INSTITUT POLYTECHNIQUE DE PARIS

MASTER THESIS

Framing Multinationals' Sales Shifting: Concept, Magnitude and Policy Implications

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Abstract

The last few decades have given birth to new aggressive tax planning mechanisms for multinational companies, putting governments under increased tax competition pressures. Showing how firms concentrate their revenues in low-tax sales platforms, Laffitte and Toubal (2022) have recently analyzed US multinational companies' sales shifting practices, which are estimated to contribute to overall profit shifting by 80 billion USD annually. In this context, we first introduce an important conceptual distinction between "paper" and real sales shifting. We illustrate it with a new theoretical framework at the intersection of the trade and public finance literatures, that provides an identification strategy to test our proposed dichotomy. Second, we document multinational companies' sales shifting practices based on country-by-country report statistics. The semi-elasticity of unrelated-party revenues to the corporate income tax rate is estimated around -2, which corroborates the existence of a real sales shifting margin. Third, we develop an adjustment of the country-by-country revenue variables to approximate a distribution of sales based on the final destination of transactions. The adjusted database, that gives a reduced weight to low-tax sales platforms and displays a greater consistency with market size indicators, is made available for future research and policy simulations.

Acknowledgements

Preliminary Remarks

This study is accompanied by an appendix, that can be downloaded from this link: https://github.com/pechouc/destination-based-sales/raw/main/assets/Online%20Appendix.pdf. The whole code supporting the following analysis is available online, in three GitHub repositories. The empirical analysis can be replicated with the Stata and Python scripts available here: https://github.com/pechouc/dbs_empirical_analysis. The download and preprocessing of UN Comtrade statistics are described in this repository: https://github.com/pechouc/comtrade_data_selection. Eventually, the code for the adjustment of country-by-country revenue variables is hosted here: https://github.com/pechouc/destination-based-sales. The associated documentation (preliminary) is available at this link: https://pechouc.github.io/destination-based-sales/index.html.

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Chapter 1

Introduction

Since the 1980s, increased economic integration has exacerbated the tax competition for multinational companies' investments, spurring countries to offer lower tax rates and / or broader tax base deductions.[1] Typically, between 1985 and 2020, the global average statutory corporate tax rate has been cut from 49% to 23.5%.[2] In the United States (US), the effective average tax rate (EATR) on corporate profits went down from close to 50% in the 1950s to 17% in 2018; within the European Union (EU), the EATR has declined from 30% to around 20% over the last two decades.[3] In addition, several large-scale profit shifting mechanisms have provided multinational companies with opportunities to book their taxable income in low-tax jurisdictions while they maintain little or no real economic activity there. Such practices have also become a key determinant of the effective taxation of corporate profits globally and have been widely documented in the literature.[4]

In the wake of such trends and in reaction to the digitalisation of economic activities that facilitates the disconnection of profits and value creation, three main developments have guided the following study.

On the policy side, several proposals for reforms of the international corporate income tax system aim at reconnecting taxation and value creation. In October 2021, 136 countries and jurisdictions agreed on the "two-pillar solution to address the tax challenges arising from the digitalisation of the economy". On the one hand, Pillar One consists in allocating part of the taxing rights over the profits of the largest and most profitable multinational companies to their "market jurisdictions", where goods or services are consumed or used. On the other hand, Pillar Two introduces a global minimum tax of 15% on corporate profits, with deductions for real economic activity (the so-called "substance-based income exclusion" based on fixed tangible assets and payroll expenses). While Pillar One would explicitly anchor a portion of multinationals' tax payments to their revenue-generating activities, Pillar Two is expected to reduce profit shifting incentives by curtailing the tax rate differential between tax-aggressive and higher-tax jurisdictions. Other proposals pursue

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1. See for instance Flamant, Godar, and Richard (2021) for an empirical investigation of the evolution of corporate income tax (and personal income tax) competition within the EU.

2. Average statutory corporate income tax rate weighted by GDP, based on the OECD's Corporate Tax Statistics and cited by Clausing, Saez, and Zucman (2020) or Janeba and Schjelderup (2022).

3. See Piketty, Saez, and Zucman (2018) for the US and Spengel et al. (2020) for the EU. The EATR corresponds to the average rate at which pre-tax profits are actually taxed and it is computed, in the simplest approach, as the ratio of taxes paid to total income. It may differ from the statutory tax rate (i.e., the headline rate imposed by the law on taxable income) due to the progressivity of corporate income taxation, to tax base deductions (e.g., deductible financing expenses) or to various tax credits.

4. See for instance Heckemeyer and Overesch (2017) or Beer, Mooij, and Liu (2020) for related literature reviews. More studies are covered in Chapter 2.

this objective such as the "Minimum Effective Tax Rate (METR)" proposal of Kadet et al. (2021) or formulary apportionment approaches.

On the academic side, researchers have refined our understanding of multinational companies' aggressive tax planning practices, with a strong focus on profit shifting over the last few years. In particular, the pioneering work of Laffitte and Toubal (2022) has provided a new framework to study the phenomenon by disaggregating profit shifting into two movements: the concentration of sales in low-tax jurisdictions on the one hand and the concentration of expenses in high-tax countries on the other hand. Investigating the former, which they characterise as "sales shifting", they show that sales shifting practices allowed US multinational companies to shift between 66 and 85 billion USD to low-tax jurisdictions in 2013, which corresponds to at least 68% of all the profits booked in tax havens. Gathering an illustrative theoretical framework, data sources, statistical indicators and anecdotal firm-level evidence, they provide tools to further examine multinationals' low-tax sales platforms and assess the size of the associated tax base shifts.

Eventually, involving somewhat different concepts, policy-makers and observers pay strong attention to multinational companies' real responses to corporate taxation, especially in the context of the global reforms being discussed. While many recent studies in the literature have focused on profit shifting and how it disconnects taxable income from production or revenue generation, little is known for instance about the potential implications of the two-pillar process for investment, employment and more generally the worldwide distribution of multinationals' real economic activity.[5]

This work contributes to these developments in three main steps.

First, taking up Laffitte and Toubal (2022)'s concept, we introduce an important dichotomy between two types of sales shifting practices. On the one hand, multinational companies can "artificially" concentrate their sales in low-tax jurisdictions, generally by manipulating their intra-group transactions. As in the traditional understanding of profit shifting, such operations are designed to register sales and profits in low-tax jurisdictions that are disproportionately large with regard to the economic activity occurring there.[6] This corresponds to the theoretical framework that Laffitte and Toubal (2022) develop to illustrate sales shifting, building upon existing models of multinationals' profit shifting. On the other hand, multinational companies' real activity also responds to corporate taxation: ex ante the shift of taxable income to low-tax places via intra-group transactions, the geographical distribution of their sales is endogenous to countries' tax environment. For instance, in their location choices, multinationals may find it optimal to set up their export platforms in relatively lower-tax jurisdictions.[7] Even without any disconnection of profits and economic activity (i.e., by producing in this country, exporting from there and booking income locally), sales are concentrated in a low-tax jurisdiction and thus, there is a form of sales shifting. We illustrate this distinction in a new theoretical framework that combines a general equilibrium model of trade and models of multinationals' aggressive tax planning to make the location of "normal" profits endogenous to taxation, albeit at the cost of tractability in some cases.

5. For instance, in their analyses of the welfare effects of the global minimum tax, Johannesen (2022) or Hebous and Keen (2022) assume that multinationals' normal profits are exogenous and focus on the modelling of profit shifting practices. Janeba and Schjelderup (2022) also study how tax havens and non-havens' corporate income tax rates are expected to respond to a global minimum tax and the resulting effect on revenues, but they add a form of real response to taxation by introducing a location decision. Eventually, Casella and Souillard (2022) propose a framework to study the impact of the global minimum tax on Foreign Direct Investment (FDI).

6. The Organisation for Economic Co-operation and Development (OECD) defines Base Erosion and Profit Shifting (BEPS) as referring to the "tax planning strategies that exploit gaps and mismatches in tax rules to artificially shift profits to low or no-tax locations where there is little or no economic activity or to erode tax bases through deductible payments such as interest or royalties".

7. See Mutti and Ohrn (2019), discussed in more details in Chapter 2.

Second, our empirical analysis based on country-by-country report statistics confirms the relevance of this distinction. Analysing the response of total revenues or of the "foreign sales ratio" defined by Laffitte and Toubal (2022) to corporate taxation would encompass the two types of sales shifting practices in the same measure. Our identifying assumption relies on the idea that the response of intra-group sales to taxation accounts for the first type of practices, while the second one is rather associated with sales to unaffiliated parties. From there, the key objective consists in determining whether multinational companies' unrelated-party revenues are sensitive to corporate taxation: if this is verified, the dichotomy described above holds. We first gather descriptive evidence of the concentration of US multinational companies' extra-group sales in some low-tax jurisdictions; in the IRS' 2017 country-by-country report statistics, 27% of foreign unrelated-party revenues are registered in the tax havens listed by Tørsløv, Wier, and Zucman (2018). This concentration is disproportionate with regard to the size of the corresponding markets, since these jurisdictions only account for less than 6% of the final consumption expenditures observed in the sample. This disproportion is particularly visible for a few sales platforms well known to be used by these firms. Controlling not only for market size but also for partner countries' foreign market access as Laffitte and Toubal (2022) do, we find a semi-elasticity of unrelated-party revenues to the local statutory corporate income tax rate of -2 (i.e., a one percentage point increase in the tax rate is associated with a 2% reduction in extra-group sales). Multinationals indeed locate their activities and their extra-group sales in reaction to corporate income taxes: they find by doing so another tax planning margin, that corresponds to the second type of sales shifting practices.

