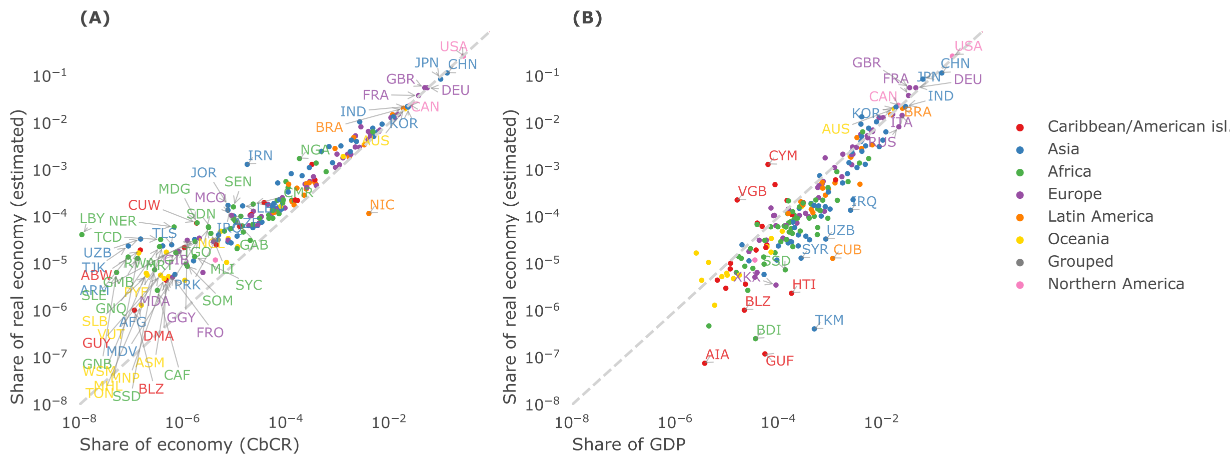
Notes: Comparison of profits shifted out (A) and profits shifted in (B) for the misalignment and the logarithmic models for the OECD data. Each dot represents a country, coloured by region. Note that profit shifting out of African countries is higher in the misalignment model.

Figure A12: Distribution of the scale of profit shifted estimated by the misalignment model at the country level



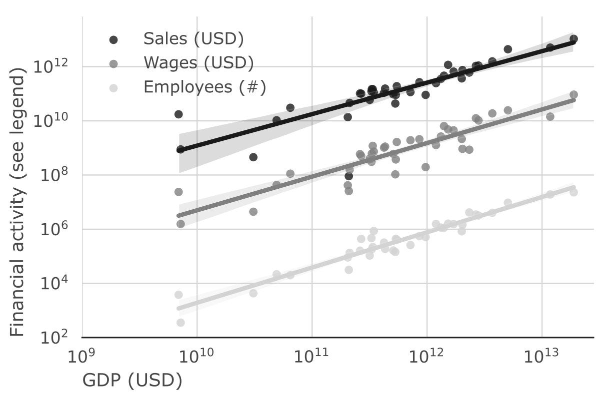
Notes: Distribution of the scale of profit shifted estimated by the misalignment model at the country level. The largest origins (top two rows, in blue) and destinations (bottom two rows, in red) are shown. The variance observed is created by the bootstrapping process detailed in Section A.1. Non reporting countries (Germany (DEU), the United Kingdom (GBR), Cayman Islands (CYM) have higher uncertainty than reporting countries such as France (FRA), Italy (ITA) or Bermuda (BMU). The 5% percentile, the median, and the 95% percentile are annotated.

Figure A13: Comparison between the redistribution formula



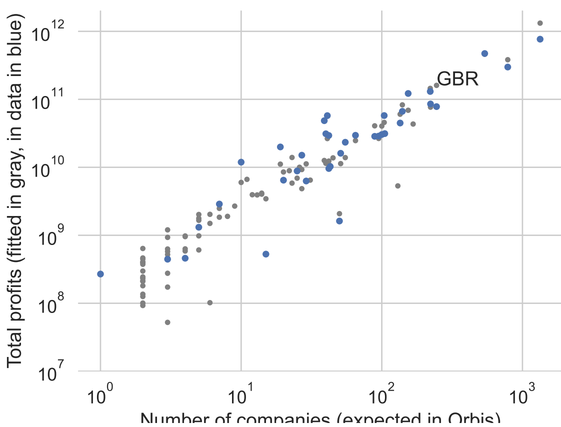
Notes: Comparison between the redistribution formula (eq. 8) (A) imputing missing data vs using raw data of firms with positive profits; and (B) imputing missing data vs using the share of GDP. Note that the estimated shares of the economy for African countries are higher than the shares of the economy for those countries in the raw data, but lower than the share of GDP of those countries.

Figure A14: Relationship between GDP and activity for countries in the OECD data



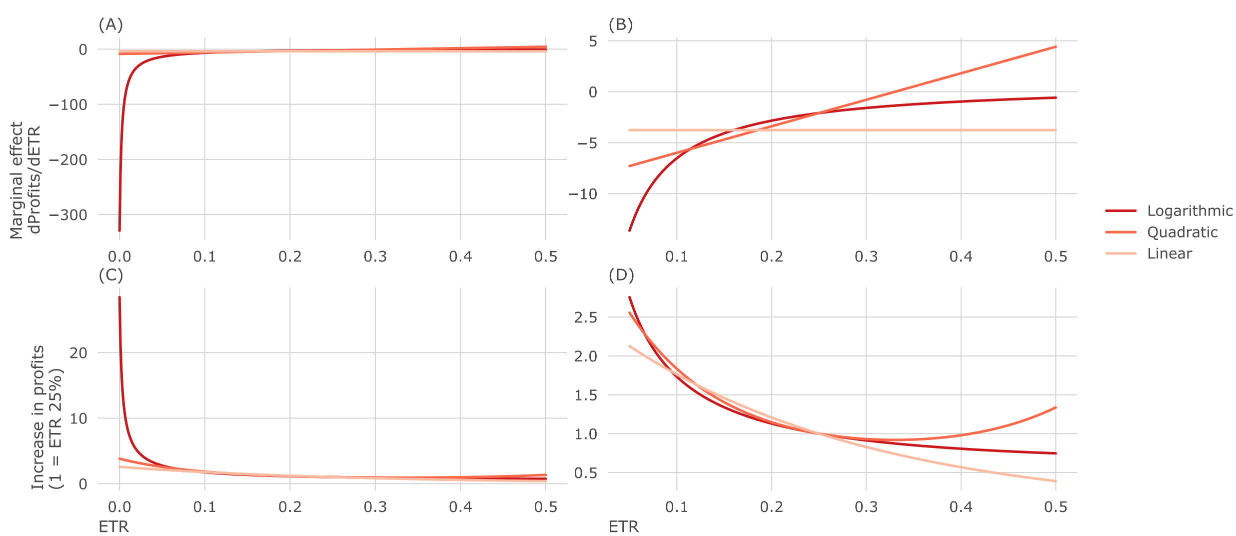
Notes: Relationship between GDP and domestic employees, sales and tangible assets for countries in the 2016 OECD data. Each dot corresponds to one country in the data.

Figure A15: Relationship between the number of large MNCs and the total profits reported domestically in the country



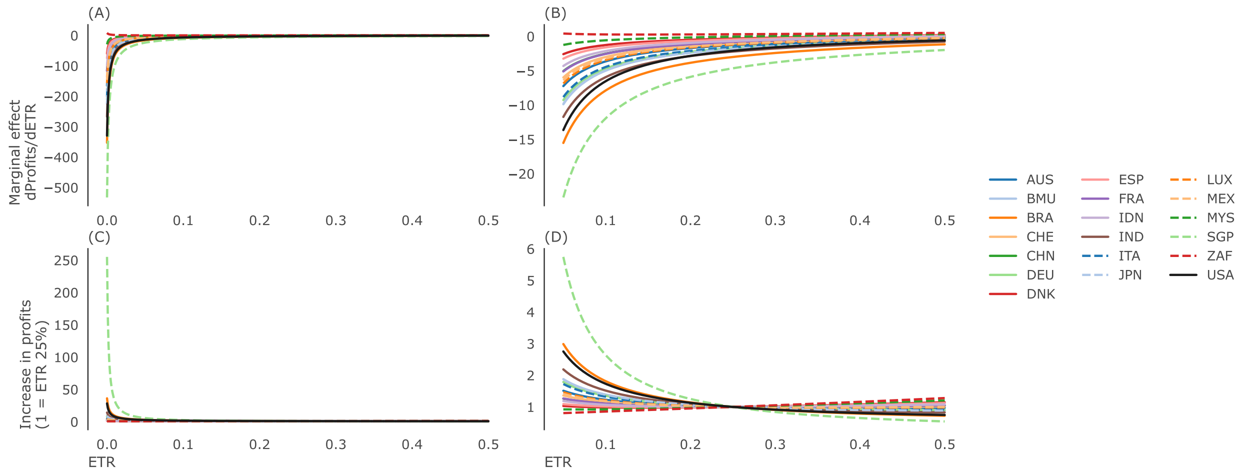
Notes: Relationship between the number of large MNCs (extracted from Orbis), and the total profits reported domestically in the country. Estimated values using a regression with GDP, population, the average ETRs and the total consolidated banking claims on an immediate counterparty basis (Table B4 of the Bank for International Settlements (BIS) data) are visualised in grey. Empirical values are visualised in blue.

Figure A16: Graphical representation of Table 3 for the logarithmic, quadratic, and linear models



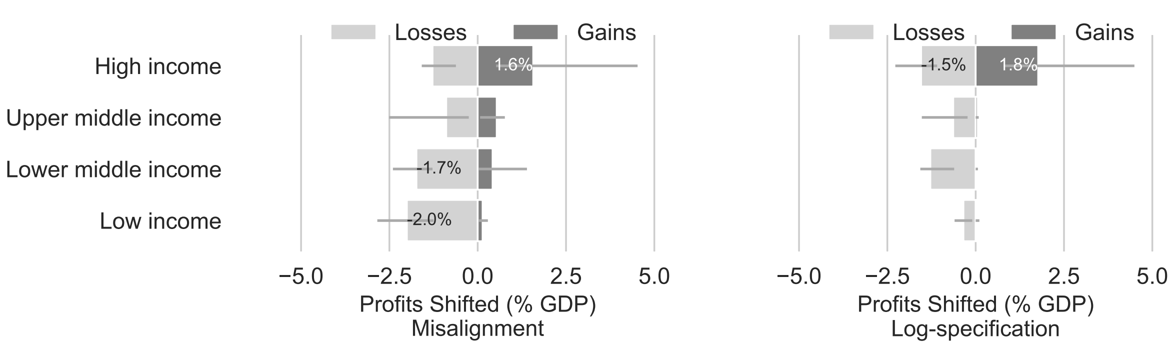
Notes: Graphical representation of Table 3 for the logarithmic, quadratic, linear and DLM models. (A, B) Marginal effect of ETR on profits. (C,D) Relative increase in profits due to profit shifting, compared with a country with an ETR of 25%. Plots B and D are close-ups of plots A and C respectively, constraining ETRs between 5 and 50%. Note that the marginal effects for the logarithmic model decreases faster than other models as the ETR approaches 0%.

Figure A17: Graphical representation of Table 3 for the logarithmic model, at the country level



Notes: Graphical representation of Table 3 for the logarithmic model, at the country level. (A, B) Marginal effect of ETR on profits. (C,D) Relative increase in profits due to profit shifting, compared with a country with an ETR of 25%. Plots B and D are close-ups of plots A and C respectively, constraining ETRs between 5 and 50%. Only countries reporting on at least 20 other countries are included.

Figure A18: Profits shifted as a percentage of GDP

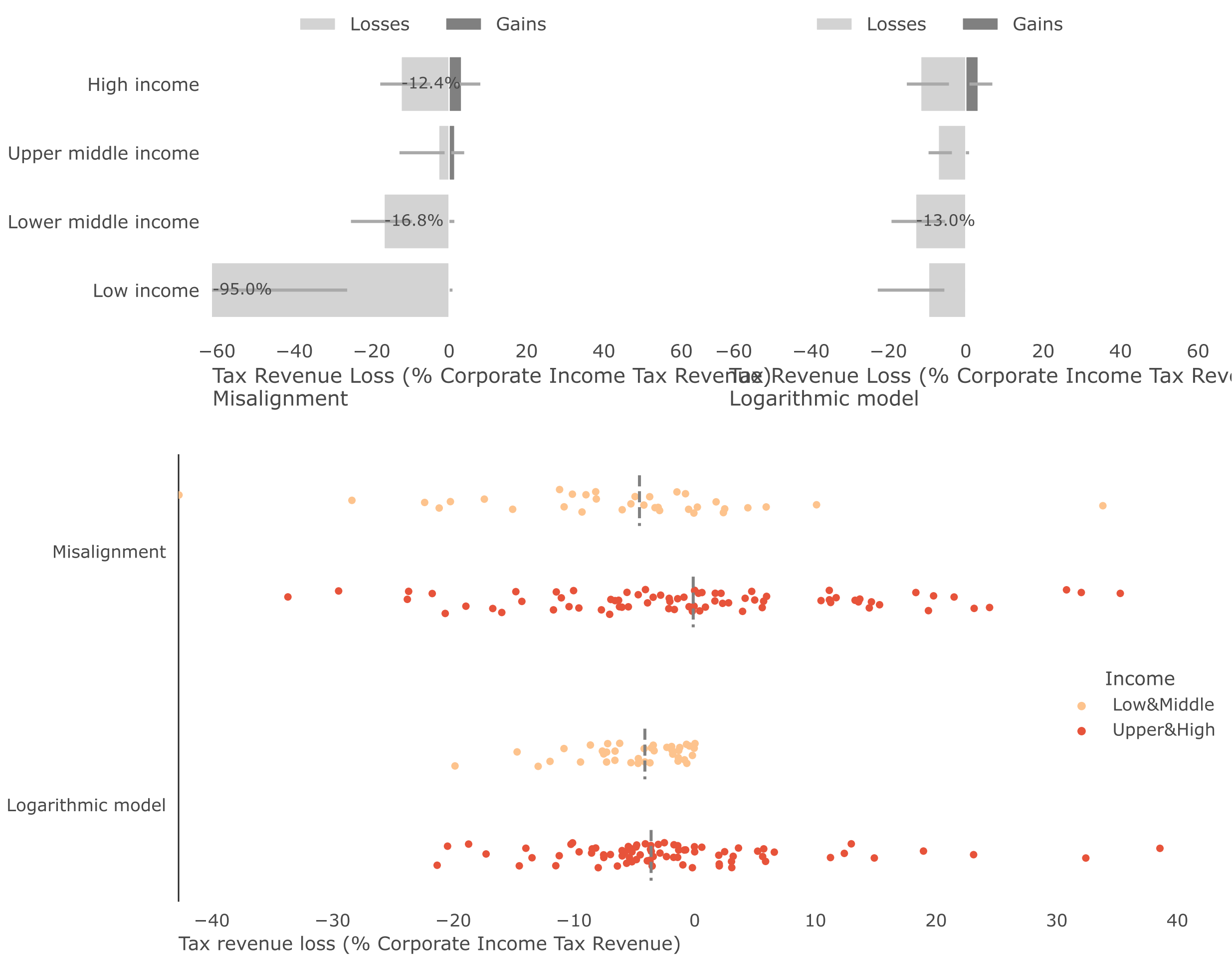


Notes: The figure shows the shifted profits as a percentage of GDP for countries in different income groups, as estimated by the misalignment (left graph) and logarithmic (right graph) models. Confidence intervals show 95% intervals, calculated via bootstrapping.