Third, we provide tools to analyse the policy implications of this dichotomy. For policy-makers, the acceptability of these practices may be very different. The disconnection between taxable income and real economic activity often appears as a central argument in favour of a stricter regulation of profit shifting mechanisms, but some forms of sales shifting, which correspond to the second type of practices described above, are not necessarily associated with such a disconnection. Furthermore, proposed reforms may not be equally effective to regulate the two forms of sales shifting. Pillar One-like proposals that attribute taxing rights to market jurisdictions or formulary apportionment approaches are likely to hinder both of these tax planning margins, but the limited availability of destination-based statistics on multinationals' sales is a heavy issue to analyze such reforms empirically, as underlined by Kadet et al. (2021). To foster further work on these questions, we develop an adjusted mapping of country-by-country revenue variables for the US and 14 other headquarter countries: the adjusted variables aim at reflecting the location of ultimate consumers or users rather than the jurisdiction where transactions are registered for financial reporting purposes. Adjusting the IRS' 2017 country-by-country report statistics, tax havens' share of US multinationals' foreign unrelated-party revenues is reduced from 27% to 18%. The "corrected" distribution of sales is significantly more in line with proxies for market size than the pre-adjustment variables, both focusing on US multinationals and for the extended sample.

Chapter 2 presents the different strands of the literature upon which this study is built and to which it contributes. In Chapter 3, we present our theoretical framework, that allows to illustrate the distinction between two sales shifting margins: costly intra-group transactions to shift profits artificially on the one hand and the strategic location of activities on the other hand. The empirical analysis of Chapter 4 comforts this conceptual distinction. Chapter 5 then discusses its implications for policy-makers and develops the proposed adjustment of country-by-country revenue variables. Chapter 6 concludes.

Chapter 2

Literature

2.1 Theoretical References

The theoretical framework presented in Section 3 comes at the crossroads of the trade literature on the organisation of multinational companies and the modelling of multinationals' tax planning practices. We use this model to illustrate the diversity of mechanisms that the notion of "sales shifting" may encapsulate.

Relationship with the trade literature. We start by adding corporate income taxation to the framework developed by Melitz (2003) and Chaney (2005). The framework of Melitz (2003) is based on the Krugman model of trade, with firm-level heterogeneity in the marginal productivity of labor. Each firm draws its productivity randomly and then chooses the foreign markets to which it will export. Exporting involves not only a variable, iceberg trade cost, but also a fixed cost determined on a bilateral basis. In the Chaney (2005) extension of this model, the free entry condition is eliminated and there is a fixed supply of entrepreneurs in each country. Three remarks are in order regarding our work on the Melitz-Chaney framework. First, in the benchmark case and when accounting for multinational firms' profit shifting capacities, we re-interpret the problem of the firm as choosing the markets that it should enter by setting up a foreign affiliate, rather than choosing the markets to which it will export. Said otherwise, in our framework, when a firm incurs the fixed cost to enter a given foreign country, it sets up a foreign subsidiary, produces goods or services in that country and sells them locally without iceberg trade costs.

Second, starting from a general equilibrium trade model allows to deal with the potential endogeneity of firms' pre-tax profit distribution to corporate income taxation, even ex ante profit shifting. Let us shed light on that particular issue by comparing this approach with that of Laffitte and Toubal (2022). In their illustrative framework, the authors derive the optimal profit shifting scheme of the firm by taking the level of *normal* pre-tax profits in all countries (ex ante profit shifting) as given. Then, they define the normal level of pre-tax profits as in Head and Mayer (2004), which results in a trade-off between production costs and market potential. However, with this approach, the normal level of pre-tax profits is exogenous to corporate income taxation: only the profits reported ex post the profit shifting operations depend on tax rates and paper profit shifting is the only tax planning margin for multinationals.

Third, when allowing multinational firms to export from their foreign affiliates, we lose tractability. As a consequence, we cannot fully model the effect of corporate income taxation on multinational companies' location decision. The literature on export platforms to which Laffitte and Toubal (2022) refer (Head and Mayer (2004) in particular) introduces the possibility for multinationals to serve a given market remotely, from one or several of its foreign subsidiaries. Tintelnot (2016)

achieves tractability in a quantifiable general equilibrium model by modelling firms as a continuum of products, with product location-specific productivity shocks. The theoretical framework presented in Chapter 3 could gain from further work to integrate the latest developments of the literature on export platforms.

Relationship with the literature on multinationals' tax planning practices. On the taxation side, some key features of the model come from Krautheim and Schmidt-Eisenlohr (2011). As in their work, there are two sectors, a differentiated good and a homogeneous good which serves as numeraire. Consumers' utility is quasi-linear over the two goods. In Krautheim and Schmidt-Eisenlohr (2011), the government raises corporate income taxes on the profit-making producers of the differentiated good to supply a third, public good. Its consumption yields a constant marginal utility strictly above 1 (the marginal utility from numeraire consumption). To simplify, we assume that the government directly acquires additional units of the numeraire good that enter consumers' utility: the key assumption lies in that government revenues are not spent on varieties of the differentiated good.

Regarding profit shifting specifically, which we present as an extension to the benchmark model, we follow the approach of Laffitte and Toubal (2022) who themselves build upon Hines and Rice (1994) and Gumpert, Hines, and Schnitzer (2016). In essence, multinational companies have access to a profit shifting technology based on intra-group transactions. It allows to transfer a share (possibly equal to 1) of the profits generated in a given country to a tax haven, where it is free from any corporate income tax. In the tax jurisdiction out of which profits are relocated, the intra-group transaction reduces reported profits, along with profit shifting costs. These are modelled as a quadratic function of the amount of profits being shifted; more precisely, it depends on the product of this amount and the share of the "normal" profits that it represents. We abstract from the fixed component of profit shifting costs introduced by Davies et al. (2018) in their model and proposed by Reynolds and Wier (2016) or Bilicka (2019) as a possible explanation for their empirical findings.

Building upon the theoretical framework of Chapter 2, the model could be re-worked and extended, for instance to conduct welfare and policy evaluation analyses as Johannesen (2022) does for the global minimum tax.[1]

2.2 Empirical Literature

This study also relates to the empirical literature on corporate tax avoidance. While focus is generally set on multinational companies' profit shifting practices, Laffitte and Toubal (2022) have put other indicators under the spotlight again and aimed at quantifying sales shifting. In Chapter 4, we support the concepts developed in our theoretical framework and explore further the mechanisms of sales shifting.

In the empirical literature on multinationals' tax planning schemes, researchers generally focus on profit shifting. For instance, many studies have identified how lower tax rates make some jurisdictions particularly attractive for multinational companies and drive upwards the amount of pre-tax profits booked there. Controlling for multinationals' real economic activity, which is especially feasible with firm-level data, benchmark analyses have identified a semi-elasticity of profits with respect to tax rate differentials of about -0.8 to -1 (Dharmapala (2014), Heckemeyer and Overesch (2017), Johansson et al. (2017), Beer, Mooij, and Liu (2020)). In other words, holding

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1. In his model, Johannesen (2022) takes the location of multinational firms' foreign affiliates and the normal level of their profits in each country (ex ante profit shifting operations) as exogenous. Companies are left with a unique tax planning margin: pure profit shifting with convex concealment costs. Mechanically, such a model does not allow to study the real responses of multinational companies to the reform.

everything else constant, a one-percentage-point reduction in the tax rate of a jurisdiction with respect to other jurisdictions is associated with a 0.8% to 1% increase in the pre-tax profits booked by multinationals in this jurisdiction. Several studies have also mobilized firm-level information to identify profit shifting mechanisms or, in another body of work, exploited macroeconomic data to estimate the global scale of profit shifting and the associated tax revenue losses.[2]

Earlier studies had lent attention to the response of other indicators, related in particular to multinationals' real economic activity, to corporate income taxation. For instance, Grubert and Mutti (1991) showed that the higher the statutory tax rate of a jurisdiction, the less fixed capital US multinational companies would register there. Grubert and Mutti (2000) and Altshuler, Grubert, and Newlon (2000) explored this relationship further to highlight the influence of countries' trade policy or by refining the estimation with first-difference specifications. Mooij and Ederveen (2003) provided a survey of the empirical literature on the links between corporate income taxation and multinationals' foreign direct investment (FDI): their meta-analysis yielded a median semi-elasticity of FDI to the tax rate of about -3.3. Although Mutti and Ohrn (2019) recently updated these findings and confirmed the sensitivity of US multinationals' location decisions to taxation, as highlighted above, focus moved from multinationals' real responses to taxation to profit shifting.

The shift operated in the literature from real indicators to pre-tax profits may be explained by the relative magnitude of the effects. Indeed, using a sample ranging from 1996 to 2004, Grubert (2012) shows that the rise in the foreign share of US multinationals' worldwide income is mainly the result of a change in the domestic versus foreign profitability margins, rather than that of a shift in sales. Despite such results, Laffitte and Toubal (2022) have put sales under the spotlight again by showing that US multinationals organize their global presence around sales platforms in response to taxation and by quantifying the weight of sales shifting practices in total profit shifting. In their main analysis, they explain the foreign sales ratio (i.e. the ratio of sales directed to any other country to total sales) as a function of the statutory corporate income tax rate: as they include both unrelated-party and related-party revenues, they implicitly account for profit shifting, as well as for some real responses to taxation.