Figure A19: Tax revenue loss as a percentage of total tax revenue estimated with the misalignment and logarithmic models

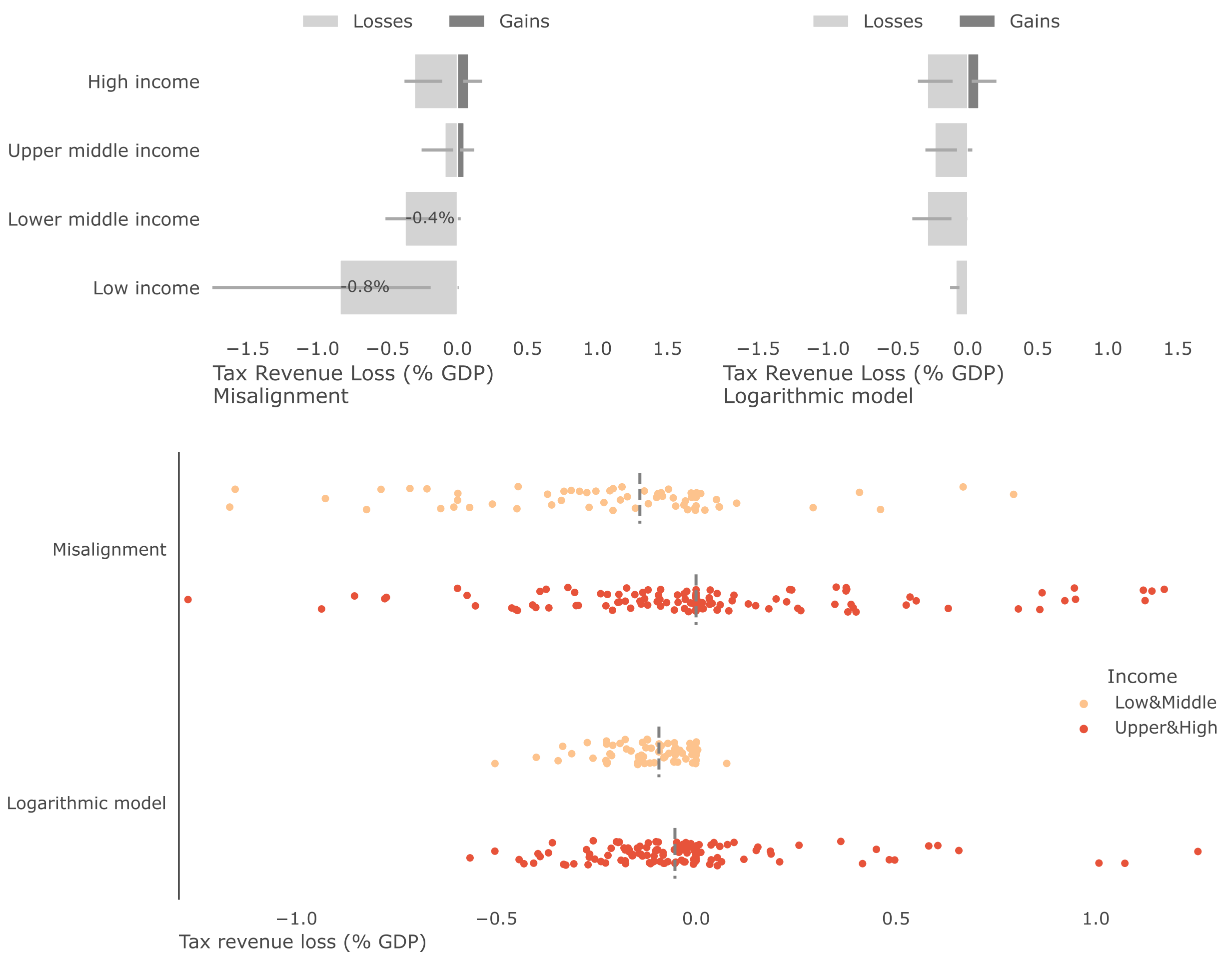
Notes: Tax revenue loss as a percentage of total tax revenue estimated with the misalignment and logarithmic models. Each dot represents an individual country, and the median values are visualised with a dashed line. The data is split into low and lower-middle income countries (Low&Middle, light orange) upper middle and high income countries (Upper&High, darker red). The statistical differences between the median are assessed with a Mann-Whitney test. Only observations within a distance from the median of 5 interquartile ranges are shown.

Figure A20: Tax revenue loss as a percentage of corporate income tax revenue



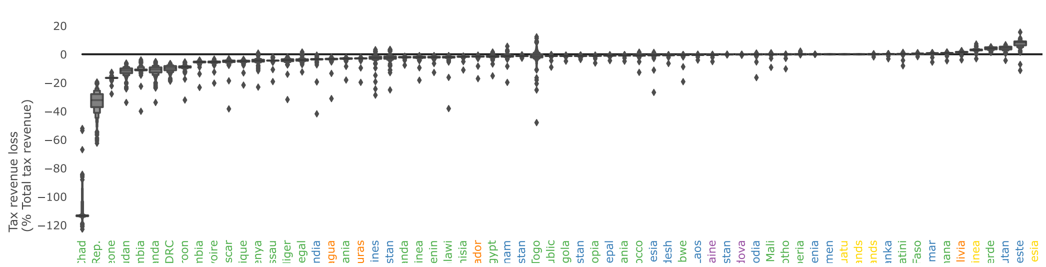
Notes: Tax revenue loss as a percentage of corporate income tax revenue. Only observations within a distance from the median of 5 interquartile ranges are shown.

Figure A21: Tax revenue loss as a percentage of GDP



Notes: Tax revenue loss as a percentage of GDP. Only observations within a distance from the median of 5 interquartile ranges are shown.

Figure A22: Distribution of tax revenue losses for lower income countries



Notes: Distribution of tax revenue losses for lower income countries, visualised with a boxen plot. Countries are colored by geographical region—green (Africa), blue (Asia), orange (South America), purple (Europe), yellow (Oceania), red (Caribbean Islands). A boxenplot is similar to a boxplot, but where the whiskers are replaced with smaller boxes. The central box visualises the interquartile range, leaving 25% of the data at each end. The smaller boxes increasingly leave smaller fractions of the data at each end (12.5%, 6.25%, etc). Outliers are represented with dots.

A.4 Supplementary Tables

Table A4: Number of jurisdictions available per country using the OECD data

	JPN	IND	DEU	USA	ZAF	CHN	CHE	ESP	DNK	ITA
All Sub-Groups	198	163	159	145	138	124	119	119	114	109
Sub-Groups with pos. profits	183	134	119	97	114	91	96	79	114	80

	BMU	MEX	LUX	FRA	AUS	IDN	BRA	MYS	SGP	BEL
All Sub-Groups	98	96	90	89	80	41	41	35	28	20
Sub-Groups with pos. profits	67	60	90	39	55	29	29	26	37	20

	PER	ARG	CAN	LVA	CHL	ROU	IMN	NOR	GBR	SVN
All Sub-Groups	19	18	13	13	9	6	5	5	5	5
Sub-Groups with pos. profits	11	14	7	0	6	6	5	5	5	4

	SWE	AUT	GRC	POL	KOR	FIN	NLD	IRL
All Sub-Groups	5	5	5	3	1	1	1	1
Sub-Groups with pos. profits	5	4	5	0	1	1	1	1

Notes: Number of jurisdictions available per country (aggregates excluded) using the OECD data. Jurisdictions with 1 observation only report on domestic activities of MNCs. JPN (Japan), IND (India), DEU (Germany), USA (United States), ZAF (South Africa), CHN (China), CHE (Switzerland), ESP (Spain), DNK (Denmark), ITA (Italy), BMU (Bermuda), MEX (Mexico), LUX (Luxembourg), FRA (France), AUS (Australia), IDN (Indonesia), BRA (Brazil), MYS (Malaisia), SGP (Singapore), BEL (Belgium), PER (Peru), ARG (Argentia), CAN (Canada), LVA (Latvia), CHL (Chile), ROU (Romania), IMN (Isle of Man), NOR (Norway), GBR (United Kingdom), SVN (Slovenia), SWE (Sweden), AUT (Austria), GRC (Greece), POL (Poland), KOR (South Korea), FIN (Finland), NLD (the Netherlands), IRL (Ireland).

Table A5: Summary statistics for the 36 countries of the sample used in the log-model, for the 2017 OECD data containing "Sub-Groups with positive profits"

Reporting	Partner	Firms profits>0	Profits US$bn	Tax accrued US$bn	Tax paid US$bn	Employees Thousands	Revenue US$bn	Assets US$bn	ETR accrued	ETR cash
Argentina	Dom.	15	2.9	1.6	1.2	143.7	43.5	34.8	54.9%	42.2%
	For.	15	0.8	0.0	0.0	8.5	2.3	3.4	4.0%	3.9%
Australia	Dom.	112	59.6	20.8	16.9	1079.0	438.9	447.9	34.9%	28.4%
	For.	112	31.0	4.8	3.8	384.5	135.0	103.1	15.4%	12.2%
Austria	For.	76	13.4	2.5	1.6	577.6	172.6	79.4	18.9%	11.6%
Belgium	Dom.	46	6.7	1.2	1.0	146.1	89.0	74.6	17.7%	14.1%
	For.	54	151.5	5.5	-0.6	450.8	163.8	101.2	3.6%	-0.4%
Bermuda	Dom.	29	3.5	0.0	0.1	2.4	10.5	31.2	1.3%	1.6%
	For.	29	28.0	4.2	3.7	585.7	181.3	209.1	15.0%	13.2%
Brazil	Dom.	71	59.4	6.5	13.3	1128.7	707.8	574.2	11.0%	22.4%
	For.	71	21.3	2.6	2.1	250.9	142.0	169.3	12.2%	10.1%
Canada	Dom.	180	126.7	13.5	14.6	1472.8	615.6	643.2	10.7%	11.5%
	For.	190	117.0	7.4	10.1	1232.8	490.1	441.1	6.3%	8.6%
Switzerland	Dom.	60	32.2	3.7	3.3	250.6	103.5	152.6	11.4%	10.4%
	For.	70	66.7	11.9	12.5	1249.5	481.3	195.6	17.9%	18.7%

Chile	For.	27	2.9	0.7	0.6	195.6	43.4	20.0	24.6%	20.9%
China	Dom.	231	472.5	116.2	126.3	19011.8	5048.4	5672.3	24.6%	26.7%
	For.	231	88.8	11.3	11.0	1505.2	657.2	564.7	12.7%	12.4%
Germany	Dom.	343	133.3	23.9	23.4	3587.6	1437.5	1016.2	17.9%	17.5%
	For.	379	200.4	31.8	32.0	4305.2	1653.0	746.6	15.9%	16.0%
Denmark	Dom.	54	23.6	3.8	3.9	195.2	140.4	66.9	16.3%	16.6%
	For.	64	19.1	2.5	1.8	860.8	164.8	68.1	13.1%	9.2%
Spain	Dom.	103	31.6	4.3	5.1	991.8	329.2	469.4	13.6%	16.1%
	For.	111	65.4	7.9	10.0	1262.6	501.6	246.6	12.1%	15.3%
Finland	Dom.	48	10.6	1.2	1.5	138.1	89.2	37.1	11.2%	14.0%
	For.	51	12.4	1.5	1.6	317.8	96.4	38.9	12.3%	12.9%
France	For.	201	141.5	35.6	31.5	4361.8	1159.5	415.8	25.1%	22.3%
	Dom.	176	73.0	19.7	17.6	3050.1	926.4	593.5	27.0%	24.2%
UK	Dom.	301	108.0	13.3	12.0	2388.1	858.7	647.1	12.3%	11.1%
Greece	For.	14	17.7	-0.9	0.8	126.6	209.2	63.0	-5.0%	4.6%
	Dom.	14	1.5	0.8	0.2	82.0	39.0	30.2	53.8%	13.4%
Indonesia	For.	23	1.0	0.1	0.1	14.1	3.0	8.1	8.3%	7.0%
	Dom.	25	12.1	3.0	3.3	478.1	84.5	166.5	25.0%	27.5%
Isle of Man	For.	5	0.7	0.0	0.0	6.1	1.9	0.6	3.5%	3.0%
	Dom.	2	0.0	0.0	0.0	0.3	0.9	0.0	0.0%	0.0%
India	For.	0	14.2	2.3	5.9	548.5	130.5	121.8	16.3%	41.7%
	Dom.	146	48.6	18.4	22.2	3891.3	564.2	864.0	37.8%	45.6%
Ireland	For.	56	86.2	2.6	3.6	1086.7	242.8	70.9	3.1%	4.2%
	Dom.	41	14.9	0.5	0.4	81.1	52.2	52.9	3.7%	2.7%
Italy	For.	129	37.8	2.8	3.7	604.3	234.4	87.3	7.3%	9.7%
	Dom.	115	35.7	4.4	6.6	780.9	351.9	206.3	12.2%	18.4%
Japan	For.	834	228.0	34.5	34.3	6409.4	2111.5	793.2	15.1%	15.0%
	Dom.	606	306.1	95.0	85.9	9340.1	4333.4	2178.7	31.0%	28.1%
South Korea	For.	209	74.6	14.1	14.1	1504.2	648.5	311.3	18.9%	18.9%
	Dom.	187	92.2	28.7	21.4	1491.7	1085.9	883.6	31.1%	23.2%
Luxembourg	For.	126	49.1	3.2	6.5	1238.5	400.9	166.1	6.6%	13.1%
	Dom.	70	13.3	0.0	0.1	11.4	12.4	22.1	0.4%	0.9%
Mexico	For.	445	7.9	1.7	1.5	460.5	84.4	58.0	21.5%	18.7%
	Dom.	69	19.9	6.7	7.4	1555.1	246.4	215.6	33.4%	37.1%
Malaysia	For.	34	7.3	0.9	1.0	131.3	34.3	96.8	11.9%	13.1%
	Dom.	34	29.4	6.6	5.7	469.4	121.6	185.1	22.5%	19.3%
Netherlands	For.	151	105.0	21.1	18.7	2901.7	1141.0	475.0	20.1%	17.8%
	Dom.	109	35.0	4.3	1.9	506.7	250.8	92.0	12.4%	5.3%
Norway	For.	57	13.5	2.7	2.8	172.6	73.5	69.6	19.8%	20.6%
	Dom.	51	31.6	9.1	8.1	173.1	149.3	140.1	28.9%	25.6%
Peru	For.	7	7.9	1.3	1.4	80.0	16.9	2.4	16.7%	18.0%
	Dom.	7	1.3	0.5	0.4	90.3	13.7	10.7	38.9%	28.7%
Romania	For.	3	0.0	0.0	0.0	2.1	0.0	0.1	20.3%	20.2%
	Dom.	3	0.4	0.0	0.0	31.5	0.1	1.7	7.4%	9.2%
Singapore	For.	59	94.5	3.6	3.6	556.0	138.8	146.4	3.8%	3.8%
	Dom.	49	49.3	2.5	2.3	176.1	144.1	149.2	5.0%	4.6%
Slovenia	For.	6	0.1	0.0	0.0	12.9	3.0	0.8	20.5%	25.9%
	Dom.	6	0.5	0.1	0.1	21.7	10.5	4.1	15.7%	11.5%
Sweden	For.	102	48.7	6.1	5.7	1241.6	286.7	131.0	12.6%	11.7%
	Dom.	90	30.7	6.3	3.8	373.8	175.9	98.1	20.5%	12.5%
United States	For.	0	1034.4	107.9	101.7	11998.7	3931.9	2116.8	10.4%	9.8%
	Dom.	1094	602.8	257.9	209.6	19601.7	9426.7	4880.5	42.8%	34.8%
South Africa	For.	51	33.5	0.7	1.8	408.0	272.3	109.0	2.0%	5.2%
	Dom.	43	18.8	2.9	3.0	688.7	100.9	104.2	15.2%	16.0%

Notes: Summary statistics for the 36 countries of the sample used in the log-model, for the OECD data containing "Sub-Groups with positive profits". The aggregated number of firms ("Firms profits>0"), profits, tax accrued, tax paid, number of employees, unrelated-party revenue, tangible assets and ETRs (accrued and cash-based) are shown for domestic activities (financial reporting of MNCs in the reporting (i.e. headquarter) countries) and foreign activities (financial reporting in all other countries). Since we are using sub-groups with positive profits, the number of firms included in the domestic section can be lower than the number of firms reporting on foreign operations. Not that two countries (Latvia and Poland) only report data on all groups, and that some countries omit reporting on domestic (Austria, Chile) or total foreign (United Kingdom) activities.

Table A6: Expected number of large MNCs headquartered in the country and observed in the OECD CBCR data

Country	#Expected\nOrbis	#Observed\nCBCR	Ratio
China	538	264	2.04
Malaysia	41	34	1.21
Bermuda	49	48	1.02
South Korea	221	221	1.00
South Africa	50	51	0.98
Sweden	94	102	0.92
Japan	785	866	0.91
Switzerland	64	71	0.90
United States	1334	1487	0.90
Denmark	54	64	0.84
Australia	103	125	0.82
India	134	165	0.81
Italy	104	129	0.81
Chile	24	30	0.80
Finland	42	53	0.79
Greece	14	19	0.74
Spain	88	120	0.73
Ireland	41	56	0.73
Canada	153	210	0.73
Romania	2	3	0.67
France	139	209	0.67
Norway	39	59	0.66
Netherlands	99	157	0.63
United Kingdom	244	394	0.62
Singapore	38	63	0.60
Germany	220	379	0.58
Poland	19	33	0.58
Peru	4	7	0.57
Belgium	28	55	0.51
Slovenia	3	6	0.50
Brazil	40	84	0.48
Argentina	6	15	0.40
Austria	26	71	0.37
Indonesia	9	27	0.33
Mexico	18	69	0.26
Luxembourg	26	129	0.20

Notes: Expected number of large MNCs headquartered in the country (according to Orbis), number of companies observed in the OECD CBCR data (using all sub-groups), and the ratio between the two.

Table A7: Countries acting as profit destination, estimated by the misalignment model

Country	Profits Shifted (M)	Profits booked (M)	TRG (M)	PS (%GDP)	PS (%Profits booked)	TRG (% tax revenue)	TRG (% corp. tax revenue)	TRG (%health)	TRG (%education)
Cayman Islands	130,276	136,292	197	2580.36	95.59				
Singapore	59,602	121,237	3,132	18.01	49.16	7.03	24.43	50.89	31.95
Netherlands	54,029	114,845	3,257	6.30	47.04	1.65	13.57	5.59	7.03
Canada	51,011	162,820	6,600	3.00	31.33	1.41	11.15	4.96	
Switzerland	47,639	107,476	3,840	6.64	44.33	2.58	18.33	14.77	10.54
Hong Kong	46,727	91,630	3,640	14.64	51.00	8.07	19.79		32.77
Bermuda	55,853	58,903	978	808.85	96.00				853.63
Luxembourg	41,520	48,845	727	64.18	85.01	4.15	23.15	24.82	28.83
Puerto Rico	33,815	36,570	541	32.84	92.47				8.38
Ireland	24,163	51,363	2,558	7.62	47.04	3.88	30.81	13.16	17.94
Malaysia	19,628	44,027	3,677	5.97	44.58	8.02	15.32	57.77	22.72
Sweden	18,785	52,014	2,048	3.45	36.11	1.13	13.68	4.10	4.97
Australia	17,055	111,334	3,362	1.21	15.32	0.85	4.97	3.84	4.64
China	15,511	583,000	4,011	0.13	2.66	0.17	0.89	1.20	0.97
Jersey	15,329	16,493	137	265.78	92.94				
Norway	15,037	41,225	3,986	3.48	36.47	3.15	14.47	11.12	12.02
Gibraltar	12,248	12,373	2	567.00	98.99				
Isle of Man	11,486	11,624	68	159.56	98.82				
British Virgin Islands	11,100	12,480	48	869.94	88.95				112.90
Barbados	10,441	10,540	106	217.69	99.06	8.73	84.27	65.11	42.58
Denmark	7,301	27,989	1,264	2.17	26.09	0.82	13.29	4.39	4.81
Taiwan	7,240	58,112	951	1.13	12.46				
Peru	7,168	15,917	1,290	3.51	45.04	4.21	14.64	21.08	17.28
United Kingdom	6,041	260,194	443	0.22	2.32	0.06	0.60	0.20	0.29
Malta	5,941	6,636	146	47.57	89.53	4.48	19.37	20.40	19.07
New Zealand	5,492	14,636	1,087	2.78	37.52	1.71	11.72	7.76	8.42
Thailand	5,120	41,914	819	1.14	12.21	1.07	3.97	6.53	4.21
Austria	4,859	29,756	553	1.15	16.33	0.47	5.71	1.75	2.39
Mauritius	4,761	5,575	108	37.95	85.40	4.68	35.26	37.17	18.89
Finland	4,554	18,892	665	1.74	24.11	0.83	11.16	3.40	3.67

Netherlands Antilles	3,189	3,546	13	101.93	89.95				8.12
Algeria	2,418	4,939	360	1.34	48.95	1.40		4.51	
Libya	1,662	1,842	0	3.64	90.22	0.00			
Macao	1,594	5,197	199	3.15	30.68	1.27	32.03		14.55
Cyprus	1,405	1,405	82	6.03	100.00	1.45	5.96	11.99	5.61
Equatorial Guinea	1,123	1,221	36	7.36	91.98	2.96		42.58	
Papua New Guinea	1,110	1,885	104	4.91	58.91	2.95		26.36	23.69
Israel	940	12,468	175	0.28	7.54	0.20	1.67	1.14	0.90
Iraq	850	1,441	67	0.42	58.96			2.81	
Czechia	777	15,269	133	0.35	5.09	0.31	1.70	0.99	1.31
Jordan	639	1,494	103	1.63	42.79	1.71	10.47	6.26	8.12
Bolivia	593	1,245	102	1.71	47.65	1.52	5.92	7.42	
Chile	573	23,106	88	0.21	2.48	0.19	2.18	0.82	0.66
Panama	570	2,865	45	1.04	19.89	0.84	5.60	1.88	
Ghana	551	1,597	59	0.95	34.47	0.86	4.41	6.64	2.11
Micronesia	536	587	66	150.82	91.21	108.83	161.14	595.82	150.41
South Sudan	477	504	0	4.36	94.55			0.18	0.09
Ecuador	281	2,741	53	0.28	10.25	0.37	4.18	1.24	1.07
Myanmar	270	1,029	33	0.42	26.24	0.68		6.52	2.58
Botswana	251	771	37	1.55	32.56	0.96		5.57	
Guatemala	250	1,588	62	0.38	15.72	0.90	2.81	4.44	3.14
Maldives	212	240	37	5.00	88.26	4.51	21.49	15.09	22.20
Burkina Faso	209	477	8	1.47	43.77	0.40	2.49	2.74	1.31
Monaco	204	810	25	3.03	25.14			23.84	27.05
Cape Verde	200	243	14	11.16	82.44	4.22	33.82	25.35	15.45
American Samoa	198	225	18	30.72	87.90				
Marshall Islands	173	258	0	84.54	67.18	0.00		0.00	
Bahrain	157	1,096	2	0.46	14.36	0.57	4.73	0.22	0.24
Portugal	148	10,380	22	0.07	1.42	0.04	0.31	0.16	0.19
Sri Lanka	139	819	18	0.17	16.94	0.19	1.78	1.36	0.99
St. Lucia	131	148	0	7.10	88.16	0.00	0.00	0.00	0.00
St. Kitts and Nevis	116	153	0	12.37	75.82	0.00	0.00	0.00	0.00
Timor-Leste	100	211	6	6.34	47.60	8.31		21.49	5.64
Fiji	90	199	17	1.85	45.05	1.50	11.27	16.77	8.94
Bhutan	85	140	14	3.96	60.93	4.57	10.10	26.74	9.92
Latvia	80	548	11	0.26	14.65	0.16	2.31	1.04	0.64
Faroe Islands	57	82	0	2.03	69.82				

Cuba	50	112	N/A	0.06	44.58				
Vanuatu	21	48	0	2.57	43.57	0.00		0.00	0.00
Palau	19	41	0	7.37	47.42	0.00		0.00	
Greenland	18	76	1	0.66	24.36				
Lebanon	18	865	2	0.04	2.11	0.03		0.12	0.21
Belize	14	19	0	0.82	75.32	0.00		0.00	0.00
Eswatini	12	163	3	0.28	7.64	0.22	2.38	1.96	0.83
Namibia	11	556	2	0.09	1.99	0.06	0.42	0.46	
Aruba	10	103	2	0.34	9.90	0.24			0.87
St. Vincent & Grenadines	5	19	N/A	0.64	25.49				
Solomon Islands	2	30	0	0.16	7.45	0.04	0.22	0.34	
Suriname	0	0	0	0.00	60.50	0.00		0.00	

Notes: Countries acting as profit destination, estimated by the misalignment model. Profits booked reflect all sub-groups. PS stands for profit shifted, TRG stands for tax revenue gain. We compare PS with the country's GDP. We compare the TRG with the total tax revenue, the corporate tax revenue, and the public health and education expenditures.

Table A8: Countries acting as profit origins, estimated by the misalignment model

Country	Profits Shifted (M)	Profits booked (M)	Tax Revenue Loss (M)	PS (%GDP)	PS (%Potential base)	TRL (% tax revenue)	TRL (% corp. tax revenue)	TRL (%health)	TRL (%education)
United States	287,971	954,310	85,258	1.52	23.18	2.32	23.70	5.43	9.12
Germany	82,717	175,971	15,117	2.24	31.98	1.76	21.74	4.77	8.33
France	82,377	92,626	20,619	3.10	47.07	2.70	33.70	9.44	14.21
Japan	71,961	346,261	19,731	1.42	17.21	2.15	10.03	4.28	11.28
India	33,269	70,523	13,885	1.43	32.05	3.51	17.43	64.86	15.46
Venezuela	21,079	-20,977	1,750	6.90	20634.27	3.52	62.04	22.89	
Mexico	19,479	56,136	6,605	1.63	25.76	4.65	18.96	18.67	11.14
Brazil	14,666	80,658	3,327	0.72	15.39	0.71	5.50	4.36	2.69
Hungary	14,259	-5,750	3,441	10.03	167.56	9.47	145.81	51.19	54.13
Italy	13,024	54,621	2,752	0.65	19.25	0.46	6.30	2.09	3.40
Poland	9,799	20,457	1,625	1.83	32.39	1.48	15.98	6.81	6.36
United Arab Emirates	9,238	21,944	3,678	2.35	29.63	5.89	96.29	38.38	
Colombia	8,241	5,258	2,802	2.51	61.05			16.51	18.80
Spain	7,923	63,375	1,170	0.60	11.11	0.40	3.91	1.38	2.06
South Africa	6,564	23,333	1,292	1.91	21.95	1.33	6.95	8.67	6.11
Chad	5,920	-6,406	2,072	51.75	-1218.17	113.44		1949.36	723.32
Nigeria	5,627	10,061	2,689	1.25	35.87		52.50	114.29	
Philippines	5,276	13,304	1,079	1.65	28.40	2.46	9.33	26.00	
Romania	4,232	5,500	626	2.03	43.48	1.67	14.32	7.52	9.83
Saudi Arabia	3,826	10,737	679	0.53	26.27	3.89		2.52	
Russia	3,514	35,355	806	0.20	9.04	0.19	1.41	1.49	1.17
Greece	3,266	2,485	782	1.54	56.79	1.40	20.67	8.02	
Argentina	3,231	14,757	1,023	0.61	17.96	0.81	6.60	3.10	3.52
Belgium	2,805	28,089	612	0.55	9.08	0.39	3.44	1.52	1.84
Vietnam	2,570	8,773	394	1.21	22.66	1.29	6.00	7.00	3.76
Indonesia	2,321	31,962	670	0.24	6.77	0.65		5.84	2.02
Egypt	2,079	6,514	565	0.70	24.19	1.45	4.94	12.31	
Congo DRC	1,965	-1,687	328	4.94	707.43	9.62	57.20	155.69	42.24
Qatar	1,614	5,230	417	0.92	23.58		4.08	11.62	7.13
Pakistan	1,603	4,501	671	0.60	26.27	2.35		30.81	9.61
Congo, Rep.	1,591	-1,301	572	11.55	548.32	32.21		339.05	94.67
Turkey	1,432	18,641	245	0.17	7.13	0.16	1.68	0.87	
Kenya	1,412	714	526	1.92	66.42	4.50	20.24	35.12	13.36

Cameroon	1,228	-495	405	3.54	167.67	8.81	45.42	282.53	41.12
Zambia	1,105	-326	191	4.57	141.80	5.40		45.94	18.86
Guernsey	1,089	-1,057	7	31.83	3347.35				
Slovakia	1,026	4,210	218	1.05	19.60	1.25	7.04	4.07	5.40
Ukraine	1,015	2,277	130	0.74	30.84	0.39	3.29	2.65	1.60
Trinidad and Tobago	975	617	371	4.01	61.26			49.98	
Iran	940	4,968	105	0.24	15.90	0.48		0.76	0.83
Morocco	907	3,332	187	0.83	21.39	0.78	3.73	7.60	
Senegal	895	-217	125	4.34	131.94	4.01	42.73	56.67	11.73
Bahamas	891	16	0	7.53	98.24	0.00	inf	0.01	
Sudan	890	-612	311	1.92	320.26	11.39		47.17	
Gabon	856	-505	235	5.29	243.78			86.52	50.10
Tunisia	835	174	153	1.97	82.80	1.70	10.82	9.01	5.62
Uganda	804	-489	66	2.53	255.76	2.05	28.40	18.99	10.02
Cote d'Ivoire	769	-106	296	1.66	115.96	5.39		57.15	15.70
Serbia and Montenegro	755	1,164	81	1.62	39.35	0.77	10.41	3.33	4.57
Slovenia	751	1,351	87	1.53	35.72	0.81	11.70	2.92	3.45
US Virgin Islands	729	-517	49	18.78	343.95				
Kazakhstan	657	11,566	166	0.35	5.38	0.53		4.53	3.19
Honduras	640	314	111	2.95	67.10	2.90	15.08	16.39	8.01
Uzbekistan	615	-519	18	0.93	641.23	0.16		1.15	0.46
Mozambique	612	-105	140	4.04	120.83	4.82		54.11	16.18
Oman	603	1,348	156	0.81	30.92	8.15	16.73	6.50	4.21
Angola	598	3,242	325	0.54	15.57	1.12		21.78	
Paraguay	566	-59	45	1.51	111.59	1.27	6.03	4.02	3.41
Guyana	543	-492	247	11.84	1056.98	24.67		172.36	100.82
Bulgaria	542	2,091	58	0.91	20.58	0.47	4.68	2.35	2.50
Syria	504	-494	N/A	2.28	4957.30				
Tanzania	487	185	171	0.94	72.46	2.99	22.37	24.18	8.61
South Korea	441	102,984	101	0.03	0.43	0.04	0.19	0.17	0.15
Andorra	409	-421	43	13.19	-3269.44			32.70	45.16
Croatia	397	1,913	73	0.70	17.18	0.51	6.23	2.24	3.04
Sierra Leone	389	-365	73	9.35	1624.87	16.60	148.09	122.53	40.42
Costa Rica	365	2,170	42	0.64	14.41	0.54	2.82	1.33	1.06
Bangladesh	341	1,776	115	0.15	16.12	0.63	2.91	11.56	2.91
Estonia	318	216	36	1.18	59.53	0.63	7.73	2.84	2.66
Rwanda	318	-210	141	3.55	295.76	10.70	68.12	70.43	41.64
Ethiopia	301	122	87	0.41	71.12	1.00		13.05	2.46
El Salvador	293	538	64	1.22	35.28	1.58	8.20	5.65	7.10

Samoa	289	-289	46	36.15	-43024.27	24.48	238.83	140.60	138.79
Jamaica	287	219	114	1.97	56.73	3.17	29.50	22.72	13.85
Albania	265	-147	26	1.99	223.97	1.04	11.46	7.33	5.38
Afghanistan	251	-168	19	1.29	304.83	1.25	8.15	20.22	2.79
Liberia	250	46	0	8.04	84.54	0.03		0.33	0.16
Nicaragua	236	330	70	1.91	41.71	3.32	inf	12.85	13.65
Mongolia	221	-117	37	1.78	212.04	1.47	9.59	12.36	6.25
Uruguay	212	1,693	31	0.37	11.14	0.28	2.11	0.87	1.11
Bosnia and Herzegovina	211	143	28	1.15	59.62	0.68	11.05	2.37	
Dominican Republic	206	1,616	34	0.28	11.30	0.34	2.15	1.73	
Iceland	201	275	29	0.98	42.24	0.41	5.61	2.10	1.85
North Macedonia	198	99	25	1.76	66.80	1.36	14.82	5.58	
Liechtenstein	190	285	13	2.95	40.04				
New Caledonia	183	39	57	1.92	82.43				
Madagascar	179	162	57	1.41	52.63	4.88		21.18	18.78
Benin	155	55	27	1.19	73.62	2.01	21.17	31.92	6.43
Reunion	146	78	85	0.68	65.15				
Moldova	144	9	3	1.46	94.39	0.16	1.47	0.77	0.51
Laos	139	214	9	0.91	39.34	0.43	3.02	7.65	2.14
Nepal	136	294	41	0.50	31.58	0.87	5.28	13.88	3.54
Montenegro	135	3	15	2.87	98.14	1.24	23.81	6.34	
Tajikistan	132	-32	19	1.65	132.41	1.10		11.79	4.98
Niger	107	275	50	0.96	28.09	4.12		24.36	12.22
Guam	97	58	5	1.66	62.72				
Lithuania	96	1,114	14	0.20	7.93	0.18	2.06	0.71	0.69
Guinea	95	290	28	0.91	24.60	2.04		47.03	11.53
Kyrgyz Republic	91	-43	N/A	1.21	191.96				
Gambia	84	-31	18	5.49	159.07	11.15		106.61	52.05
Togo	75	208	12	1.31	26.37	1.22	11.19	16.89	4.39
Armenia	64	85	0	0.55	42.71	0.01	0.07	0.11	0.06
Malawi	57	241	25	0.72	19.01	2.01	10.13	13.11	6.39
Yemen	55	90	0	0.17	38.09	0.00		0.00	
North Korea	55	137	17	0.28	28.66				
Mauritania	52	23	9	0.76	69.22	0.86		8.32	6.25
Turks and Caicos Islands	49	-6	N/A	5.20	114.94				

Belarus	47	564	9	0.07	7.66	0.06	0.47	0.38	0.29
Zimbabwe	45	399	16	0.24	10.16	0.52	4.21	4.49	1.40
Brunei	40	92	3	0.28	30.11	0.14		0.92	0.53
Somalia	34	9	N/A	0.81	79.78				
Guinea-Bissau	33	-5	5	2.65	118.36	4.45		59.34	17.98
Kuwait	30	2,366	0	0.02	1.24	0.03		0.01	
Georgia	25	230	4	0.15	9.96	0.10	0.89	0.94	0.74
Northern Mariana Islands	21	-1	0	1.99	104.24				
Djibouti	19	17	5	0.73	51.66	1.31		11.79	4.87
Cambodia	15	675	2	0.07	2.11	0.09	0.50	0.94	0.64
Haiti	12	-2	N/A	0.08	118.63				
Turkmenistan	11	-10	N/A	0.03	1444.16				
Kosovo	11	5	N/A	0.15	67.92				
Dominica	9	11	2	1.72	44.61	1.98		12.75	9.95
Mali	7	191	2	0.04	3.35	0.08		1.17	0.31
Central African Republic	7	6	2	0.32	53.42	1.17	9.01	14.05	
Sao Tome and Principe	5	-3	N/A	1.29	266.01				
Tonga	4	1	2	0.95	77.27	2.58		16.26	
Azerbaijan	3	1,734	1	0.01	0.19	0.01	0.05	0.16	0.07
Anguilla	3	-3	N/A	1.11	-1613858.16				
Burundi	2	-1	N/A	0.06	184.73				
Lesotho	2	149	0	0.07	1.11	0.06	0.76	0.39	0.28
French Guiana	1	0	N/A	0.02	140.86				
French Polynesia	0	145	0	0.00	0.06				

Notes: Countries acting as profit origins, estimated by the misalignment model. Profits booked reflect all sub-groups. PS stands for profit shifted, TRL stands for tax revenue loss. We compare PS with the country's GDP. We compare the TRL with the total tax revenue, the corporate tax revenue, and the public health and education expenditures.