In Chapter 4, we focus on the sensitivity of multinational companies' unrelated-party revenues to taxation: this allows to highlight that real responses still exist and that taxation affects not only the distribution of multinationals' profits but also their actual organisation.

2.3   Previous Works on Country-by-Country Data

Recently made available, country-by-country report statistics have rapidly appeared as a valuable data source to investigate multinational firms' tax planning practices. In this work, we highlight what the revenue variables reflect in these data and examine the consequences of this definition for the study of corporate tax avoidance.

The anonymized and aggregated country-by-country report statistics released by the IRS and the OECD (see IRS (2016-2019) and OECD (2016-2017)) have been mobilised to answer diverse research questions. For instance, Garcia-Bernando, Janský, and Tørsløv (2021) estimate the effective tax rates faced globally by US multinational companies from different data sources, including country-by-country report statistics, and examine how they determine reported pre-tax profits. Garcia-Bernardo and Janský (2022) use these data to estimate the global scale of multinationals' profit shifting practices. Furthermore, country-by-country report statistics have been used to assess the revenue potential of global minimum taxes (OECD (2020), Clausing, Saez, and Zucman (2020),

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2. One can refer for instance to Laffitte and Toubal (2022) who compile lists of studies relevant for both of these research questions.

Baraké et al. (2021a)) or to evaluate reforms (Garcia-Bernardo, Janský, and Zucman (2022)).[3]

Although researchers have already used these data for diverse purposes, important limitations have been identified. First, some profits are double-counted. On the one hand, profits assigned to "stateless entities" (which are particularly large in the case of US multinationals) are often also counted elsewhere (either under US domestic profits, or in a non-US jurisdiction). Most studies using aggregated country-by-country report statistics therefore drop stateless entities entirely. On the other hand, intra-firm dividends may give rise to double-counting: these payments can inflate profits before tax and artificially reduce effective tax rates as they are generally subject to no or light taxation (Horst and Curatolo (2020)).[4] Second, the coverage of the OECD's data remains limited in terms of sample period (only two income years, 2016 and 2017), headquarter countries (28 in 2016 and 38 in 2017) and partner jurisdictions. Indeed, the degree of detail of the bilateral breakdown can vary significantly from a parent jurisdiction to another (Garcia-Bernando, Janský, and Tørsløv (2021)). Third, as underlined by Baraké et al. (2021b), some observations display excessive profitability margins or large fluctuations in profits between years, which may indicate additional inconsistencies in the data.[5]

However, little attention has been given so far to the revenue variables ("Unrelated-party revenues", "Related-party revenues" and "Total revenues"). When they describe the limitations of the data used to model their METR proposal, Kadet et al. (2021) explain that the turnover matrix compiled by the OECD (2020) presents two main shortcomings: not only does it include intra-group sales which are a key tool for multinational companies to shift their profits to low-tax jurisdictions, but extra-group sales also reflect the location of the payment recipient, not the location of the ultimate beneficiaries of the corresponding transactions. This turnover matrix is primarily based on country-by-country report statistics. Indeed, in these data, revenue variables reflect the tax jurisdiction of the subsidiaries that register the transactions in their financial accounts, instead of the ultimate destination of the sales. For instance, even though the actual customer resides in France or in Germany, the sales of goods and services operated by Apple or Amazon via their Irish affiliates are attributed to Ireland.

We contribute to the literature using country-by-country report statistics by evidencing the related distortions. We also propose a methodology to adjust the country-by-country revenue variables based on the ultimate destination of multinational companies' sales.

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3. In addition to this literature, several researchers have gained access to firm-level country-by-country reports: Fuest, Hugger, and Neumeier (2022) study the reports of German firms and Bratta, Santomartino, and Acciari (2021) could access this information for all the multinationals in the scope of these reporting rules that have at least one affiliate in Italy. As some multinational companies have voluntarily started to release their reports online, a few studies have also mobilized those: see Baraké et al. (2021a), who use them to test the robustness of their revenue gain estimates, as well as Faccio et al. (2021) for a more comprehensive exploration and assessment of these data.

4. When a multinational from country A owns an affiliate in country B that itself owns an affiliate in country C, dividends paid by C to B are not counted as part of B's revenue, but they are sometimes counted as part of B's profit. This problem applies mainly to domestic observations as intra-firm dividends accrue mostly to the headquarter. Baraké et al. (2021b) discuss this issue and possible adjustments in more details.

5. Other potential limitations are covered in the related disclaimer maintained by the OECD (see OECD (2021)).

Chapter 3

Theoretical Framework

3.1 Generalities

3.1.1 Demand side

We consider N potentially asymmetric countries, each with a population L_i. Individuals share identical preferences and they are immobile across countries.

There are two sectors. One produces an homogeneous good used as numeraire. The production technology for that good displays constant returns to scale and requires one unit of labour per unit of output. Assuming that it is produced in all countries, it implies that wages are the same in all countries and are constant, equal to 1. The second sector consists of a differentiated good with a continuum of varieties.

Taking the example of country i, we define each individual's utility as:[1]

$$U_i = \alpha \ln(X_i) + q_i + \frac{G_i}{L_i} \tag{3.1}$$

Where:

- X_i is the constant elasticity of substitution (CES) aggregator of the individual's consumption of heterogeneous good varieties. Denoting by $x_i(\omega)$ the individual's consumption of variety ω and by σ the elasticity of substitution across varieties, it is defined as:

$$X_i = \left(\int_{\Omega_i} [x_i(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}} \tag{3.2}$$

- q_i is the individual's private consumption of the numeraire good;

- G_i is the total purchase of the numeraire good by country i's government, financed via a tax levied on corporate profits. Each individual thus benefits from a share $\frac{1}{L_i}$ of this public expenditure.

We recognize a two-stage utility with CES preferences over the varieties of the differentiated good and quasi-linear preferences over the two sectors. As they observe the policy choices of the government, individuals take G_i as given in their utility maximisation program. We solve the

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1. Since all consumers in country i share identical preferences, we do not index variables for the individual concerned. However, it should be underlined that U_i, X_i, q_i and the $x_i(\omega)$'s are individual-level variables.

maximisation problem of consumers in two stages. We can first view their choice of varieties as a cost minimization problem:

$$\min_{[x_i(\omega)]_{\omega \in \Omega_i}} \int_{\Omega_i} p_i(\omega) x_i(\omega) d\omega$$

$$\text{s.t.} \quad (\int_{\Omega_i} [x_i(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega)^{\frac{\sigma}{\sigma-1}} \geq X_i$$

With P_i denoting the usual CES price index, demand for a variety ω is then given by (see proof in Appendix 1.1):

$$x_i(\omega) = [\frac{p_i(\omega)}{P_i}]^{-\sigma} X_i \tag{3.3}$$

The total amount spent on differentiated goods is given by:

$$\int_{\Omega_i} p_i(\omega) x_i(\omega) d\omega = X_i P_i \tag{3.4}$$

From there, denoting R_i the individual income of each consumer in country i, the second stage of consumers' maximisation problem writes as:

$$\max_{q_i, X_i} \quad \alpha \ln(X_i) + q_i + \frac{G_i}{L_i}$$

$$\text{s.t.} \quad q_i + X_i P_i \leq R_i$$

We obtain (see proof in Appendix 1.1):

$$X_i = \frac{\alpha}{P_i} \text{ and } q_i = R_i - \alpha \tag{3.5}$$

3.1.2   Supply side

As in Chaney (2005), each country i has L_i entrepreneurs (L_i being also equal to population size), who get a draw from a Pareto productivity distribution.[2] The latter is defined by the cumulative density function F and can be written over $[1; +\infty)$:

$$P(\varphi > \Phi) = \Phi^{-\gamma}$$
$$\text{with } \gamma > \sigma - 1 \text{ and } \gamma > 2 \tag{3.6}$$

Under monopolistic competition, firms choose a price so as to maximize after-tax profits, taking the demand schedule of consumers (given by Equation 3.3) and the price index as given. The problem of a firm with productivity φ exporting its output from country j into country k writes as:[3]

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2. With a productivity draw φ, $\frac{1}{\varphi}$ then designates the quantity of labor required by the firm to produce one unit of differentiated good.

3. As individuals are identical, we abstract from the population size in this price setting problem and only consider individual demands. However, the resulting sales and profits must then be scaled by L_k.

$$\max_{p_{j,k}(\varphi)} \quad (1 - tax_j)(p_{j,k}(\varphi)x_k[p_{j,k}(\varphi)] - x_k[p_{j,k}(\varphi)]\frac{\tau_{j,k}}{\varphi})$$

$$\text{s.t.} \quad x_k[p_{j,k}(\varphi)] = [\frac{p_{j,k}(\varphi)}{P_k}]^{-\sigma}\frac{\alpha}{P_k}$$

Where tax_j is the rate at which the firm's profits are booked in country j and $\tau_{j,k}$ denotes bilateral iceberg trade costs incurred when exporting from country j into country k. We notice that corporate income taxes do not influence the firm's pricing decision. This heavily relies on (i) the assumption that the government spends its corporate income tax revenues exclusively on the numeraire, non-differentiated good and (ii) the assumption of quasi-linear preferences over the two sectors.