Table A9: Countries acting as profit destination, estimated by the logarithmic model

Country	Profits Shifted (M)	Profits booked (M)	TRG (M)	PS (%GDP)	PS (%Profits booked)	TRG (% tax revenue)	TRG (% corp. tax revenue)	TRG (%health)	TRG (%education)
United Kingdom	190,160	367,449	13,933	6.78	51.75	1.90	18.96	6.25	9.02
Cayman Islands	133,045	133,045	225	2635.21	100.00				
Luxembourg	83,360	96,860	1,459	128.86	86.06	8.34	46.49	49.82	57.88
Singapore	79,058	126,182	4,154	23.89	62.65	9.33	32.41	67.51	42.38
Canada	59,342	179,683	7,678	3.49	33.03	1.64	12.98	5.77	
Netherlands	59,256	143,699	3,573	6.91	41.24	1.81	14.88	6.13	7.71
Bermuda	35,089	36,313	615	508.15	96.63				536.30
Switzerland	32,231	113,369	2,598	4.49	28.43	1.75	12.40	9.99	7.13
Puerto Rico	31,090	32,090	498	30.20	96.88				7.70
Ireland	18,124	54,350	1,919	5.71	33.35	2.91	23.11	9.87	13.46
Jersey	13,311	13,311	130	230.80	100.00				
Austria	9,571	30,046	1,088	2.26	31.85	0.92	11.25	3.44	4.71
Hong Kong	8,567	72,175	667	2.68	11.87	1.48	3.63		6.01
British Virgin Islands	7,868	11,454	34	616.60	68.69				80.02
Sweden	7,729	50,833	843	1.42	15.20	0.47	5.63	1.69	2.04
Isle of Man	7,192	7,192	47	99.91	100.00				
Mauritius	5,939	7,143	135	47.33	83.15	5.83	43.99	46.37	23.56
Brazil	5,326	94,295	1,208	0.26	5.65	0.26	2.00	1.58	0.98
Barbados	4,776	5,696	48	99.58	83.86	4.00	38.55	29.78	19.48
Gibraltar	4,588	4,588	1	212.39	100.00				
Finland	2,692	15,493	393	1.03	17.38	0.49	6.60	2.01	2.17
Macao	2,360	4,637	295	4.66	50.90	1.88	47.43		21.55
Cyprus	1,491	2,145	44	6.40	69.51	0.78	3.19	6.42	3.01
Chile	1,368	23,125	210	0.51	5.92	0.45	5.22	1.96	1.58
OAF	1,010	1,448	332		69.75				
Netherlands Antilles	953	1,103	4	30.46	86.37				2.43
Malta	943	5,589	23	7.55	16.87	0.71	3.07	3.24	3.03
OTE	700	725	62		96.56				
Hungary	560	7,239	135	0.39	7.73	0.37	5.72	2.01	2.12
Bahamas	390	914	0	3.30	42.66	0.00	inf	0.01	
Panama	311	2,585	25	0.57	12.02	0.46	3.05	1.03	

Costa Rica	263	1,837	30	0.46	14.33	0.39	2.03	0.96	0.76
Uruguay	249	1,797	37	0.43	13.88	0.32	2.48	1.03	1.31
Micronesia	249	331	31	70.06	75.17	50.55	74.85	276.76	69.87
Guernsey	215	493	1	6.27	43.55				
Bahrain	196	508	3	0.57	38.51	0.71	5.88	0.27	0.30
Papua New Guinea	185	1,569	17	0.82	11.76	0.49		4.38	3.94
Marshall Islands	171	181	0	83.20	94.26	0.00		0.00	
St. Lucia	73	79	0	3.95	92.38	0.00	0.00	0.00	0.00
South Sudan	62	66	0	0.57	93.48			0.02	0.01
Georgia	58	149	9	0.35	39.07	0.22	2.04	2.16	1.70
Paraguay	55	427	4	0.15	12.97	0.12	0.59	0.39	0.33
St. Kitts and Nevis	42	73	0	4.52	58.19	0.00	0.00	0.00	0.00
Myanmar	21	789	3	0.03	2.71	0.05		0.52	0.20
Liberia	21	109	0	0.68	19.39	0.00		0.03	0.01
Netherlands Antilles	16	1,392	0	0.15	1.17				
British Indian Ocean Territory	8	8	0		100.00				
Palau	3	8	0	1.23	39.07	0.00		0.00	
American Samoa	2	23	0	0.38	10.86				
Burkina Faso	2	203	0	0.02	1.12	0.00	0.03	0.03	0.01
Bouvet Island	2	2	0		100.00				
Belize	1	2	0	0.05	43.77	0.00		0.00	0.00

Notes: Countries acting as profit destination, estimated by the logarithmic model. Profits booked reflect all sub-groups. PS stands for profit shifted, TRG stands for tax revenue gain. We compare PS with the country's GDP. We compare the TRG with the total tax revenue, the corporate tax revenue, and the public health and education expenditures.

Table A10: Countries acting as profit origins, estimated by the logarithmic model

Country	Profits Shifted (M)	Profits booked (M)	Tax Revenue Loss (M)	PS (%GDP)	PS (%Potential base)	TRL (% tax revenue)	TRL (% corp. tax revenue)	TRL (%health)	TRL (%education)
United States	259,254	830,405	76,756	1.37	23.79	2.09	21.34	4.89	8.21
China	139,394	568,916	36,044	1.18	19.68	1.57	7.99	10.82	8.71
Japan	104,214	345,212	28,575	2.06	23.19	3.11	14.53	6.20	16.33
Germany	51,268	186,474	9,369	1.39	21.56	1.09	13.48	2.96	5.17
France	45,782	102,368	11,459	1.72	30.90	1.50	18.73	5.25	7.90
India	28,086	73,589	11,722	1.21	27.62	2.96	14.71	54.75	13.05
South Korea	26,235	108,270	6,032	1.72	19.50	2.19	11.51	10.18	9.13
Mexico	17,761	41,085	6,022	1.48	30.18	4.24	17.28	17.02	10.16
Spain	10,976	60,681	1,621	0.83	15.32	0.56	5.41	1.91	2.85
Taiwan	10,320	12,712	1,356	1.62	44.81				
Italy	9,979	59,452	2,108	0.50	14.37	0.35	4.83	1.60	2.61
Australia	9,854	105,087	1,942	0.70	8.57	0.49	2.87	2.22	2.68
Russia	9,031	15,445	2,071	0.52	36.90	0.49	3.63	3.83	3.00
South Africa	7,748	24,440	1,525	2.25	24.07	1.57	8.20	10.23	7.22
Indonesia	7,109	31,606	2,054	0.73	18.36	1.98		17.88	6.20
Poland	6,285	19,456	1,043	1.17	24.42	0.95	10.25	4.37	4.08
Norway	5,859	39,838	1,553	1.36	12.82	1.23	5.64	4.33	4.68
Thailand	5,278	24,980	845	1.17	17.44	1.10	4.09	6.73	4.33
Denmark	5,261	27,334	911	1.56	16.14	0.59	9.57	3.17	3.47
Turkey	4,908	8,071	839	0.58	37.81	0.55	5.77	2.97	
Malaysia	4,513	42,226	845	1.37	9.66	1.84	3.52	13.28	5.22
Philippines	4,261	6,422	872	1.33	39.88	1.98	7.54	21.00	
Belgium	3,917	28,260	854	0.77	12.17	0.55	4.81	2.12	2.58
Argentina	3,688	12,289	1,167	0.70	23.08	0.93	7.53	3.54	4.02
Saudi Arabia	3,362	2,751	597	0.47	55.00	3.42		2.22	
Colombia	3,143	4,206	1,069	0.96	42.77			6.30	7.17
Portugal	2,457	5,560	358	1.10	30.65	0.64	5.20	2.71	3.17
Nigeria	2,129	1,057	1,017	0.47	66.82		19.86	43.23	
Czechia	2,059	10,764	351	0.94	16.06	0.83	4.51	2.62	3.48
Vietnam	1,998	5,507	306	0.94	26.62	1.00	4.67	5.44	2.92
United Arab Emirates	1,964	8,388	782	0.50	18.98	1.25	20.48	8.16	
Romania	1,893	5,181	280	0.91	26.76	0.75	6.40	3.36	4.40
Peru	1,813	11,051	326	0.89	14.09	1.06	3.70	5.33	4.37

New Zealand	1,768	10,236	350	0.90	14.73	0.55	3.77	2.50	2.71
Israel	1,692	5,006	315	0.51	25.26	0.36	3.02	2.06	1.61
Kazakhstan	1,676	2,053	424	0.90	44.95	1.35		11.55	8.14
Greece	1,599	1,676	383	0.75	48.82	0.69	10.12	3.93	
Iran	1,504	406	168	0.39	78.76	0.78		1.21	1.32
Egypt	1,444	2,467	392	0.48	36.91	1.01	3.43	8.55	
Pakistan	1,379	1,902	577	0.51	42.03	2.02		26.50	8.27
Slovakia	1,237	3,068	262	1.26	28.74	1.51	8.49	4.91	6.51
Morocco	1,004	2,212	207	0.92	31.21	0.86	4.13	8.41	
Qatar	993	1,997	257	0.57	33.22		2.51	7.15	4.39
Ukraine	590	1,652	75	0.43	26.31	0.22	1.91	1.54	0.93
Algeria	586	568	87	0.33	50.77	0.34		1.09	
Croatia	544	683	99	0.97	44.34	0.70	8.54	3.07	4.16
Kenya	509	606	189	0.69	45.65	1.62	7.29	12.65	4.81
Ecuador	507	1,832	96	0.51	21.68	0.66	7.54	2.23	1.93
Kuwait	501	409	7	0.36	55.06	0.43		0.15	
Venezuela	476	486	39	0.16	49.49	0.08	1.40	0.52	
Slovenia	448	1,004	52	0.91	30.85	0.48	6.98	1.75	2.06
Serbia and Montenegro	436	610	47	0.94	41.65	0.45	6.01	1.92	2.63
Oman	405	711	105	0.54	36.29	5.47	11.22	4.36	2.82
Guatemala	325	820	81	0.50	28.40	1.18	3.66	5.78	4.10
Angola	281	1,465	152	0.25	16.08	0.53		10.22	
Bangladesh	271	754	91	0.12	26.41	0.50	2.30	9.17	2.31
Tunisia	259	287	48	0.61	47.52	0.53	3.36	2.80	1.75
Trinidad and Tobago	250	524	95	1.03	32.26			12.80	
Cameroon	234	8	77	0.67	96.80	1.68	8.64	53.76	7.82
Lithuania	227	311	34	0.47	42.16	0.42	4.86	1.68	1.64
Bulgaria	202	1,185	22	0.34	14.59	0.18	1.75	0.88	0.93
Senegal	198	64	28	0.96	75.51	0.89	9.46	12.55	2.60
Cote d'Ivoire	176	559	68	0.38	23.94	1.23		13.06	3.59
Iraq	167	955	13	0.08	14.87			0.55	
Zambia	162	660	28	0.67	19.70	0.79		6.74	2.77
Lebanon	160	186	20	0.33	46.33	0.30		1.05	1.85
Cambodia	153	421	26	0.75	26.64	0.90	5.28	9.90	6.71
Honduras	152	327	26	0.70	31.75	0.69	3.59	3.90	1.91
El Salvador	150	458	33	0.62	24.65	0.81	4.19	2.89	3.63
Namibia	146	379	29	1.20	27.78	0.76	5.50	6.08	
Nicaragua	144	17,917	43	1.16	0.80	2.02	inf	7.83	8.32
Bolivia	138	283	24	0.40	32.76	0.35	1.38	1.72	
Jamaica	136	111	54	0.93	54.98	1.50	13.99	10.77	6.57

Tanzania	135	249	48	0.26	35.23	0.83	6.21	6.72	2.39
Botswana	129	361	19	0.80	26.41	0.49		2.87	
Iceland	129	111	18	0.63	53.84	0.26	3.59	1.34	1.19
Congo DRC	127	83	21	0.32	60.52	0.62	3.70	10.08	2.73
Latvia	119	346	16	0.39	25.65	0.24	3.44	1.55	0.95
Ethiopia	116	120	34	0.16	49.10	0.39		5.03	0.95
Sri Lanka	97	546	12	0.12	15.04	0.13	1.24	0.95	0.69
Estonia	96	148	11	0.36	39.44	0.19	2.34	0.86	0.80
Monaco	96	395	12	1.42	19.53			11.22	12.73
Azerbaijan	95	402	28	0.18	19.17	0.37	1.41	4.63	1.99
Gabon	93	74	26	0.58	55.85			9.42	5.46
Madagascar	90	110	28	0.71	44.95	2.44		10.61	9.41
Belarus	86	217	16	0.14	28.40	0.11	0.86	0.69	0.53
Ghana	85	1,156	9	0.15	6.83	0.13	0.68	1.02	0.33
Mozambique	81	481	19	0.53	14.38	0.64		7.15	2.14
Liechtenstein	80	119	5	1.25	40.41				
Zimbabwe	78	238	27	0.42	24.79	0.90	7.30	7.79	2.44
Guinea	78	139	23	0.75	35.88	1.67		38.57	9.46
Bosnia and Herzegovina	75	55	10	0.41	57.74	0.24	3.93	0.84	
Niger	75	59	35	0.66	55.96	2.86		16.91	8.49
Sudan	74	0	26	0.16	100.00	0.95		3.92	
Malawi	72	72	31	0.92	50.32	2.57	12.97	16.78	8.17
Togo	72	33	12	1.27	68.60	1.18	10.83	16.34	4.25
North Macedonia	70	68	9	0.62	50.72	0.48	5.19	1.96	
Congo, Rep.	67	103	24	0.48	39.18	1.35		14.21	3.97
Laos	62	197	4	0.41	24.00	0.19	1.36	3.43	0.96
Reunion	61	8	36	0.28	88.00				
New Caledonia	59	25	18	0.62	69.86				
Mali	56	28	14	0.37	66.24	0.69		9.85	2.64
Benin	53	13	9	0.40	80.52	0.69	7.21	10.87	2.19
North Korea	51	15	16	0.26	76.95				
Libya	51	18	0	0.11	73.78	0.00			
Nepal	48	132	15	0.18	26.86	0.31	1.89	4.95	1.26
Moldova	42	12	1	0.43	78.23	0.05	0.43	0.23	0.15
Uzbekistan	42	0	1	0.06	100.00	0.01		0.08	0.03
Chad	41	1	14	0.36	97.58	0.79		13.50	5.01
Yemen	40	11	0	0.13	78.49	0.00		0.00	
Armenia	38	16	0	0.32	69.97	0.01	0.04	0.07	0.04
Rwanda	36	6	16	0.40	85.12	1.20	7.65	7.91	4.68
Guam	35	84	2	0.60	29.37				

Eswatini	35	90	7	0.79	27.83	0.62	6.61	5.45	2.30
Montenegro	34	18	4	0.73	64.91	0.31	6.02	1.60	
Albania	31	15	3	0.23	67.72	0.12	1.33	0.85	0.62
Tajikistan	30	1	4	0.37	96.50	0.25		2.67	1.13
Equatorial Guinea	29	0	1	0.19	100.00	0.08		1.10	
Brunei	29	25	2	0.20	53.79	0.10		0.66	0.38
Guyana	28	6	13	0.60	83.33	1.26		8.78	5.14
Lesotho	26	70	8	1.13	27.33	0.90	11.98	6.15	4.46
Afghanistan	26	6	2	0.13	81.64	0.13	0.84	2.09	0.29
Timor-Leste	26	35	2	1.62	42.43	2.13		5.50	1.44
US Virgin Islands	24	64	2	0.62	27.44				
Mongolia	23	101	4	0.18	18.24	0.15	0.98	1.26	0.64
Mauritania	21	0	4	0.31	100.00	0.35		3.41	2.56
Aruba	20	57	3	0.66	25.64	0.47			1.66
French Polynesia	20	93	7	0.34	17.33				
Sierra Leone	17	1	3	0.42	93.80	0.74	6.60	5.46	1.80
Syria	16	0	N/A	0.07	100.00				
Gambia	16	0	3	1.07	100.00	2.17		20.70	10.11
Cuba	16	0	N/A	0.02	100.00				
Kyrgyz Republic	15	0	N/A	0.20	100.00				
Seychelles	15	20	5	1.07	42.08	1.08	5.35	9.35	9.00
Fiji	14	135	3	0.28	9.17	0.23	1.72	2.55	1.36
Turks and Caicos Islands	13	0	N/A	1.35	100.00				
Somalia	12	0	N/A	0.29	100.00				
Greenland	12	23	1	0.42	33.45				
Jordan	12	310	2	0.03	3.60	0.03	0.19	0.11	0.15
Bhutan	11	16	2	0.52	40.42	0.60	1.32	3.49	1.29
Cape Verde	11	28	1	0.60	27.55	0.23	1.82	1.36	0.83
Djibouti	10	4	2	0.39	70.07	0.70		6.29	2.60
Guinea-Bissau	8	0	1	0.67	100.00	1.11		14.87	4.51
Andorra	8	0	1	0.26	100.00			0.65	0.90
Maldives	7	29	1	0.17	20.01	0.16	0.75	0.53	0.77
Samoa	7	2	1	0.90	81.15	0.61	5.92	3.48	3.44
Solomon Islands	6	6	0	0.46	53.13	0.12	0.65	0.99	

Northern Mariana Islands	6	0	0	0.56	100.00				
Vanuatu	5	2	0	0.67	77.57	0.00		0.00	0.00
Dominica	5	1	1	1.03	82.69	1.18		7.59	5.93
Uganda	5	429	0	0.02	1.22	0.01	0.19	0.13	0.07
Faroe Islands	5	8	0	0.17	36.29				
Kosovo	4	0	N/A	0.06	100.00				
St. Vincent & Grenadines	4	0	N/A	0.49	100.00				
Central African Republic	3	0	1	0.17	100.00	0.61	4.69	7.31	
Haiti	3	0	N/A	0.02	100.00				
Dominican Republic	2	1,207	0	0.00	0.15	0.00	0.02	0.01	
Tonga	2	0	1	0.35	100.00	0.95		5.99	
Sao Tome and Principe	1	0	N/A	0.16	100.00				
Turkmenistan	1	0	N/A	0.00	100.00				
Burundi	0	0	N/A	0.01	100.00				
French Guiana	0	0	N/A	0.00	100.00				
Anguilla	0	0	N/A	0.03	100.00				
Suriname	0	0	0	0.00	100.00	0.00		0.00	

Notes: Countries acting as profit origins, estimated by the logarithmic model. Profits booked reflect all sub-groups. PS stands for profit shifted, TRL stands for tax revenue loss. We compare PS with the country's GDP. We compare the TRL with the total tax revenue, the corporate tax revenue, and the public health and education expenditures.

Table A11: Profits and effective tax rates

Country	Profits (+)	Profits (all groups)	ETRa (wmean)	ETRc (wmean)	ETRa (median)	ETRc (median)	Number of reporters	ETRa for (wmean)	ETRc for (wmean)	N. reporters
Japan	342,267	336,551	30.2	27.4	0.3	0.2	19.0	22.8	21.9	198
India	73,594	64,902	36.0	41.7	0.3	0.4	18.0	32.5	34.1	163
Germany	186,474	165,736	18.6	18.2	0.2	0.2	18.0	20.3	20.0	155
United States	830,459	722,804	35.4	29.6	0.1	0.1	23.0	15.8	15.9	141
South Africa	24,629	19,773	16.2	19.7	0.2	0.2	18.0	19.4	31.6	138
China	571,000	566,574	24.1	25.9	0.2	0.2	21.0	21.6	21.7	120
Switzerland	114,731	96,128	8.3	8.1	0.1	0.1	17.0	7.1	7.1	115
Spain	62,087	56,405	12.8	14.5	0.1	0.1	22.0	12.0	12.8	115
Denmark	27,157	26,138	16.7	17.2	0.1	0.1	15.0	19.9	21.6	110
Italy	53,945	49,882	19.8	21.1	0.2	0.2	19.0	34.6	26.6	105
Mexico	37,947	54,938	30.7	32.3	0.3	0.3	21.0	27.8	27.0	96
Bermuda	53,922	48,481	1.1	1.7	0.0	0.0	13.0	1.1	1.8	95
Luxembourg	97,135	38,286	2.1	1.8	0.0	0.0	18.0	2.4	1.9	86
France	101,626	87,184	25.5	25.0	0.2	0.2	20.0	21.7	27.2	85
Australia	116,739	107,677	22.3	19.7	0.2	0.1	21.0	9.3	10.6	76
Indonesia	31,940	27,725	24.4	28.9	0.2	0.3	18.0	24.0	29.7	41
Brazil	96,555	78,921	17.4	22.7	0.2	0.3	21.0	27.5	23.1	37
Singapore	122,593	108,941	5.4	5.3	0.1	0.1	19.0	5.6	5.7	33
Malaysia	42,204	40,962	20.8	18.7	0.2	0.2	19.0	17.0	17.2	31
Belgium	28,260	24,371	18.5	21.8	0.2	0.2	17.0	18.8	24.2	16
Peru	14,032	12,710	17.1	17.8	0.3	0.2	18.0	14.9	16.7	16
Argentina	15,973	13,607	30.3	31.7	0.3	0.3	19.0	24.9	29.3	15
Latvia	117	416	8.9	6.9	0.2	0.1	13.0	8.9	6.9	9
Canada	180,601	161,224	11.9	12.8	0.2	0.2	21.0	14.9	15.8	9
Romania	5,180	4,463	13.7	14.8	0.1	0.1	18.0	14.3	15.3	6
Slovenia	1,027	990	14.0	11.6	0.2	0.1	12.0	12.7	11.7	5
Chile	15,885	20,739	14.3	13.9	0.1	0.1	19.0	14.3	13.9	5
Poland	12,990	17,658	17.7	16.6	0.2	0.2	17.0	17.7	16.6	2
Isle of Man	445	6,022	0.7	0.6	0.0	0.0	8.0	0.8	0.6	1
Ireland	55,421	44,551	10.4	10.2	0.1	0.1	17.0	12.8	13.0	1
Sweden	50,833	45,456	15.8	10.9	0.1	0.1	17.0	8.8	8.4	1
Norway	39,856	37,599	30.8	26.5	0.2	0.2	16.0	38.1	30.0	1
United Kingdom	369,428	246,985	7.7	7.3	0.1	0.1	22.0	5.8	5.7	1
Greece	3,213	2,037	43.0	23.2	0.3	0.3	15.0	33.0	32.2	1
Finland	16,321	15,492	12.0	14.6	0.2	0.1	16.0	13.6	15.7	1
Netherlands	142,596	96,389	8.7	5.9	0.1	0.1	22.0	7.4	6.1	1

Austria	14,614	27,459	6.9	11.4	0.1	0.1	18.0	6.9	11.4	1
South Korea	108,245	99,626	29.7	22.9	0.2	0.2	19.0	21.4	21.2	1
Paraguay	317	-46	6.4	8.0	0.1	0.1	9.0	6.4	8.0	0
Papua New Guinea	1,158	1,533	9.5	9.3	0.1	0.0	9.0	9.5	9.3	0
Puerto Rico	32,200	30,220	1.6	1.6	0.0	0.0	12.0	1.6	1.6	0
Montenegro	19	1	9.9	11.2	0.1	0.1	4.0	9.9	11.2	0
North Korea	15	14	22.5	31.1	0.2	0.3	2.0	22.5	31.1	0
Portugal	4,246	4,979	17.2	14.6	0.2	0.2	16.0	17.2	14.6	0
French Polynesia	2	93	38.7	33.6	0.4	0.3	2.0	38.7	33.6	0
Northern Mariana Islands	1	0	3.4	0.0	0.0	0.0	1.0	3.4	0.0	0
Myanmar	810	625	8.2	12.3	0.0	0.1	10.0	8.2	12.3	0
Malta	5,153	5,314	13.5	2.4	0.0	0.0	14.0	13.5	2.4	0
Qatar	2,534	1,930	11.3	8.0	0.1	0.0	12.0	11.3	8.0	0
Reunion	8	8	14.9	58.6	0.1	0.6	1.0	14.9	58.6	0
Mali	28	19	19.4	24.9	0.2	0.2	4.0	19.4	24.9	0
North Macedonia	55	63	12.8	12.8	0.1	0.1	9.0	12.8	12.8	0
Marshall Islands	4	150	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0
Mongolia	101	-42	20.1	16.6	0.1	0.1	4.0	20.1	16.6	0
Mozambique	438	-65	21.1	21.7	0.1	0.2	12.0	21.1	21.7	0
Rwanda	5	-47	58.3	-97.9	0.4	0.1	5.0	58.3	-97.9	0
Pakistan	1,912	1,814	32.1	41.4	0.3	0.4	8.0	32.1	41.4	0
Nicaragua	17,915	257	26.8	29.7	0.3	0.2	9.0	26.8	29.7	0
Nigeria	4,729	3,330	56.2	37.6	0.2	0.2	12.0	56.2	37.6	0
Niger	2	48	36.6	46.9	0.4	0.5	3.0	36.6	46.9	0
Nepal	132	98	30.6	30.5	0.3	0.3	3.0	30.6	30.5	0
New Zealand	10,141	9,952	21.2	19.8	0.2	0.2	16.0	21.2	19.8	0
Oman	798	507	32.9	25.5	0.2	0.1	13.0	32.9	25.5	0
New Caledonia	26	34	23.4	12.3	0.1	-0.1	5.0	23.4	12.3	0
Palau	8	8	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0
Panama	2,460	1,470	8.3	7.9	0.1	0.0	16.0	8.3	7.9	0
Namibia	364	367	17.0	19.8	0.2	0.2	8.0	17.0	19.8	0
Malawi	57	70	21.2	43.4	0.3	0.4	5.0	21.2	43.4	0
Mauritius	7,127	4,203	2.5	2.2	0.0	0.0	16.0	2.5	2.2	0
Philippines	6,192	6,082	18.4	20.4	0.2	0.2	18.0	18.4	20.4	0
Mauritania	2	2	9.2	17.1	0.1	0.2	4.0	9.2	17.1	0
Russia	16,443	16,025	23.6	22.9	0.2	0.2	17.0	23.6	22.9	0
Aruba	5	57	14.3	15.3	0.1	0.1	4.0	14.3	15.3	0
Saudi Arabia	2,878	1,377	15.2	17.0	0.2	0.2	15.0	15.2	17.0	0
Sudan	4	-223	100.4	78.6	1.0	0.8	4.0	100.4	78.6	0

Tanzania	250	100	30.5	34.9	0.3	0.3	10.0	30.5	34.9	0
Uganda	284	-288	23.2	8.2	0.3	0.3	9.0	23.2	8.2	0
Ukraine	1,379	1,469	13.6	11.8	0.1	0.1	14.0	13.6	11.8	0
Uruguay	1,657	1,142	11.1	12.6	0.1	0.1	16.0	11.1	12.6	0
Uzbekistan	1	-106	-2.2	2.9	-0.0	0.0	5.0	-2.2	2.9	0
St. Vincent & Grenadines	0	5	-	-	-	-	2.0	-	-	0
Venezuela	559	-17,786	41.8	8.2	0.1	0.0	16.0	41.8	8.2	0
British Virgin Islands	9,063	9,883	1.0	0.4	0.0	0.0	19.0	1.0	0.4	0
US Virgin Islands	64	-237	3.5	6.8	0.0	0.2	3.0	3.5	6.8	0
Vietnam	5,591	5,242	14.9	15.3	0.1	0.2	17.0	14.9	15.3	0
Vanuatu	2	9	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0
Samoa	2	-58	10.6	16.0	0.2	0.3	2.0	10.6	16.0	0
Kosovo	0	1	-	-	-	-	2.0	-	-	0
Yemen	11	11	14.5	-294.0	0.0	0.0	3.0	14.5	-294.0	0
Zambia	549	-240	26.5	17.3	0.3	0.2	8.0	26.5	17.3	0
Zimbabwe	218	239	38.6	34.8	0.4	0.3	7.0	38.6	34.8	0
AFRIC	N/A	N/A	-	-	-	-	-	12.5	11.6	0
AMER	N/A	N/A	-	-	-	-	-	19.1	16.8	0
ASIAT	N/A	N/A	-	-	-	-	-	18.1	16.3	0
EUROP	N/A	N/A	-	-	-	-	-	10.0	9.1	0
Taiwan	12,296	12,180	14.1	12.8	0.1	0.1	18.0	14.1	12.8	0
Turkey	8,296	7,053	20.4	17.1	0.2	0.2	17.0	20.4	17.1	0
Tunisia	81	117	6.5	16.2	0.1	0.2	12.0	6.5	16.2	0
Slovakia	3,356	3,178	18.9	17.8	0.2	0.2	16.0	18.9	17.8	0
Senegal	63	-357	13.4	11.3	0.2	0.1	12.0	13.4	11.3	0
Solomon Islands	2	7	0.8	7.4	0.0	0.1	3.0	0.8	7.4	0
Sierra Leone	1	-37	29.7	18.7	0.3	0.2	4.0	29.7	18.7	0
El Salvador	458	434	21.3	21.9	0.3	0.3	9.0	21.3	21.9	0
Somalia	1	1	129.8	167.5	1.3	1.7	1.0	129.8	167.5	0
Madagascar	6	89	20.3	31.5	0.2	0.2	6.0	20.3	31.5	0
Serbia and Montenegro	783	700	9.2	7.5	0.1	0.0	14.0	9.2	7.5	0
South Sudan	66	57	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0
Sao Tome and Principe	0	0	-	-	-	-	1.0	-	-	0
Suriname	0	0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0
Eswatini	90	87	21.0	20.6	0.2	0.3	4.0	21.0	20.6	0
Trinidad and Tobago	524	152	27.9	38.0	0.3	0.2	8.0	27.9	38.0	0
Seychelles	20	20	37.9	30.9	0.2	0.1	4.0	37.9	30.9	0