We find (see the computations in Appendix 1.1):

$$p_{j,k}(\varphi) = \frac{\sigma}{\sigma - 1}\frac{\tau_{j,k}}{\varphi} \tag{3.7}$$

The firm's total sales from country j in country k are then given by (see Appendix 1.1 for more details):

$$r_{j,k}(\varphi) = [\frac{\sigma\tau_{j,k}}{(\sigma - 1)\varphi P_k}]^{1-\sigma}\alpha L_k \tag{3.8}$$

We can also write the after-tax profits of the firm exporting its output from country j into country k (see development in Appendix 1.1):[4]

$$\pi_{j,k}(\varphi) = \frac{1}{\sigma}(1 - tax_j)[\frac{\sigma\tau_{j,k}}{(\sigma - 1)\varphi P_k}]^{1-\sigma}\alpha L_k \tag{3.9}$$

3.2   Benchmark Case

We have derived the demand for varieties of the differentiated good as a function of their local prices, as well as the price set by a firm exporting from country j into country k and the resulting after-tax profits. Having defined these general results, we now turn to the full optimization program of multinational firms, that decide where to locate their productive activities, which markets to enter, etc. **In the benchmark case that we develop below, a firm can sell in a country if and only it has set up an affiliate there and the output is produced locally**.

3.2.1   Productivity cut-off

Let us consider an entrepreneur from country i, thinking about entering country j. In our benchmark, this first requires the creation of a local affiliate, for which the firm must incur a fixed cost $f_{i,j}$, expressed as a quantity of labor.[5] Second, output is produced locally. Third, the profits generated by these transactions are entirely booked in country j and they are taxed at rate tax_j by the local government.

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4. All these derivations generalize to local production and sales. Countries j and k can be the same and there are then no iceberg trade costs: $\forall i \in [\![1, N]\!], \tau_{j,j} = 1$.

5. Fixed costs $f_{i,j}$ for the creation of a local affiliate are determined bilaterally to reflect the fact that international agreements, linguistic barriers, cultural or historical relations between countries i and j can make the process more or less costly for the firm.

The firm's after-tax profits in country j, net of the fixed costs for the creation of the local affiliate, are given by Equation 3.9. Two remarks are however in order when adapting the general expression. First, since production and sales all take place locally, there are no iceberg trade costs. Second, after-tax profits only depend on country j characteristics and we can drop the double index. This gives:

$$\pi_j(\varphi) = \frac{1}{\sigma}(1 - tax_j)[\frac{\sigma}{(\sigma - 1)\varphi P_j}]^{1-\sigma}\alpha L_j$$

Clearly, the firm from country i will enter country j if and only if:

$$\pi_j(\varphi) - f_{i,j} \geq 0$$

Since $\pi_j(.)$ is strictly increasing in φ, this defines a unique cut-off productivity level at which the firm is indifferent between entering country j and not entering it. Below this cut-off, the firm does not enter this market; with a higher productivity, it enters country j. We denote this productivity cut-off level by $\bar{\varphi}_{i,j}$. It is defined as (see development in Appendix 1.2):

$$\bar{\varphi}_{i,j} = (\frac{f_{i,j}}{1 - tax_j})^{\frac{1}{\sigma-1}}(P_j^{\sigma-1}L_j)^{-\frac{1}{\sigma-1}}\lambda_1 \tag{3.10}$$

Where λ_1 is a constant:

$$\lambda_1 = \frac{\sigma}{\sigma - 1}(\frac{\alpha}{\sigma})^{\frac{1}{1-\sigma}}$$

The productivity cut-off $\bar{\varphi}_{i,j}$ increases in the corporate income tax rate of country j. The higher it is, the more productive the firm must be to compensate for the fixed entry cost $f_{i,j}$. Tax rates are taken as exogenous here but we can already touch upon a dilemma for governments: beyond the mechanical revenue gain, a higher tax rate reduces attractiveness for foreign multinational firms, which weighs down on revenues and restricts the set of varieties available for consumption.

3.2.2 Equilibrium

We can first compute the price index in country j. Computations are developed in Appendix 1.2 and yield:

$$P_j = \lambda_2(\frac{L_j}{L})^{\frac{1}{\gamma}}L_j^{-\frac{1}{\sigma-1}}(1 - tax_j)^{\frac{1}{\gamma} - \frac{1}{\sigma-1}}\theta_j \tag{3.11}$$

Where λ_2 is a constant:

$$\lambda_2 = \lambda_1^{\frac{\gamma-\sigma+1}{\gamma}}[\frac{\gamma}{\gamma - (\sigma - 1)}]^{-\frac{1}{\gamma}}(\frac{\sigma}{\sigma - 1})^{\frac{\sigma-1}{\gamma}}$$

And:

$$\theta_j^{-\gamma} = \sum_{i=1}^{N} s_i f_{i,j}^{-(\frac{\gamma}{\sigma-1}-1)}$$

With s_i denoting country i's share of worldwide population and θ_j a measure of the remoteness of country j. Appendix 1.2 provides more details regarding the interpretation of this formula for the price index.

Plugging the expression found above for the price level in Equation 3.10, we can recompute the productivity cut-off $\bar{\varphi}_{i,j}$ (see Appendix 1.2 for the detailed computations). With an additional notation, $\lambda_3 = \frac{\lambda_1}{\lambda_2}$, we get:

$$\bar{\varphi}_{i,j} = \lambda_3 f_{i,j}^{\frac{1}{\sigma-1}} \left(\frac{L}{L_j}\right)^{\frac{1}{\gamma}} \frac{1}{\theta_j} (1 - tax_j)^{-\frac{1}{\gamma}} \tag{3.12}$$

We can discuss some comparative statics based on this result. First, $\bar{\varphi}_{i,j}$ is of course increasing in the fixed, bilateral set-up cost $f_{i,j}$: the larger this cost, the larger the firm's gross profits in country j must be for the creation of a local affiliate to be profitable. Second, the productivity cut-off is increasing in the local corporate income tax rate, as a higher rate implies lower after-tax profits for the firm. Third, it is decreasing in country j's population (i.e., in the local market size), since a higher number of potential consumers raises profits and more foreign firms find it profitable to enter country j. Fourth, $\bar{\varphi}_{i,j}$ is decreasing in the measure of country j's remoteness, θ_j: the more remote country j, the less intense competition is on the local market and the higher the profits that the firm can expect.

Furthermore, we can write the equilibrium sales, costs and profits in country j for a firm headquartered in country i (for details, refer to Appendix 1.2). Regarding the equilibrium sales, the general expression writes as:

$$r_j(\varphi) = \begin{cases} \lambda_4 \left(\frac{L_j}{L}\right)^{\frac{\sigma-1}{\gamma}} (1 - tax_j)^{\frac{\sigma-1}{\gamma}-1} \varphi^{\sigma-1} \theta_j^{\sigma-1} & \text{if } \varphi \geq \bar{\varphi}_{i,j} \\ 0 & \text{otherwise} \end{cases} \tag{3.13}$$

Where λ_4 is a constant:

$$\lambda_4 = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \lambda_2^{\sigma-1} \alpha$$

Noticing that $\frac{\sigma-1}{\gamma} - 1$ is negative, we deduce that $r_j(\varphi)$ is increasing in tax_j in the first case. Said otherwise, conditional on satisfying the productivity cut-off and entering country j, the firm's sales are increasing in the local corporate income tax rate. Indeed, a higher tax rate reduces the number of foreign firms active in country j and the firm faces a less intense competition. As for equilibrium profits, we deduce that for any productivity level φ, after-tax profits gross of the fixed entry cost are given by:

$$\pi_j(\varphi) = (1 - tax_j)[r_j(\varphi) - c_j(\varphi)] = \left(\frac{1 - tax_j}{\sigma}\right) r_j(\varphi) \tag{3.14}$$

These expressions for sales, costs and profits are given at the firm level, depending on whether or not the multinational enters country j. We turn to the aggregate sales recorded in country j by firms headquartered in country i. They are given by (see Appendix 1.2):

$$X_{i,j} = \lambda \frac{L_i L_j}{L} f_{i,j}^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \theta_j^{\gamma} \tag{3.15}$$

Where λ is a constant:

$$\lambda = \frac{\gamma}{\gamma - (\sigma-1)} \lambda_3^{\sigma-\gamma-1} \lambda_4$$

Interestingly, in our benchmark, the corporate income tax rate of the destination country does not have any impact on aggregate sales. Two effects are at work that offset each other: on the one hand, an increase in tax_j reduces the number of foreign firms that find it profitable to enter country j but on the other hand, this barrier to entry makes competition in country j less intense and allows entering firms to capture larger market shares. The extensive margin effect has a negative impact on aggregate sales $X_{i,j}$, while the intensive margin or market share effect has a positive impact.

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3.3 Two Tax Planning Margins

In the benchmark case of our theoretical framework, multinational firms' aggregate sales and pre-tax profits are unaffected by corporate income taxes. This is mainly due to (i) the idea that corporate income tax revenues are solely spent on the numeraire and (ii) the absence of tax planning margins for multinational companies. In this section, we propose two extensions of this benchmark that provide firms with tax planning margins of different natures. Each corresponds to one of the two forms of sales shifting described in Chapter 1. The following thus aims at underlining the difference between profit shifting on the one hand, which has no impact on the distribution of firms' extra-group sales, and the tax-motivated location of activities on the other hand, that may affect unrelated-party revenues.