Syria	0	-138	-	-	-	-	2.0	-	-	0
Turks and Caicos Islands	0	-1	-	-	-	-	1.0	-	-	0
Chad	1	-641	44.4	145.4	0.4	1.5	3.0	44.4	145.4	0
Togo	21	33	16.2	16.5	0.2	0.2	4.0	16.2	16.5	0
Thailand	24,982	23,947	16.3	15.9	0.2	0.1	18.0	16.3	15.9	0
Tajikistan	1	-9	42.8	89.5	0.4	0.9	2.0	42.8	89.5	0
Turkmenistan	0	-1	-	-	-	-	2.0	-	-	0
Timor-Leste	5	23	6.8	6.5	0.0	0.0	4.0	6.8	6.5	0
Tonga	0	0	42.3	27.0	0.4	0.2	2.0	42.3	27.0	0
Maldives	30	29	32.1	17.3	0.2	0.1	2.0	32.1	17.3	0
Lebanon	139	182	14.1	12.7	0.2	0.2	9.0	14.1	12.7	0
Moldova	3	5	11.3	2.1	0.1	0.0	5.0	11.3	2.1	0
Bhutan	16	16	16.3	16.9	0.2	0.2	1.0	16.3	16.9	0
Botswana	316	358	21.2	14.6	0.2	0.2	7.0	21.2	14.6	0
Central African Republic	1	1	53.7	90.1	0.5	0.9	1.0	53.7	90.1	0
Cote d'Ivoire	508	-76	26.7	28.6	0.1	0.2	11.0	26.7	28.6	0
Cameroon	34	-416	70.9	12.7	0.7	0.6	9.0	70.9	12.7	0
Congo DRC	83	-1,013	28.1	16.7	0.3	0.2	5.0	28.1	16.7	0
Congo, Rep.	141	-479	24.1	24.4	0.0	0.0	8.0	24.1	24.4	0
Colombia	4,557	2,494	26.8	91.9	0.3	0.3	18.0	26.8	91.9	0
Cape Verde	28	28	10.9	7.1	0.1	0.1	2.0	10.9	7.1	0
Costa Rica	1,880	1,560	9.6	11.5	0.2	0.2	14.0	9.6	11.5	0
Cuba	0	27	-	-	-	-	2.0	-	-	0
Netherlands Antilles	707	1,098	0.7	0.4	0.0	0.1	6.0	0.7	0.4	0
Cayman Islands	134,187	121,533	0.3	0.2	0.0	0.0	18.0	0.3	0.2	0
Cyprus	2,048	321	2.7	2.9	0.0	0.0	15.0	2.7	2.9	0
Czechia	9,244	10,477	15.4	17.1	0.1	0.1	16.0	15.4	17.1	0
Djibouti	0	4	-	-	-	-	1.0	-	-	0
Dominica	1	1	15.3	26.0	0.2	0.3	1.0	15.3	26.0	0
Dominican Republic	1,221	1,088	11.9	16.2	0.1	0.2	12.0	11.9	16.2	0
Algeria	1,110	1,748	-9.0	-22.8	0.2	0.0	11.0	-9.0	-22.8	0
Ecuador	1,832	1,630	25.6	12.9	0.3	0.1	17.0	25.6	12.9	0
Egypt	2,915	2,803	20.8	21.3	0.2	0.1	15.0	20.8	21.3	0
Estonia	112	126	8.2	11.2	0.1	0.1	12.0	8.2	11.2	0
Bouvet Island	2	2	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0
Brunei	35	35	1.6	0.2	0.0	0.0	5.0	1.6	0.2	0
Fiji	113	128	17.3	18.7	0.2	0.2	5.0	17.3	18.7	0
Barbados	80	5,573	1.5	1.0	0.0	0.0	9.0	1.5	1.0	0
Angola	1,622	1,217	39.0	53.5	0.3	0.2	9.0	39.0	53.5	0

Anguilla	0	0	-	-	-	-	1.0	-	-	0
Albania	17	-33	-15.4	-16.8	-0.1	-0.1	6.0	-15.4	-16.8	0
Andorra	12	-138	-5.4	10.6	-0.1	0.1	3.0	-5.4	10.6	0
Netherlands Antilles	1,392	1,392	22.9	0.3	0.2	0.0	1.0	22.9	0.3	0
United Arab Emirates	17,847	12,911	34.7	34.3	0.0	0.0	18.0	34.7	34.3	0
Armenia	6	15	8.8	0.3	0.1	0.0	4.0	8.8	0.3	0
American Samoa	23	23	1.5	8.9	0.0	0.1	4.0	1.5	8.9	0
Antigua and Barbuda	0	0	-	-	-	-	1.0	-	-	0
Azerbaijan	298	578	16.6	20.2	0.2	0.1	7.0	16.6	20.2	0
Burundi	0	0	23.5	-94.0	0.2	-0.9	2.0	23.5	-94.0	0
Benin	16	16	-3.0	-94.5	0.0	0.0	4.0	-3.0	-94.5	0
Burkina Faso	107	203	8.7	3.9	0.3	0.3	5.0	8.7	3.9	0
Bangladesh	751	640	33.5	32.6	0.3	0.3	8.0	33.5	32.6	0
Bulgaria	1,022	990	7.0	10.7	0.1	0.1	16.0	7.0	10.7	0
Bahrain	526	270	2.8	1.3	0.0	0.0	11.0	2.8	1.3	0
Bahamas	914	-205	0.4	0.0	0.0	0.0	8.0	0.4	0.0	0
Bosnia and Herzegovina	79	80	6.6	7.7	0.1	0.1	10.0	6.6	7.7	0
Belarus	122	202	18.8	18.9	0.2	0.2	7.0	18.8	18.9	0
Belize	2	2	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0
Bolivia	760	741	-34.4	-17.6	0.1	0.1	14.0	-34.4	-17.6	0
Ethiopia	120	78	24.6	28.9	0.3	0.3	6.0	24.6	28.9	0
Faroe Islands	8	8	1.0	0.8	0.0	0.0	1.0	1.0	0.8	0
Monaco	70	458	11.6	12.5	0.1	0.1	6.0	11.6	12.5	0
Iceland	84	53	27.5	14.3	0.2	0.0	5.0	27.5	14.3	0
Jamaica	35	134	72.1	39.6	0.2	0.2	7.0	72.1	39.6	0
Jersey	13,665	10,916	0.3	0.9	0.0	0.0	12.0	0.3	0.9	0
Jordan	70	317	7.5	7.9	0.1	0.1	9.0	7.5	7.9	0
Kazakhstan	6,992	6,639	-8.0	12.8	0.1	0.3	13.0	-8.0	12.8	0
Kenya	628	180	31.1	37.3	0.3	0.4	12.0	31.1	37.3	0
Kyrgyz Republic	0	-15	-	-	-	-	1.0	-	-	0
Cambodia	367	388	18.2	17.2	0.1	0.1	9.0	18.2	17.2	0
Kiribati	0	0	-	-	-	-	1.0	-	-	0
St. Kitts and Nevis	0	72	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0
Kuwait	129	300	6.9	1.0	0.0	0.0	10.0	6.9	1.0	0
Laos	197	118	9.5	6.3	0.1	0.0	5.0	9.5	6.3	0
Afghanistan	6	-17	5.1	7.7	0.0	0.1	3.0	5.1	7.7	0
Liberia	62	-74	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0

Libya	0	951	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0
St. Lucia	0	79	-	-	-	-	2.0	-	-	0
Liechtenstein	79	69	7.1	6.6	0.1	0.0	5.0	7.1	6.6	0
Sri Lanka	484	508	10.7	12.0	0.2	0.1	12.0	10.7	12.0	0
Lesotho	70	68	20.1	29.4	0.2	0.3	2.0	20.1	29.4	0
Lithuania	321	292	13.3	15.0	0.1	0.1	12.0	13.3	15.0	0
Macao	1,641	4,651	11.5	12.2	0.1	0.1	12.0	11.5	12.2	0
Morocco	2,212	1,855	23.8	20.3	0.2	0.2	15.0	23.8	20.3	0
Israel	4,950	4,253	14.7	18.5	0.1	0.1	13.0	14.7	18.5	0
Iraq	61	791	17.1	5.9	0.1	0.0	8.0	17.1	5.9	0
Micronesia	331	330	1.8	12.4	0.0	0.1	1.0	1.8	12.4	0
Iran	338	354	9.0	11.1	0.1	0.1	8.0	9.0	11.1	0
Gabon	78	-381	25.2	27.5	0.3	0.3	7.0	25.2	27.5	0
Georgia	73	125	2.8	14.8	0.0	0.0	8.0	2.8	14.8	0
Guernsey	555	-1,057	0.8	0.6	0.0	0.0	9.0	0.8	0.6	0
Ghana	1,256	981	14.5	8.2	0.3	0.2	13.0	14.5	8.2	0
Gibraltar	37	4,551	-0.0	-0.0	0.0	0.0	10.0	-0.0	-0.0	0
Guinea	135	93	24.9	30.0	0.3	0.2	5.0	24.9	30.0	0
Guadeloupe	0	0	-	-	-	-	1.0	-	-	0
Gambia	1	-3	17.1	21.0	0.2	0.2	3.0	17.1	21.0	0
Guinea-Bissau	0	-1	-170.4	795.1	-1.7	8.0	2.0	-170.4	795.1	0
Equatorial Guinea	260	480	-3.1	3.2	-0.0	0.0	5.0	-3.1	3.2	0
Greenland	23	22	1.9	6.1	0.0	0.1	1.0	1.9	6.1	0
Guatemala	1,207	1,162	8.1	9.9	0.2	0.2	12.0	8.1	9.9	0
French Guiana	0	0	-	-	-	-	1.0	-	-	0
Guam	14	47	4.6	5.5	0.1	0.7	3.0	4.6	5.5	0
Guyana	6	-102	34.0	45.5	0.4	0.4	3.0	34.0	45.5	0
Hong Kong	72,175	66,324	8.4	7.8	0.1	0.1	20.0	8.4	7.8	0
Honduras	344	274	14.1	15.6	0.2	0.1	11.0	14.1	15.6	0
Croatia	929	938	7.8	3.1	0.2	0.2	14.0	7.8	3.1	0
Haiti	0	0	-	-	-	-	1.0	-	-	0
Hungary	7,403	-5,340	9.1	23.5	0.1	0.1	16.0	9.1	23.5	0
British Indian Ocean Territory	8	8	0.0	3.6	0.0	0.0	1.0	0.0	3.6	0

Notes: Profits (in USD million) reported by groups with positive profits (Profits (+)) and all groups (Profits (all groups)). Effective tax rates (ETRs) accrued (signified with 'a') and cash-based (signified with 'c'). Three types of ETRs were calculated, the weighted ETR by profits (ETRx (wmean)), the median (ETRx (median) and the weighted ETR by foreign profits (ETRx for (wmean). The number of countries disclosing data on the country (N. reporters) and the number of countries reported by the country (Reporting on).

Table A12: Estimates of profits shifted and tax revenue loss worldwide

	Profits shifted	TRL (total ETR)	TRL (foreign ETR)	TRL (CIT)
Misalignment	854 B	214 B	173 B	238 B
Logarithmic	862 B	226 B	177 B	234 B

Notes: Estimates of profits shifted and tax revenue loss (TRL) for the misalignment and logarithmic models. Three different tax rates are used, the total ETR (both domestic and foreign MNCs), the foreign ETR (only foreign MNCs), and the statutory tax rate (CIT).

Table A13: Comparing estimates of profits shifted and tax revenue loss worldwide

Study	Profit shifting	Revenue loss	Data (type)	Individual countries	Countries (number)	Year (data)
Cobham and Janský (2018)	-	90	Revenue	Yes	102	2013
IMF's Crivelli et al. (2016)	-	123	Revenue	No	173	2013
Keen et al. (2014)	-	180	Revenue	Yes	46	2012
OECD's Johansson et al. (2017)	-	100-240	Orbis	No	46	2010
Fuest, Greil et al. (2022)	271	104	CBCR	No	-	2019
Janský and Palanský (2019)	420	125	FDI	Yes	79	2016
UNCTAD's Bolwijn et al. (2018)	700	200	FDI	No	72	2012
Bratta et al. (2021)	786	217	CBCR	No	-	2017
This paper	**862-867**	**177-257**	**CBCR**	**Yes**	**214**	**2017**
Tørsløv et al. (2023b)	946	243	FDI	Yes	57	2018
Wier and Zucman (2022)	969	247	FDI	Yes	57	2019
Clausing (2016)	1076	279	FDI	Yes	25	2012
Tax Justice Network (2021)	1163-1334	312	CBCR	Yes	200	2017

Notes: Profit shifting and tax revenue loss are annual estimates expressed in billion USD (using average exchange rates from the year of the data if needed, as in the case of Bratta et al., 2021). The studies are listed in the table according to the highest estimated tax revenue loss. Some studies estimate only either profit shifting or tax revenue loss due to profit shifting. We focus on those providing tax revenue losses, some of which do not provide estimates of profit shifting scale (e.g. due to the methodology as in the case of Crivelli et al. (2016) and Cobham and Janský (2018). The country coverage differs a lot across studies and we focus on those aiming at a worldwide coverage or covering many countries. We thus omit, for example, some studies that investigated only profit shifting by US-headquartered MNCs such as Guvenen et al. (2022) or Cobham and Janský (2019). On country coverage, see, for example, Janský and Palanský (2019) for a detailed comparison of selected studies. Keen et al. (2014) refers to the analysis in their Appendix IV. Using Gross Operating Surplus to Explore Spillovers (rather than Appendix III., which has been published as Crivelli et al., 2016). Authors of Tørsløv et al. (2023b) publish estimates for 2016 on their website. While we refer to profit shifting here, each of the studies has its nuances and its own concepts and definitions, for example, aggressive tax planning (Johansson et al., 2017) or excess income booked in low-tax countries (Clausing, 2016). The data column lists the type of the main data source a study relies on and, for example, FDI can indicate both country-level foreign affiliate statistics (Tørsløv et al., 2023b) as well as bilateral data on FDI stocks (Janský & Palanský, 2019). The individual countries column indicates whether the results have been published for individual countries. The year column refers to the year of data used (or the last year of data in case the data are used for a period of time).

A.5 Data-driven calculation of the effect of tax on profit shifting

An alternative method of profit shifting analysis adopts a model-agnostic approach. Instead of fitting the data to a pre-determined model, we can use symbolic regression to search for models that fit the data well. The search space (i.e. potential models) in symbolic regression is, however, infinitely large. The state-of-the-art method uses evolutionary algorithms – algorithms inspired by biological evolution, widely used in optimisation problems, to find the best model, balancing the fitness of the model with its complexity in order to avoid overfitting. These algorithms start with a pool of solutions (in this case models), which are *re-combined* and *mutated*, increasing the pool of solutions. The best solutions found in this augmented pool are *selected* and allowed to be combined and mutated in the next generation. The algorithms efficiently explore the search space and reach a near-optimum solution. The main challenge in symbolic regression is how to score the solutions in order to find the best model, since using an error term alone will lead to finding highly complex models (overfitting). Here, we use the software *Eureqa* (Schmidt & Lipson, 2009). In order to avoid overfitting, the software keeps the best model for each level of complexity, where the complexity is determined by the number of variables included and the operations (e.g. a log-transformation costs 4 units, an addition cost 1 unit) and the best model by the R^2. The model "profits = 20" is very simple, but has a very low R^2. A model with 20 variables interacting with each other may be able to fit the data perfectly, but will most likely result in data overfitting.

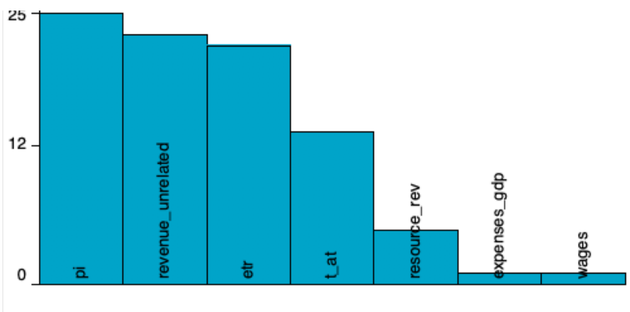
The model tries to find the best model for the location of profits, based on the following variables: revenue from unrelated party, employment, tangible assets, ETR, log(ETR), wages, population, gross fixed capital formation, consumption, GDP, tax complexity, statistical capacity, and revenue resources. The first five variables come from CBCR, wages are approximated as employment*GDP/population, the last variable from the ICTD / UNU-WIDER Government Revenue Dataset 2018, and the rest from the World Bank. We do not include revenue from related parties since it is heavily affected by profit shifted. Employees and tangible assets are less relevant to tax avoidance structures. All variables except for the last three are log-transformed. While the evolutionary algorithm can transform variables, that transformation is costly and seldom found.

We let the algorithm run for 20 hours using eight CPU cores, until it reached a "Percent Coverage" of 100%; "Percent Coverage is actually designed to replace the older stability and maturity metrics by providing an improved estimate of how close the search is to the plateau point where continuing the search will most likely not turn up any better solutions. It is based on the early stopping rule of thumb estimate and tracks how long has it been since any significant improvement on the validation data set." (Eureqa documentation).

Figure A23 shows the variables included in at least one model. Our dependent variable (pi) is logically included in all models. Revenue from unrelated party and ETRs were almost always included, while tangible assets, revenue from natural resources, expenses/GDP and wages were only included in more complicated models. The absence of statutory corporate income tax in all models is perhaps surprising.

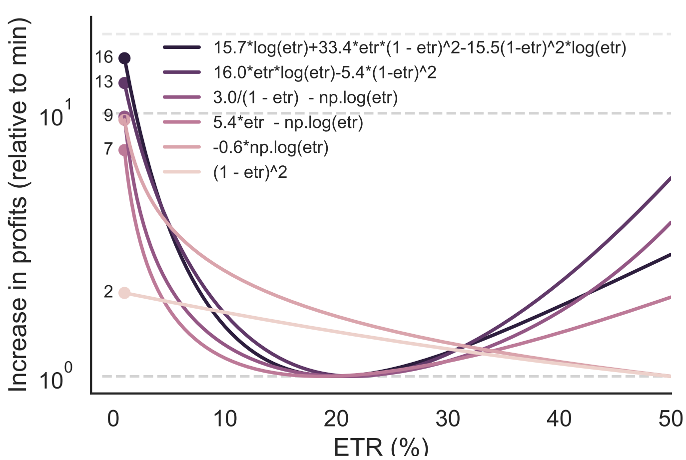
Figure A24 shows the relationship between $\log \pi$ and the ETR. We see an extreme non-linear relationship for all models, independently of their complexity. In general, when the ETR is 1 per cent, the profits increase 6 to 14 times in comparison with the minimum. Interestingly, all models allowed for a U-curve, and the minimum effect found is achieved when ETR is 20 per cent. This could reflect the importance of resource-rich countries.

Figure A23: A frequency of the variables found in the models



Notes: Variables found in the models. 25 different models were found, and unrelated party revenues, effective tax rates, and tangible assets were found in the majority of them.

Figure A24: The relationship between the effective tax rates and profits

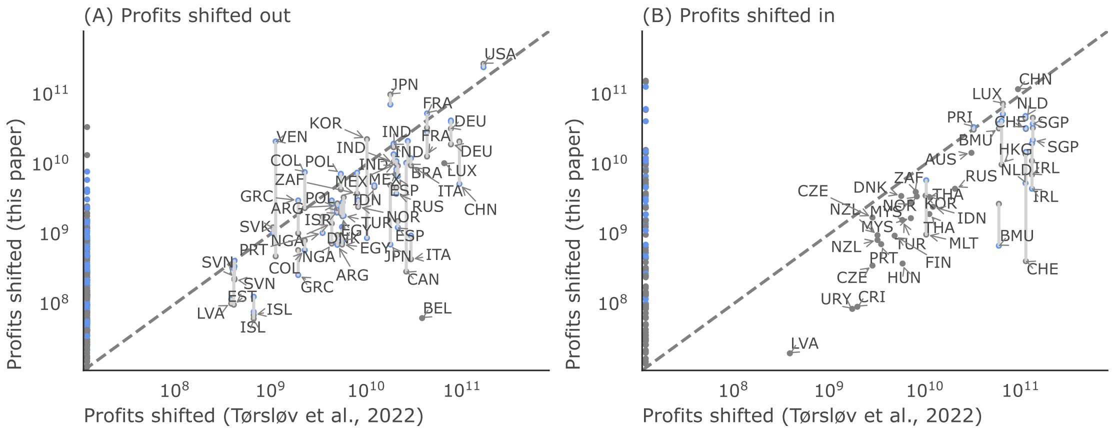


Notes: The found dependency between the ETR and profits is visualised. The complexity of the model is depicted with a number.

A.6 Sensitivity analysis, additional information

A.6.1 (iii) Comparison with Tørsløv et al. (2023b)

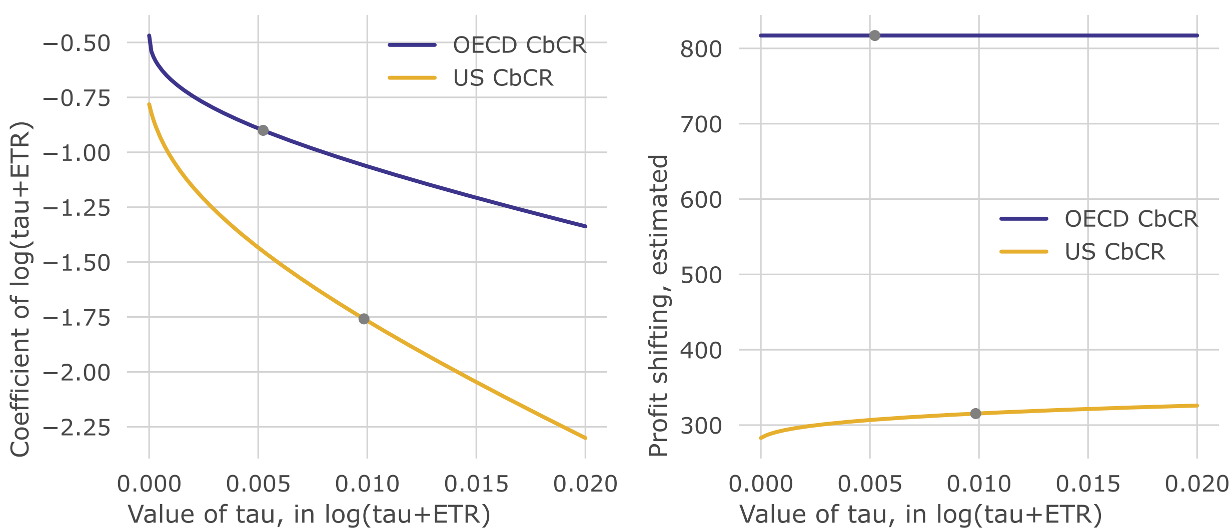
Figure A25: Comparison with the estimates of profit shifting by Tørsløv et al. (2023b)



Notes: Comparison with the estimates of profit shifting by Tørsløv et al. (2023b). Countries not included in the sample of Tørsløv et al. (2023b) appear in the left of the plots. Estimates of profits shifted using the misalignment model are visualised in blue. Estimates using the logarithmic model are visualised in grey. A light grey line is used to connect the blue and grey points corresponding to the same country.

A.6.2 (vi) Sensitivity to the offset in the logarithmic model

Figure A26: Effect of the parameter t in the logarithmic model



Notes: Effect of the parameter t in the logarithmic model. (A) The coefficient of $log(t + ETR)$ is affected by the election of t. (B) The effect of t on our estimate of total profits shifted is small. Dots indicate the parameter and results of this paper.

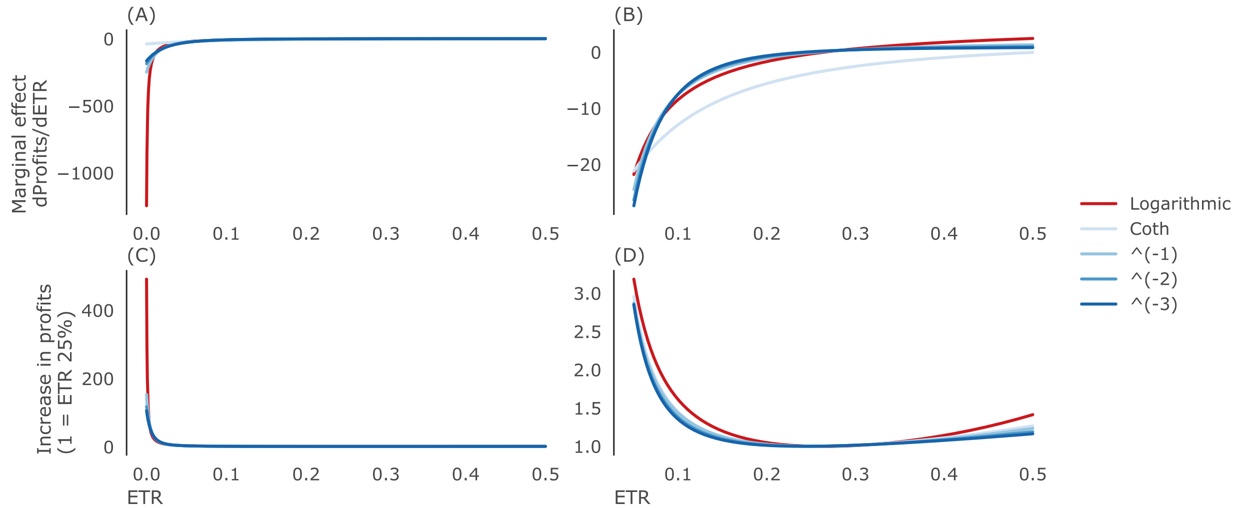
A.6.3 (vii) Other non-linear functions

Table A14: Regression table using the US data and applying other specifications that allow for extreme non-linearities

	$log(ETR)$	$1/(ETR)$	$1/(ETR)^2$	$1/(ETR)^3$	$coth(ETR))$
$1/(0.024 + ETR)$		0.1445***			
		(0.0204)			
$1/(0.056 + ETR)^2$			0.0164***		
			(0.0023)		
$1/(0.090 + ETR)^3$				0.0036***	
				(0.0005)	
$(oth(0.026 + ETR)$					0.1563***
					(0.0221)
ETR		1.8455*	1.1830	0.9029	1.9697*
		(1.0685)	(1.0083)	(0.9846)	(1.0799)
Intercept	-3.0012	-0.5952	-0.0397	0.1316	-0.6994
	(1.8341)	(1.7340)	(1.7198)	(1.7162)	(1.7366)
R-squared	0.8850	0.8854	0.8855	0.8856	0.8855
R-squared Adj.	0.8768	0.8773	0.8774	0.8774	0.8773
ETR	5.1998***				
	(1.4324)				
log(0.0011 + ETR)	-1.3813***				
	(0.1959)				
log(Population)	0.1638*	0.1653*	0.1643*	0.1634*	0.1658*
	(0.0859)	(0.0857)	(0.0857)	(0.0856)	(0.0858)
log(GDPpc)	0.1664	0.1646	0.1648	0.1650	0.1653
	(0.1316)	(0.1314)	(0.1314)	(0.1313)	(0.1314)
log(Tangible Assets)	0.5456***	0.5276***	0.5257***	0.5256***	0.5278***
	(0.0751)	(0.0760)	(0.0760)	(0.0760)	(0.0759)
log(Wages)	0.2481***	0.2622***	0.2638***	0.2640***	0.2618***
	(0.0885)	(0.0890)	(0.0890)	(0.0890)	(0.0889)
N	91	91	91	91	91
R2	0.885	0.885	0.886	0.886	0.885
BIC	230.48	230.15	230.07	230.05	230.12

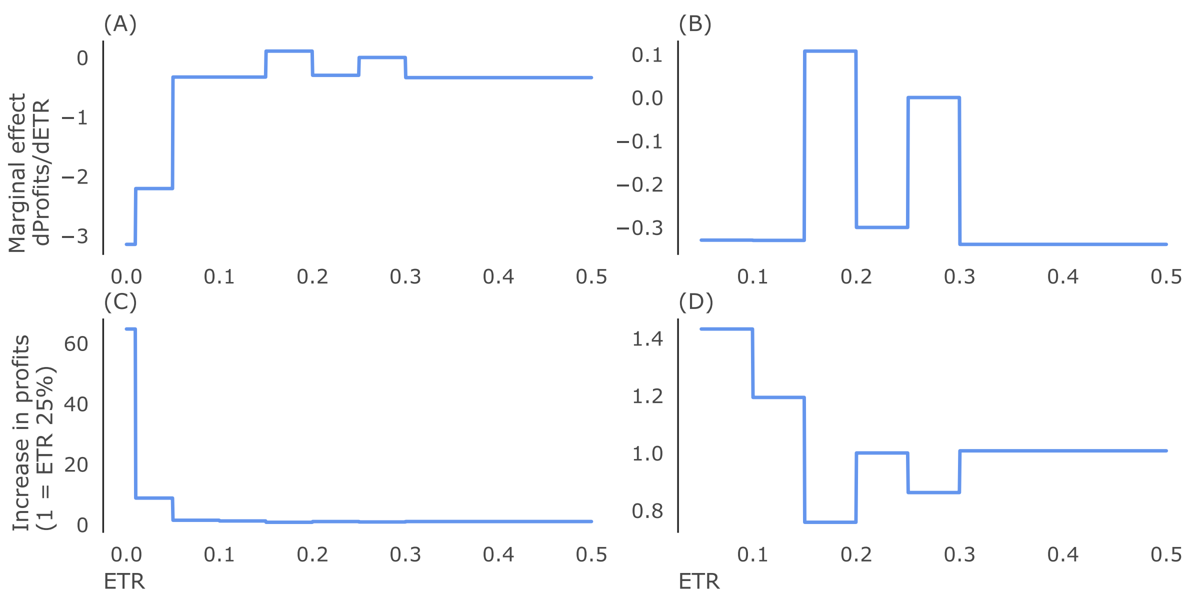
Notes: Regression table using the US data and applying other specifications that allow for extreme non-linearities. A graphical visualization is presented in Fig. A27.

Figure A27: Graphical representation of Table A14 for the $log(\tau + ETR)$, $1/(\tau + ETR)$, $1/(\tau + ETR)^2$,$1/(\tau + ETR)^3$ and $coth(\tau + ETR)$ models



Notes: Graphical representation of Table A14 for the $log(\tau+ETR)$, $1/(\tau+ETR)$, $1/(\tau+ETR)^2$,$1/(\tau+ETR)^3$ and $coth(\tau+ETR)$ models. Semi-elasticities calculated using US data. The τ offset is calculated independently for all models. (A, B) Marginal effect of ETR on profits. (C,D) Relative increase in profits due to profit shifting, compared with a country with an ETR of 25%. Plots B and D are close-ups of plots A and C, constraining ETRs between 5 and 50%.

Figure A28: Graphical representation of Table A14 for the model with extra dummy variables for categories of effective tax rates



Notes: Graphical representation of Table A14 for the model with extra dummy variables for the following categories of ETRs: <1%,1-5%,5-10%,10-15%,15-20%,20-25%,25-30%,>30%. Semi-elasticities are calculated using US data. (A, B) Marginal effect of ETR on profits. (C,D) Relative increase in profits due to profit shifting, compared with a country with an ETR of 25%. Plots B and D are close-ups of plots A and C, constraining ETRs between 5 and 50%.

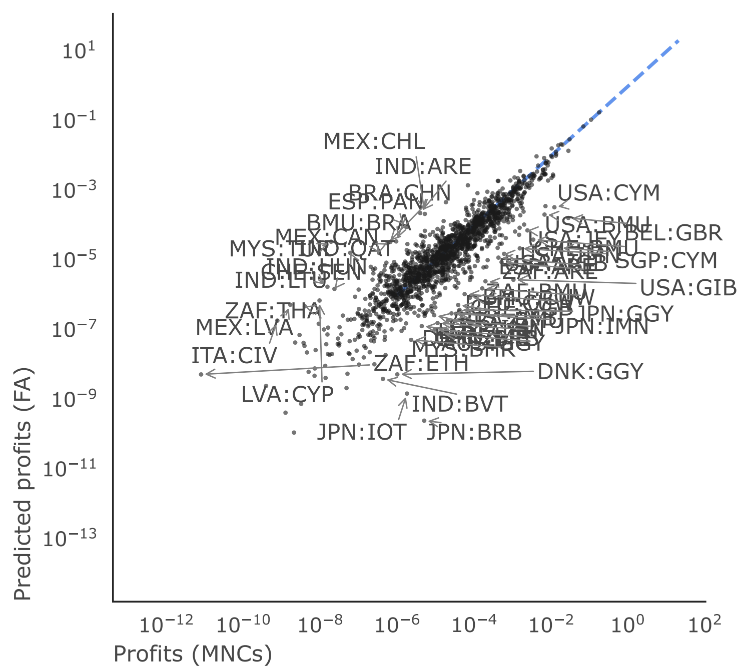
A.6.4 (viii) Effect of the redistribution formula

Table A15: Results of a robust linear model, where the share of profits booked in a country is regressed against the shares of employees, capital, sales and wages

	Share of profits
Share of employees	0.0733***
	(0.0005)
Share of capital	0.2683***
	(0.0004)
Share of sales	0.4372***
	(0.0004)
Share of wages	0.0607***
	(0.0002)
N	2199

Notes: Results of a robust linear model, where the share of profits booked in a country is regressed against the shares of employees, capital, sales and wages, using the dataset created for the misalignment method. See Fig. A29.