3.3.1 Profit shifting opportunities

In this first extension of the benchmark, we maintain the assumption that production must take place locally, but multinationals now have the possibility to shift (a part of) their profits to lower-tax jurisdictions thanks to intra-group transactions. Profit shifting is modelled similarly to Laffitte and Toubal (2022).[6] We will analyse in particular how profit shifting opportunities affect the distribution of firms' unrelated-party revenues.

To do so, we must reconsider the pricing decision of multinational firms, which may be affected by their profit shifting capacities. Consider a firm headquartered in country i with productivity φ. Recall the expression for the quantity of its output demanded by country j consumers at price $p_j^{PS}(\varphi)$ (from Equations 3.3 and 3.5):

$$x_j[p_j^{PS}(\varphi)] = [\frac{p_j^{PS}(\varphi)}{P_j^{PS}}]^{-\sigma}\frac{\alpha}{P_j^{PS}}$$

Where notations have been adapted with a PS superscript, reflecting the fact that variables may be affected by firms' profit shifting. At price $p_j^{PS}(\varphi)$, the firm generates the following *pre-tax* profits in country j:

$$\pi_j^{PT,0}[p_j^{PS}(\varphi)] = [\frac{p_j^{PS}(\varphi)}{P_j^{PS}}]^{-\sigma}\frac{\alpha}{P_j^{PS}}p_j^{PS}(\varphi) - [\frac{p_j^{PS}(\varphi)}{P_j^{PS}}]^{-\sigma}\frac{\alpha}{\varphi P_j^{PS}}$$

Besides, the firm has the possibility to shift (a part of) these pre-tax profits to a foreign jurisdiction h, by organising an intra-group transaction.[7] For instance, an establishment of the multinational in country h charges $\Psi_j(\varphi)$ to the affiliate in j for the use of intellectual property. This intra-group transaction reduces pre-tax profits in country j (from $\pi_j^{PT,0}$ as above to $\pi_j^{PT,1}$) and increases the revenues and profits booked in jurisdiction h. We assume, again as a simplification, that the shifted profits are not taxed in h. The tax rate differential between non-shifted and shifted profits is thus equal to tax_j.

We model the costs of profit shifting similarly to Laffitte and Toubal (2022). Costs are incurred in the country of origin of the profits (j in our case), and they depend on a parameter $\varepsilon_j \in (1, +\infty)$

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6. Laffitte and Toubal (2022) themselves rely on Hines and Rice (1994) and Gumpert, Hines, and Schnitzer (2016). More details about our theoretical references can be found in Section 2.1.

7. We assume that the multinational can shift profits to any foreign jurisdiction, even if it has not set up an affiliate there and if it is not selling there, ex ante the intra-group transaction. Thereby, we shut off a feedback effect. When choosing the markets in which it will set up an affiliate, the multinational does not need to enter a tax haven with the specific purpose of shifting profits there.

that decreases with the degree of transparency of the local tax environment.[8] This gives the following expression:

$$\frac{a^{\frac{1}{\varepsilon_j}}}{2} \frac{[\Psi_j(\varphi)]^2}{\pi_j^{PT,0}[p_j^{PS}(\varphi)]}$$

The profit maximization problem of the multinational firm then accounts for the profits booked and taxed in country j, but also for those shifted to jurisdiction h:

$$\max_{p_j^{PS}(\varphi), \Psi_j(\varphi)} \quad (1 - tax_j)\pi_j^{PT,1}[p_j^{PS}(\varphi), \Psi_j(\varphi)] + \Psi_j(\varphi)$$

$$\text{s.t.} \quad \pi_j^{PT,1} = \pi_j^{PT,0} - \Psi_j(\varphi) - \frac{a^{\frac{1}{\varepsilon_j}}}{2} \frac{[\Psi_j(\varphi)]^2}{\pi_j^{PT,0}[p_j(\varphi)]} \tag{3.16}$$

The detailed resolution of this problem and all the subsequent derivations are presented in Appendix 1.3. First, the first-order condition with respect to $\Psi_j(\varphi)$ gives:

$$\Psi_j(\varphi) = \frac{1}{a^{\frac{1}{\varepsilon_j}}} \left(\frac{tax_j}{1 - tax_j}\right) \pi_j^{PT,0}[p_j(\varphi)] \tag{3.17}$$

Plugging this in the first-order condition with respect to price gives:

$$p_j^{PS}(\varphi) = \frac{\sigma}{\sigma - 1} \frac{1}{\varphi} \tag{3.18}$$

Interestingly, the profit shifting opportunities of the firm do not affect its pricing decision.[9] Note that, based on this result, we drop the PS subscript and move back to the previous $p_j(\varphi)$ notation in the following. The pre-tax profits ex ante the intra-group transaction are thus the same as in the benchmark case and the optimal intra-group transaction is given by: :

$$\Psi_j(\varphi) = \frac{\alpha L_j}{a^{\frac{1}{\varepsilon_j}}} \left(\frac{tax_j}{1 - tax_j}\right) (P_j^{PS}\varphi)^{\sigma-1} \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma} \frac{1}{\sigma - 1} \tag{3.19}$$

From there, the pre-tax profits actually booked in country j, $\pi_j^{PT,1}(\varphi)$, write as:

$$\pi_j^{PT,1}(\varphi) = \pi_j^{PT,0}(\varphi)\left[1 - \frac{1}{a^{\frac{1}{\varepsilon_j}}}\left(\frac{tax_j}{1 - tax_j}\right) - \frac{1}{2a^{\frac{1}{\varepsilon_j}}}\left(\frac{tax_j}{1 - tax_j}\right)^2\right]$$

On the other hand, earnings equal to $\Psi_j(\varphi)$ are reported in the low-tax jurisdiction to which profits are shifted. When considering whether to enter market j or not, the firm, considers the total after-tax profits $\pi_j^{PS}(\varphi)$. These write as:

$$\pi_j^{PS}(\varphi) = \pi_j^{PT,0}(\varphi)\left[1 - tax_j + \frac{tax_j^2}{2a^{\frac{1}{\varepsilon_j}}(1 - tax_j)}\right] \tag{3.20}$$

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8. First, note that ε_j corresponds to γ_j in Laffitte and Toubal (2022)'s original notations. Second, as a simplification, the costs of profit shifting are assumed to be the same regardless of the headquarter country of the multinational. One might want to correct for this simplification as the headquarter country can implement regulations and controls that hinder the firm's profit shifting opportunities.

9. Again, this result might not be robust to the choice of another utility function or to another assumption about how corporate income tax revenues are spent by the government.

Note that this expression gives the effective tax rate ETR_j that applies to the profits actually generated by the firm's activity in country j. Naturally, through the effect of profit shifting, it is lower than the corporate income tax rate chosen by country j's government:

$$ETR_j = tax_j - \frac{tax_j^2}{2a^{\frac{1}{\varepsilon_j}}(1 - tax_j)} < tax_j \tag{3.21}$$

From there, a firm headquartered in country i enters market j if and only if:

$$\pi_j^{PS}(\varphi) > f_{i,j}$$

Profit shifting opportunities modify the productivity cut-off, which we now denote $\bar{\varphi_{i,j}}^{PS}$. Indeed, the above is equivalent to (see Appendix 1.3 for detailed computations):

$$\varphi > \bar{\varphi_{i,j}}^{PS}$$
$$\text{where } \bar{\varphi_{i,j}}^{PS} = \lambda_1[(P_j^{PS})^{\sigma-1}L_j]^{-\frac{1}{\sigma-1}}(\frac{f_{i,j}}{1 - ETR_j})^{\frac{1}{\sigma-1}} \tag{3.22}$$

We directly see that, since $ETR_j < tax_j \iff 1 - ETR_j > 1 - tax_j$:

$$\bar{\varphi_{i,j}}^{PS} = (\frac{1 - tax_j}{1 - ETR_j})^{\frac{1}{\sigma-1}}\bar{\varphi_{i,j}} < \bar{\varphi_{i,j}}$$

Said otherwise, as it reduces the rate at which profits generated in country j are effectively taxed, profit shifting lowers the productivity requirement that must be met for the firm to enter country j. Compared to our benchmark, more multinational firms enter a given potential destination if they can shift part of their profits to a low-tax jurisdiction. Profit shifting has real consequences through the extensive margin identified in the benchmark case.