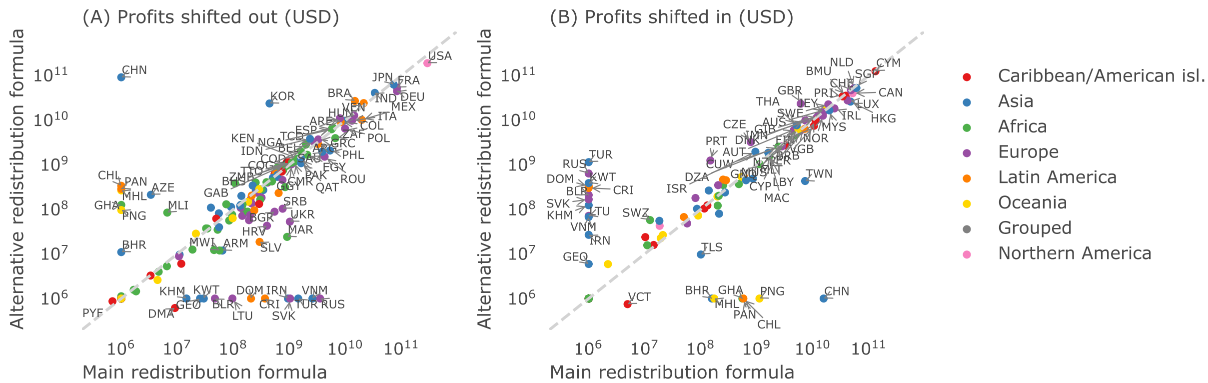
Figure A29: Fit of the robust model



Notes: Each dot correspond to an observation (reporting country : partner country). Dotted line represent the fit of a robust linear model. Outliers are annotated. Note the large presence of tax havens among the outliers.

A.6.5 Regressions using statutory corporate income tax rates (US data)

Figure A30: Comparison of the main results and the results using a different reditribution formula



Notes: Comparison of profits shifted out (A) and profits shifted in (B) for the misalignment models and the OECD data using the redistribution formula of the main results and the redistribution formula from Table A15. Each dot represents a country, coloured by region.

A.6.6 Regressions using statutory corporate income tax rates (OECD data)

Table A17: Regressions using statutory corporate income tax rates and OECD data

	Logarithmic	Quadratic	Log*FE + Quad	Log + Quad*FE	Linear
CIT	1.4400*	-6.0996***	6.5629***	4.9875*	-0.8741***
	(0.7389)	(1.4248)	(1.9323)	(2.5680)	(0.3089)
CIT^2		12.9445***	-8.7991***	-3.8842	
		(3.0646)	(2.5242)	(4.0846)	
log(0.0005 + CIT)	-0.2870***		-0.3942***	-0.3273***	
	(0.0422)		(0.0579)	(0.0856)	
Argentina:tax	0.1784**	-1.8552	0.1729**	-3.4651	0.0148
	(0.0837)	(3.1993)	(0.0834)	(3.1576)	(1.2826)
Australia:tax	-0.0555	-3.0180***	-0.0547	-1.9923**	-0.6364
	(0.0596)	(0.9052)	(0.0594)	(0.8625)	(0.7150)
Austria:tax	-0.1838**	0.0280***	-0.1601*	0.0230**	0.0842**
	(0.0832)	(0.0102)	(0.0838)	(0.0103)	(0.0393)
Belgium:tax	-0.2060	-4.5750**	-0.2885	-7.2173***	-0.3114
	(0.3384)	(1.9331)	(0.3424)	(2.2415)	(1.0478)
Bermuda:tax	0.0258	-8.2589***	0.0282	-6.6941***	-2.9980***
	(0.0247)	(0.9314)	(0.0248)	(1.0994)	(0.4516)
Brazil:tax	-0.2865***	-15.4299***	-0.2855***	-15.0876***	-7.0702***
	(0.0325)	(1.5946)	(0.0325)	(1.5675)	(0.5483)
Canada:tax	-4.1645***	-29.8828***	-4.0443***	-30.1732***	-14.0172***
	(0.4603)	(3.1078)	(0.4562)	(3.0135)	(1.7158)
Switzerland:tax	0.6349***	-0.1547	0.6370***	0.2988	3.3283***

	(0.1236)	(0.7724)	(0.1141)	(0.7087)	(0.2306)
Chile:tax	-0.5576**	-4.2302***	-0.3607	-3.7424**	-0.0929
	(0.2365)	(1.5347)	(0.2251)	(1.4717)	(0.8219)
China:tax	-0.0257	4.3893***	-0.0345*	1.7466**	1.0688***
	(0.0217)	(0.6979)	(0.0209)	(0.8025)	(0.2697)
Germany:tax	0.1298***	-0.8652***	0.1278***	-1.3857***	0.5984***
	(0.0139)	(0.2567)	(0.0139)	(0.2772)	(0.0798)
Denmark:tax	0.1589***	2.3131***	0.1544***	2.4513***	2.2991***
	(0.0427)	(0.6745)	(0.0426)	(0.6567)	(0.3410)
Spain:tax	0.1762***	7.8377***	0.1630***	4.6676***	2.9896***
	(0.0355)	(0.8336)	(0.0362)	(1.2133)	(0.3920)
Finland:tax	-0.2649***	0.0245***	-0.2557***	0.0254***	0.0933***
	(0.0578)	(0.0054)	(0.0578)	(0.0052)	(0.0257)
France:tax	0.3319***	2.3248***	0.3321***	2.4562***	3.4236***
	(0.0229)	(0.4968)	(0.0223)	(0.4728)	(0.2220)
United Kingdom:tax	-0.5178***	0.0446***	-0.5237***	0.0462***	0.2140***
	(0.0865)	(0.0077)	(0.0869)	(0.0076)	(0.0384)
Indonesia:tax	-0.0010	-9.2248**	-0.0004	-9.2873**	-3.5780***
	(0.0273)	(3.9045)	(0.0273)	(3.9394)	(0.9895)
Isle of Man:tax	0.2576***	0.0000***	0.2624***	-0.0000***	0.0000***
	(0.0302)	(0.0000)	(0.0299)	(0.0000)	(0.0000)
India:tax	0.1126***	-3.7260***	0.1130***	-2.4655***	-1.0597***
	(0.0139)	(0.1967)	(0.0138)	(0.4332)	(0.1291)
Ireland:tax	-0.3042***	0.0105***	-0.3431***	0.0152***	0.0747***
	(0.0582)	(0.0025)	(0.0622)	(0.0026)	(0.0195)
Italy:tax	0.1800***	5.0378***	0.1759***	2.9227**	2.0950***
	(0.0295)	(1.1037)	(0.0294)	(1.2110)	(0.4338)
Japan:tax	0.0424**	-2.3018***	0.0356**	-3.8152***	-0.9882***
	(0.0178)	(0.8259)	(0.0180)	(0.8002)	(0.2574)
South Korea:tax	-0.5353***	0.0610***	-0.5281***	0.0598***	0.2491***
	(0.1000)	(0.0106)	(0.0995)	(0.0105)	(0.0452)
Luxembourg:tax	0.1734***	-0.2131	0.1746***	0.1675	1.8387***
	(0.0256)	(0.4265)	(0.0252)	(0.3849)	(0.0727)
Latvia:tax	-7.5951***	-118.2983***	-7.8002***	-125.6481***	-42.7990***
	(0.6161)	(9.5601)	(0.5894)	(8.9389)	(3.4427)
Mexico:tax	-0.9016***	-13.3302***	-0.8906***	-11.5343***	-8.6175***
	(0.1279)	(1.0489)	(0.1257)	(0.9735)	(1.0678)
Malaysia:tax	-0.0710	-11.6447***	-0.0556	-8.3263***	-4.5282***
	(0.0500)	(0.8000)	(0.0502)	(1.0041)	(0.3671)
Netherlands:tax	-0.5055***	0.0702***	-0.4837***	0.0648***	0.2490***
	(0.0738)	(0.0094)	(0.0738)	(0.0096)	(0.0355)
Norway:tax	-0.4280***	0.0551***	-0.4040***	0.0517***	0.1906***
	(0.0931)	(0.0109)	(0.0935)	(0.0108)	(0.0442)

Peru:tax	0.2547***	-6.7245***	0.2541***	-4.5420**	-0.7834*
	(0.0175)	(2.2672)	(0.0173)	(2.2654)	(0.4263)
Poland:tax	4.7008***	127.3540***	4.4729***	113.4746***	35.6456***
	(0.5889)	(12.1894)	(0.6008)	(13.2754)	(3.5864)
Romania:tax	1.6906***	23.2113***	1.4667***	13.9686*	9.2136***
	(0.3623)	(7.9435)	(0.3391)	(7.4518)	(2.4834)
Singapore:tax	-0.7700***	-21.2715***	-0.7596***	-18.9783***	-13.1173***
	(0.0252)	(0.7085)	(0.0256)	(0.7767)	(0.3378)
Slovenia:tax	0.8917***	28.7474***	0.6390**	15.8622**	7.0300***
	(0.2854)	(5.6210)	(0.3042)	(6.5613)	(1.7270)
Sweden:tax	-0.4611***	0.0510***	-0.4454***	0.0496***	0.1983***
	(0.0736)	(0.0079)	(0.0737)	(0.0078)	(0.0339)
South Africa:tax	0.1750***	8.4991***	0.1620***	6.1626***	3.5149***
	(0.0041)	(0.8727)	(0.0065)	(1.0879)	(0.2805)
log(Tangible assets)	0.3389***	0.3296***	0.3364***	0.3206***	0.3366***
	(0.0502)	(0.0461)	(0.0497)	(0.0453)	(0.0477)
log(wages)	0.1813***	0.1649***	0.1839***	0.1792***	0.1596***
	(0.0472)	(0.0433)	(0.0472)	(0.0429)	(0.0458)
log(Population)	0.1274*	0.1365*	0.1185	0.1332*	0.1113
	(0.0717)	(0.0699)	(0.0726)	(0.0690)	(0.0715)
log(GDPpc)	0.3529***	0.3899***	0.3548***	0.3809***	0.3947***
	(0.1058)	(0.0988)	(0.1046)	(0.0964)	(0.1012)
N	1430	1430	1430	1430	1430
R-squared	0.7192	0.7055	0.7201	0.7101	0.7079
R-squared Adj.	0.7050	0.6906	0.7057	0.6952	0.6933
BIC	5331.26	5399.41	5333.74	5384.01	5380.58

Notes: The CIT was imputed using ETR for the following countries: Anguilla, Antigua and Barbuda, Cuba, Djibouti, French Guiana, Guadeloupe, Haiti, Kiribati, Kosovo, Kyrgyz Republic, Sao Tome and Principe, St. Lucia, St. Vincent & Grenadines, Syria, Turkmenistan, Turks and Caicos Islands

Table A16: Regressions using statutory corporate income tax rates

	Logarithmic (CIT)	Quadratic (CIT)	Log + Quad (CIT)	Linear (CIT)
I(CIT ** 2)		10.1173	3.9315	
		(7.5504)	(13.7265)	
Intercept	2.9519	5.1495**	3.6572	4.7595**
	(2.4645)	(2.1322)	(3.4936)	(2.1223)
R-squared	0.8135	0.8130	0.8137	0.8090
R-squared Adj.	0.8000	0.7995	0.7978	0.7976
CIT	2.4111	-5.7256	-0.4890	-0.7712
	(2.6177)	(3.9366)	(10.4620)	(1.3576)
log(0.02 + CIT)	-0.6100		-0.4231	
	(0.4299)		(0.7826)	
log(Population)	-0.1368	-0.1425	-0.1365	-0.1668*
	(0.1017)	(0.1013)	(0.1023)	(0.1001)
log(GDPpc)	0.1237	0.1072	0.1173	0.1236
	(0.1636)	(0.1642)	(0.1660)	(0.1646)
log(Tangible assets)	0.6697***	0.6867***	0.6734***	0.7048***
	(0.0887)	(0.0864)	(0.0902)	(0.0857)
log(wages)	0.1826*	0.1739*	0.1814*	0.1564
	(0.1032)	(0.1025)	(0.1039)	(0.1022)
N	90	90	90	90
R2	0.814	0.813	0.814	0.809
BIC	268.46	268.69	272.87	266.12

IES Working Paper Series

2023

1. Josef Bajzik, Tomáš Havránek, Zuzana Iršová, Jiří Novák: *Are Estimates of the Impact of Shareholder Activism Published Selectively?*
2. Klára Kantová: *Ex-Prisoners and the Labour Market in the Czech Republic*
3. Theodor Petřík, Martin Plajner: *Concurrent Business and Distribution Strategy Planning Using Bayesian Networks*
4. Tijmen Tuinsma, Kristof De Witte, Petr Janský, Miroslav Palanský, Vitezslav Titld: *Effects of Corporate Transparency on Tax Avoidance: Evidence from Country-by-Country Reporting*
5. Zuzana Irsova, Pedro R. D. Bom, Tomas Havranek, Heiko Rachinger: *Spurious Precision in Meta-Analysis*
6. Vojtěch Mišák: *Does Heat Cause Homicides? A Meta-Analysis*
7. Fan Yang: *The Impact of Regulatory Change on Hedge Fund Performance*
8. Boris Fisera: *Distributional Effects of Exchange Rate Depreciations: Beggar-Thy-Neighbour or Beggar-Thyself?*
9. Salim Turdaliev: *Powering Up Cleaner Choices: A Study on the Heterogenous Effects of Social Norm-Based Electricity Pricing on Dirty Fuel Purchases*
10. Kseniya Bortnikova: *Beauty and Productivity in Academic Publishing*
11. Vladimír Benáček, Pavol Frič: *Ossified Democracy as an Economic Problem and Policies for Reclaiming its Performance*
12. Petr Janský, Miroslav Palanský, Jiří Skuhrovec: *Public Procurement and Tax Havens*
13. Katarzyna Bilicka, Evgeniya Dubinina, Petr Janský: *Fiscal Consequences of Corporate Tax Avoidance*
14. Evžen Kočenda, Shivendra Rai: *Drivers of Private Equity Activity across Europe: An East-West Comparison*
15. Adam Geršl, Barbara Livorová: *Does Monetary Policy Reinforce the Effects of Macroprudential Policy*
16. Tersoo David Iorngurum: *Method versus cross-country heterogeneity in the exchange rate pass-through*
17. T. D. Stanley, Hristos Doucouliagos, Tomas Havranek: *Meta-Analyses of Partial Correlations Are Biased: Detection and Solutions*
18. Samuel Fiifi Eshun, Evžen Kočenda: *Determinants of Financial Inclusion in Africa and OECD Countries*
19. Matej Opatrny, Tomas Havranek, Zuzana Irsova, Milan Scasny: *Publication Bias and Model Uncertainty in Measuring the Effect of Class Size on Achievement*
20. Soňa Sivá: *Effects of Government Interventions on Bank Performance*
21. Oleg Alekseev, Karel Janda, Mathieu Petit, David Zilberman: *Impact of Raw Material Price Volatility on Returns in Electric Vehicles Supply Chain*

22. Karel Janda, Barbora Schererova, Jan Sila, David Zilberman: *Graph Theory Approach to Prices Transmission in the Network of Commonly Used Liquid Fuels*
23. Yermone Sargsyan, Salim Turdaliev, Silvester van Koten: *The Heterogeneous Effects of Social Cues on Day Time and Night Time Electricity Usage, and Appliance Purchase: Evidence from a Field Experiment in Armenia*
24. Jan Sila, Evzen Kocenda, Ladislav Kristoufek, Jiri Kukacka: *Good vs. Bad Volatility in Major Cryptocurrencies: The Dichotomy and Drivers of Connectedness*
25. Zuzana Irsova, Hristos Doucouliagos, Tomas Havranek, T. D. Stanley: *Meta-Analysis of Social Science Research: A Practitioner's Guide*
26. Diana Kmetkova, Milan Scasny, Iva Zverinova, Vojtech Maca: *Exploring the Link Between Diet and Sustainability in Europe: A Focus on Meat and Fish Consumption*
27. Fisnik Bajrami: *The Impact of Dollarisation on Economic Growth, Investment, and Trade*
28. Miroslav Svoboda, Michael Fanta, Jan Mošovský: *Effectiveness of Car Scrappage Schemes: Comparative Analysis of European Countries*
29. Nicolas Fanta, Roman Horvath: *Artificial Intelligence and Central Bank Communication: The Case of the ECB„*
30. Karel Janda, Jan Sila, David Zilberman: *Fueling Financial Stability: The Financial Impact of U.S. Renewable Fuel Standard*
31. Anna Pavlovova: *High-Frequency Groceries Prices: Evidence from Czechia*
32. Kumar Chandrakamal Pramod Kumar: *Less-cash or more-cash? Determinants and trends of currency in circulation in a panel of 17 economies*
33. Javier Garcia-Bernardo, Petr Janský:*Profit Shifting of Multinational Corporations Worldwide*

All papers can be downloaded at: http://ies.fsv.cuni.cz

Univerzita Karlova v Praze, Fakulta sociálních věd
Institut ekonomických studií [UK FSV – IES] Praha 1, Opletalova 26
E-mail : ies@fsv.cuni.cz http://ies.fsv.cuni.cz