Let us now solve for the new equilibrium with profit shifting. We consider the price index P_j and directly adapt earlier computations, replacing tax_j by ETR_j (more details in Appendix 1.3). This gives:

$$P_j^{PS} = \lambda_2(\frac{L_j}{L})^{\frac{1}{\gamma}}L_j^{-\frac{1}{\sigma-1}}(1 - ETR_j)^{\frac{1}{\gamma}-\frac{1}{\sigma-1}}\theta_j \tag{3.23}$$

We can plug this result back into the expression for the new productivity cut-off:

$$\bar{\varphi_{i,j}}^{PS} = \lambda_3 f_{i,j}^{\frac{1}{\sigma-1}}(\frac{L}{L_j})^{\frac{1}{\gamma}}\frac{1}{\theta_j}(1 - ETR_j)^{-\frac{1}{\gamma}} \tag{3.24}$$

Furthermore, we can rewrite the equilibrium sales recorded in country j by a firm headquartered in country i:

$$r_j^{PS}(\varphi) = \begin{cases} \lambda_4(\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}}(1 - ETR_j)^{\frac{\sigma-1}{\gamma}-1}\varphi^{\sigma-1}\theta_j^{\sigma-1} & \text{if } \varphi \geq \bar{\varphi_{i,j}}^{PS} \\ 0 & \text{otherwise} \end{cases} \tag{3.25}$$

Where:

$$\lambda_4 = (\frac{\sigma}{\sigma - 1})^{1-\sigma}\lambda_2^{\sigma-1}\alpha$$

In the benchmark case, conditional on entering country j, firm-level sales were found to increase in the tax rate tax_j. We interpreted this as a market share or intensive margin effect: the higher the tax rate, the higher the productivity level required to profitably enter country j and thus, the

lower the number of firms competing in the jurisdiction, which involves a larger demand for the available varieties. With profit shifting, we retrieve such a relationship although it is now driven by the effective tax rate ETR_j.

From there, we can deduce the expression for the aggregate sales registered in country j by multinationals headquartered in i. It is given by:

$$X_{i,j}^{PS} = \lambda \frac{L_i L_j}{L} f_{i,j}^{-(\frac{\gamma}{\sigma-1}-1)} \theta_j^{\gamma} = X_{i,j} \qquad (3.26)$$

We therefore find that the distribution of multinationals' unrelated-party revenues is unaffected by their profit shifting opportunities. As in the benchmark case, when allowing for the first form of sales shifting practices, extra-group sales do not depend on corporate income taxation.

3.3.2 Tax-motivated location of activities

We now consider the more general case in which a firm headquartered in country i (i.e., created by an entrepreneur from country i) has three options to operate in country k. We successively describe these options, which are also illustrated in Figure 3.1:

- Either the firm exports from its headquarter country i. These exports imply iceberg trade costs $\tau_{i,k}$ but we assume that there is no fixed cost for exporting. In that case, the profits generated by the firm's sales in country k are booked and taxed in country i.

- Or it sets up a local affiliate by incurring the fixed cost $f_{i,k}$, produces directly in country k and can sell its output there without any iceberg trade costs. Contrarily to the above, the profits generated by the firm's sales in country k are booked and taxed locally.

- Or it exports into country k from a third country j where it has set up a foreign affiliate. These exports again imply iceberg trade costs $\tau_{j,k}$ and while we still assume that there is no fixed cost for exporting from j to k, the creation of the foreign affiliate required to incur the fixed costs $f_{i,j}$. The profits generated by the firm's sales in country k are booked and taxed in country j.

Figure 3.1: Set of possibilities to serve market k for a firm headquartered in i

Panel A: Exporting from the headquarter country
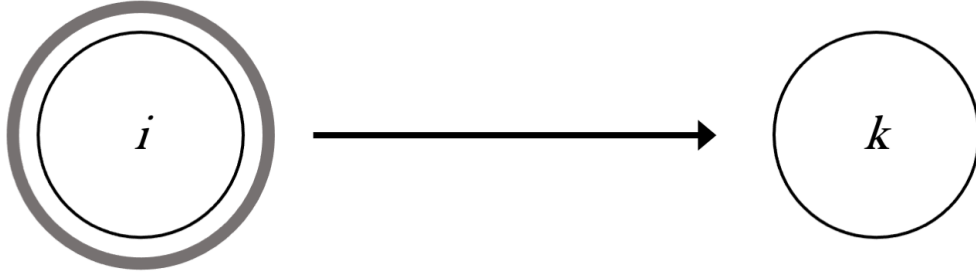
Panel B: Setting up a local affiliate
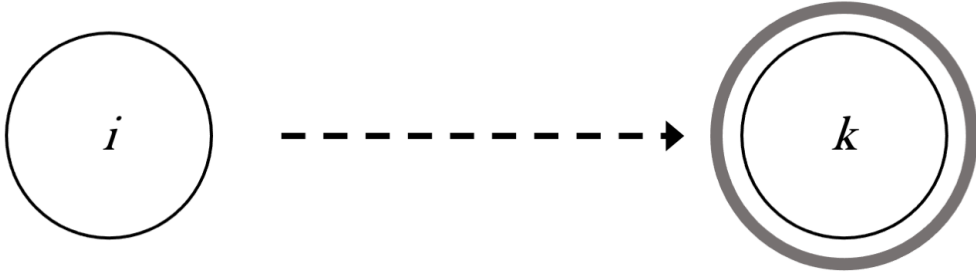
Panel C: Exporting from a foreign affiliate

○ Location of the production → Exporting – ➔ Setting up an affiliate
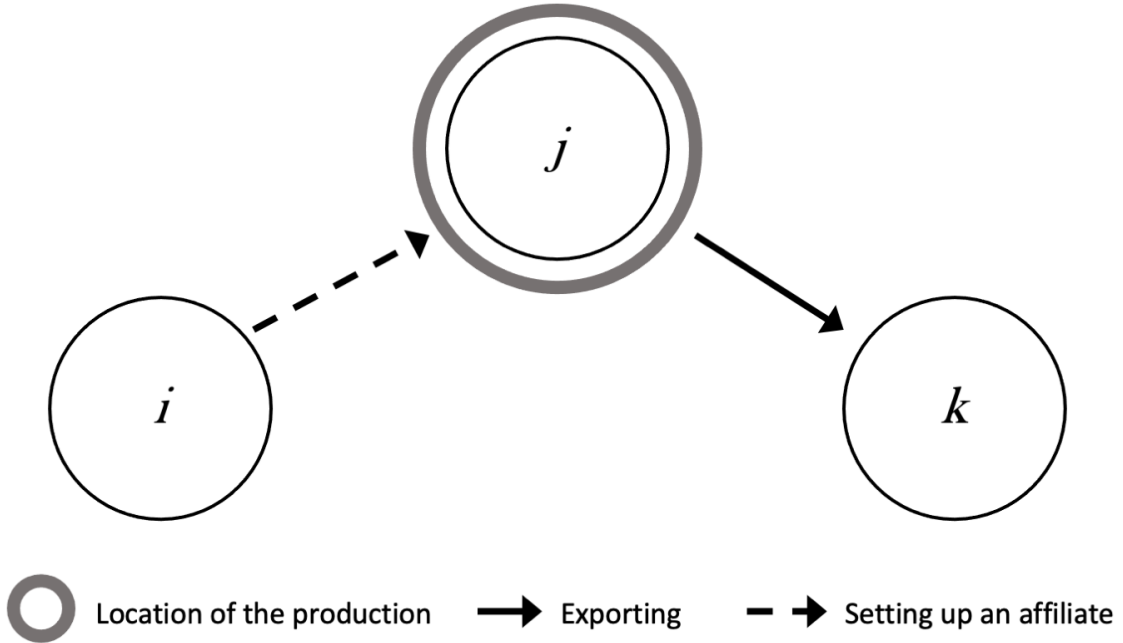
Let us consider a firm headquartered in country i. Because there are no fixed costs for exporting and since there is always an (even small) demand for its variety in all countries, it will sell its output in every country k. However, the firm may choose a set of countries J ($J \subset [\![1, N]\!] \setminus \{i\}$) where to set up foreign affiliates so as to maximize after-tax profits. Besides, for any country k, the firm

must choose from which country in $J \cup \{i\}$ it will export to k.

Assuming that J is fixed and focusing on the second step of the firm's maximization problem, we have that sales in country k will be operated from country j such that:

$$j = \underset{l \in J \cup \{i\}}{\arg\max}(\pi_{l,k})$$

From 3.9, with φ the productivity level of the firm, this is equivalent to:

$$j = \underset{l \in J \cup \{i\}}{\arg\max}(\frac{1}{\sigma}(1 - tax_l)[\frac{\sigma\tau_{l,k}}{(\sigma - 1)\varphi P_k}]^{1-\sigma}\alpha L_k)$$

Abstracting from the terms that do not depend on l, the problem simplifies into a trade-off between the corporate income tax rate that will be applied to the profits generated in country k (tax_l) and the iceberg trade costs ($\tau_{l,k}$):

$$j = \underset{l \in J \cup \{i\}}{\arg\max}[(1 - tax_l)\tau_{l,k}^{1-\sigma}] \tag{3.27}$$

Importantly, according to this expression, the firm might decide to operate in country k from a relatively distant country j (more precisely, with high iceberg trade costs $\tau_{j,k}$) if the corporate income tax rate applied there is substantially lower than in the direct neighbors of country k.

To go further, for any country j in $J \cup \{i\}$, we denote by Φ_j the set of countries into which the firm exports from j:

$$\Phi_j = \{k \in [\![1, N]\!] \ / \ j = \underset{l \in J \cup \{i\}}{\arg\max}[(1 - tax_l)\tau_{l,k}^{1-\sigma}]\}$$

The after-tax profits booked by the firm in country j are then given by:

$$\sum_{k \in \Phi_j} \pi_{j,k}$$

And to set up its affiliate in country j, the firm incurs the fixed cost $f_{i,j}$. The total after-tax profits of the firm, net of the fixed costs of creating its foreign affiliates, can be written as:

$$\sum_{j \in J \cup \{i\}} \sum_{k \in \Phi_j} \pi_{j,k} - \sum_{j \in J} f_{i,j}$$

Eventually, the program of the multinational company is given by:

$$\underset{J \subset [\![1, N]\!] \setminus \{i\}}{\max} \quad \sum_{j \in J \cup \{i\}} \sum_{k \in \Phi_j} \pi_{j,k} - \sum_{j \in J} f_{i,j}$$

$$\text{s.t.} \qquad \Phi_j = \{k \in [\![1, N]\!] \ / \ j = \underset{l \in J \cup \{i\}}{\arg\max}[(1 - tax_l)\tau_{l,k}^{1-\sigma}]\}$$

We cannot solve for this problem without further assumptions but 3.27 underlines how multinational firms account for corporate income taxation when setting up their foreign affiliates. The location and global organization of their activities provides them with an additional tax planning margin, which is representative of the second form of sales shifting practices as per Chapter 1. In the benchmark case and when allowing for the first kind of sales shifting operations, we showed that extra-group sales are not expected to respond to taxation. If corporate income taxes were to affect unrelated-party revenues in practice, based on our theoretical framework, we would thus attribute this effect to the second form of sales shifting practices.

Chapter 4

Empirical Analysis

We wish to determine whether multinationals' unrelated-party revenues respond to corporate income taxation. Under the benchmark framework and with profit shifting opportunities, our theoretical model predicts that aggregate sales are not sensitive to the corporate tax rate of the partner country. We will evaluate whether this assertion holds in aggregated and anonymized country-by-country report statistics. A response of unrelated-party revenues to taxation would indicate that multinationals' sales shifting also involves a real tax planning margin and would justify the dichotomy of Section 1.

Section 4.1 describes the data sources mobilized in our empirical analysis. In Section 4.2, we present descriptive statistics that highlight the disproportionate weight of some small, low-tax jurisdictions in country-by-country report statistics. Eventually, Section 4.3 proposes a more rigorous identification of the response of unrelated-party revenues to taxation.

4.1 Data

4.1.1 Country-by-country report statistics

General remarks

This study first relies on aggregated and anonymized country-by-country report statistics. Released so far for four financial years (from 2016 to 2019) by the IRS and for two financial years (2016 and 2017) by the OECD, these datasets provide information on the domestic and foreign activities of multinational companies, respectively headquartered in the US or in a broader set of parent jurisdictions. For each tax jurisdiction where they are active, country-by-country data display their aggregated revenues, pre-tax profits, corporate income taxes paid and accrued, among other variables.

In particular, the dataset comprises three revenue variables: "Unrelated party revenues", which correspond to transactions between subsidiaries of the reporting multinational company and unaffiliated partners; "Related party revenues", associated with intra-group transactions; "Total revenues" (i.e., the sum of the two other variables). In country-by-country data, the notion of revenues encompasses a wide scope of transactions. The definition provided by the OECD, in charge of supervising the global collection of country-by-country data, is the following: "revenues should include revenues from sales of inventory and properties, services, royalties, interest, premiums and any other amounts". Besides, dividends paid by affiliated corporations are excluded.[1]

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1. Importantly, due to the exclusion of intra-group dividends, revenue variables should be free from the double-counting identified for profit before tax in the literature (see Horst and Curatolo (2020) or Baraké et al. (2021b) on

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Several studies have underlined the limitations of country-by-country data.[2] When focusing on revenues, three shortcomings of this dataset should be taken into account:

- **Stateless entities**. Aggregated and anonymized country-by-country report statistics, especially the IRS' data, include "stateless" entities. These correspond to affiliates of multinational companies whose tax jurisdiction could not be properly established for various possible reasons. Importantly, they may lead to double-counting in the revenue variables and therefore, following most of the studies that have resorted to country-by-country data (OECD (2020), Garcia-Bernardo and Janský (2022) or Clausing, Saez, and Zucman (2020)), we exclude stateless entities from our analysis.

- **Aggregation levels and taxpayer confidentiality**. For a given pair of headquarter country and market jurisdiction, the number of active multinational companies may be so low that aggregated country-by-country reports would breach taxpayers' confidentiality. Most tax administrations, including the IRS, therefore gather partner countries with a too low number of reporting entities, typically at the continental level. This introduces rows such as "Other Europe" or "Other Africa". In the OECD's country-by-country data, the granularity of bilateral breakdowns is very heterogeneous across parent jurisdictions; we explain in more details below how we approach this issue.

- **Voluntary and mandatory reporting**. For the financial year 2016, the reporting of country-by-country data by in-scope multinational companies was not yet mandatory. As noticed by the OECD (2020), from the 2016 to the 2017 US country-by-country data, the number of reporting companies increased by roughly 40%. Our benchmark results are presented for the financial year 2017 and they are therefore preserved from this limitation. The latter might however affect our results for the financial year 2016, presented as robustness checks.

The IRS' country-by-country report statistics

Country-by-country reporting has been mandatory for US multinational companies with a consolidated turnover of more than 850 million USD since 2017. Based on the firm-level reports of in-scope multinationals, the IRS produces and releases aggregated and anonymized data (see IRS (2016-2019)). For the financial year 2017, the US country-by-country data relied on the reporting of 1,575 multinational companies, with 180,370 entities globally. Excluding "Stateless entities", which account for 3.8% of US multinational enterprises' total revenues worldwide, as well as intermediary totals, the preprocessed dataset provides information for 145 unique partner jurisdictions. This includes the US themselves, the revenues registered domestically by US multinational companies representing 67.1% of the global total. Among the partner jurisdictions, there are also 4 continental aggregates ("Other Africa", "Other Europe", "Other Americas" and "Other Asia and Oceania") that together account for less than 0.1% of the total revenues booked abroad.

We also use the IRS' split of US country-by-country report statistics per industry group. Available from 2016 to 2019, these data allow to distinguish 7 industry groups. The initial classification by sector of activity is based upon the North American Industry Classification System (NAICS) but certain groups have been marginally renamed for convenience in this report. The resulting set of sectors is the following: "Agriculture, forestry, fishing and hunting, mining, quarrying, oil and gas extraction, utilities, and construction" (designated as "Primary" in this document and in

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dividend double-counting).

2. The OECD's dedicated disclaimer also covers various issues associated with these data (see OECD (2021)).

the Appendix); "Manufacturing"; "Wholesale and retail trade, transportation and warehousing" ("Trade"); "Information"; "Finance and insurance, real estate and rental and leasing" ("Finance"); "Professional, scientific, and technical services" ("Technical services"); "Management of companies and enterprises, all other services (except public administration)" ("Management"). The partner jurisdiction breakdown is more limited and only 66 unique partner jurisdictions are covered in this second sample.

The OECD's bilateral country-by-country report statistics

We then consider the OECD's aggregated and anonymized country-by-country report statistics that cover 38 parent jurisdictions for the 2017 income year (see OECD (2016-2017)). We however restrict our attention to a subset of headquarter countries. We first exclude the 4 parent jurisdictions that only report a split of the country-by-country variables between domestic and foreign activities (all activities abroad being aggregated into a "Foreign jurisdictions total"). Our empirical analysis could then be applied to the remaining 34 headquarter countries but it would be more or less relevant depending on the detail of the bilateral breakdown reported by each parent. Typically, some reporters only provide a continental breakdown. Therefore, we focus on the 15 parent jurisdictions that report at least 60 unique partners in their country-by-country reports. Table 4.1 presents the list of these headquarter countries, as well as their respective number of partner jurisdictions.

Table 4.1: Parent jurisdictions covered in the extension of the adjustment

Parent country	Number of partner jurisdictions
Japan	196
India	161
Germany	158
United States	144
South Africa	137
China	123
Switzerland	119
Spain	118
Denmark	114
Italy	108
Bermuda	97
Mexico	94
France	89
Luxembourg	89
Australia	79

Note: This table shows the 15 parent jurisdictions retained for the extension of the destination-based adjustment beyond US multinational companies, as well as the number of unique partners in their respective aggregated country-by-country reports. Data come from the OECD's country-by-country report statistics.

For the financial year 2017, these country-by-country data restricted to 15 parent jurisdictions relied on the reporting of over 4,000 multinational companies, with roughly 525,000 entities globally. Excluding "Stateless entities", which account for 1.5% of total revenues worldwide, as well as intermediary totals, the preprocessed dataset provides information for 221 unique partner jurisdictions. This includes the headquarter countries themselves, the revenues registered domestically

representing 62% of the global total. Among the unique partner jurisdictions, there are also 4 continental aggregates ("Other Africa", "Other Europe", "Other Americas" and "Other Asia and Oceania") that together account for 0.6% of the total revenues booked abroad.

4.1.2 Other data sources

First, we investigate whether multinational companies' unrelated-party revenues respond to corporate income taxation. The main tax variable that we consider is the statutory corporate income tax rate. Statutory tax rates are sourced in the OECD's Corporate Tax Statistics (OECD (2016-2019c)), complemented with the Tax Foundation's dataset (Bray (2021)). Effective tax rates (average and marginal) are also used as regressors in alternative specifications. They are taken from the OECD's Corporate Tax Statistics (OECD (2016-2019b)) and from the CBT Tax Database (Oxford University Centre for Business Taxation (2017)). Effective tax rate series are extended based on statutory rates, using a methodology similar to that of Bratta, Santomartino, and Acciari (2021).

Second, our three main control variables are the size of the partner jurisdiction's economy, its foreign market access and the distance from the headquarter country to the partner jurisdiction, which accounts for the cost of setting up a local affiliate. Gross Domestic Product (GDP) data come from the World Economic Outlook database (IMF (2022)). Foreign market access is estimated as per Laffitte and Toubal (2022)'s and Head and Mayer (2013)'s methodology, based on the bilateral trade series of the BACI database (Gaulier and Zignago (2010)) and on gravity variables from the gravity database of the CEPII (Head and Mayer (2013)). Distance measures are taken from the gravity database of the CEPII.

Third, we add a variety of secondary control variables. Most of them (contiguity, common language dummies, colonial relationships and regional trade agreements) come from the CEPII gravity database. For the tax environment of the partner jurisdiction, we identify tax havens based on two alternative lists: the one gathered by Hines and Rice (1994) and the one compiled by Tørsløv, Wier, and Zucman (2018). Data on tax treaties were scraped on the website of the Exchange of Information database (OECD (n.a.)).

Eventually, Gross National Income (GNI) series are sourced from the World Bank's and the OECD's National Accounts Statistics (World Bank and OECD (2016-2019)), while data on consumption expenditures are provided by the United Nations Conference on Trade and Development (UNCTAD, see UNCTAD (2016-2019)).

4.2 Descriptive Study

4.2.1 US country-by-country report statistics

Preliminary remarks

We first explore the geographical distribution of US multinational companies' sales based on the country-by-country report statistics of the IRS. Among the variables provided, we mainly focus on "Unrelated party revenues", which cover sales and transactions operated with unaffiliated entities. Table 4.2 first displays the respective weight of the four continental aggregates that we use throughout our computations. We also distinguish domestic operations, i.e., the unrelated-party revenues registered by the US-based entities of in-sample multinational groups.

Table 4.2: Evolution of the continental distribution of US multinationals' unrelated-party revenues

	2016	2017	2018	2019
Sales to the US (billion USD)	7,800.0	10,618.0	11,323.7	11,679.7
Sales abroad (billion USD)	3,025.7	3,984.2	4,397.3	4,369.9
Of which Europe (%)	45.6	45.5	46.0	46.1
Of which Asia-Pacific (%)	31.7	32.4	33.9	33.5
Of which America (%)	21.1	20.7	18.9	19.2
Of which Africa (%)	1.6	1.4	1.3	1.2

Note: This table presents the absolute amounts of US multinational companies' unrelated-party revenues in the US and in foreign jurisdictions. The latter total is obtained by summing unrelated-party revenues over all non-US partner countries but "Stateless entities" and continental totals. These figures are presented in current billion USD. The distribution of foreign unrelated-party revenues among 4 regional aggregates (Europe, Asia-Pacific, America, Africa) is also presented, continents' respective weights being expressed in percentage. All figures are based on the IRS' aggregated and anonymized country-by-country data.

The bulk of sales to unaffiliated companies is registered in Europe (roughly 46%) and Asia-Pacific countries form the second largest continental partner for the US. We also notice the strong time consistency of each continent's share of unrelated-party revenues, including for the year 2016 in which country-by-country reporting was not yet mandatory. These four years of data are naturally insufficient to draw strong conclusions but the weight of Asia-Pacific increases over time, while the American and African continents rather seem to recede. The continental distribution of unrelated-party revenues however hides noticeable country-level specificities. Table 4.3 shows the 20 largest destinations for US multinational companies' sales based on the IRS' 2017 country-by-country data.

Table 4.3: Top 20 largest partner jurisdictions

Partner jurisdiction	UPR (USD billion)	Share of foreign UPR (%)
United Kingdom	486.7	12.2
Canada	372.9	9.4
Ireland	245.0	6.1
China	239.5	6.0
Germany	217.5	5.5
Japan	209.1	5.2
Singapore	207.3	5.2
Switzerland	180.6	4.5
Brazil	147.1	3.7
France	146.5	3.7
Mexico	129.5	3.3
Australia	122.9	3.1
Netherlands	121.5	3.0
Hong Kong	112.6	2.8
Italy	84.4	2.1
Belgium	64.4	1.6
India	58.1	1.5
Spain	56.5	1.4
Korea	54.7	1.4
Russia	43.8	1.1

Note: This table presents the 20 most important partner countries for US multinational companies. This ranking is based on the unrelated-party revenues booked by US multinational enterprises in each of these jurisdictions. Revenues are presented in absolute amounts (expressed in 2017 billion USD) and as a share of US multinational companies' total foreign unrelated-party revenues (expressed in percentage). All figures are based on the IRS' 2017 country-by-country data. "UPR" stands for unrelated-party revenues.

Two long-term commercial partners of the US, the United Kingdom and Canada, come respectively first and second. Major industrialized economies (e.g. Germany, Japan, France), the largest emerging countries (China, Brazil, India) or members of the North American Free Trade Agreement (NAFTA; Canada mentioned above and Mexico) appear among this top 20. But the position of smaller economies, such as Ireland, Singapore or Switzerland that respectively rank third, seventh and eighth, may be more surprising.

Relationship between sales and consumption expenditures

Table 4.4 relates each country's share of US multinationals' unrelated-party revenues with its share of the final consumption expenditures observed for the year 2017 in the sample. This variable serves as a proxy for the final destination of sales in the draft nexus and revenue sourcing rules released by the OECD for the Pillar One Amount A in February 2022.[3]

3. We exclude 10 countries for which we have no data on 2017 final consumption expenditures; because these partner jurisdictions account for 0.4% of US multinational companies' total unrelated-party revenues, the "Share of total UPR (%)" column can be marginally different between Tables 4.3 and 4.4.

Table 4.4: Relationship between the 20 largest partners' share of foreign unrelated-party revenues and their share of final consumption expenditures

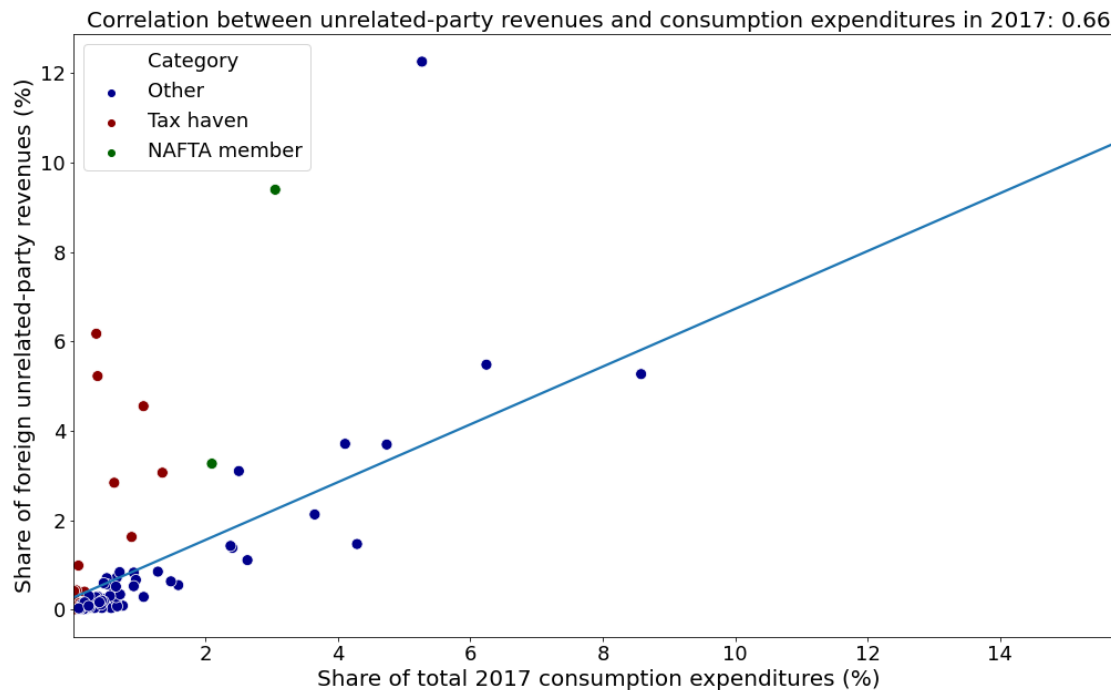| Partner jurisdiction	Share of foreign UPR (%)	Share of cons. exp. (%)
United Kingdom	12.3	5.3
Canada	9.4	3.1
Ireland	6.2	0.3
China	6.0	15.9
Germany	5.5	6.2
Japan	5.3	8.6
Singapore	5.2	0.4
Switzerland	4.5	1.1
Brazil	3.7	4.1
France	3.7	4.7
Mexico	3.3	2.1
Australia	3.1	2.5
Netherlands	3.1	1.3
Hong Kong	2.8	0.6
Italy	2.1	3.6
Belgium	1.6	0.9
India	1.5	4.3
Spain	1.4	2.4
Korea	1.4	2.4
Russia	1.1	2.6

Note: This table presents the 20 main partner jurisdictions for US multinational companies, based on the unrelated-party revenues booked by the latter. It displays each country's share of the total foreign unrelated-party revenues of US multinational enterprises and its share of the final consumption expenditures observed in the sample. For instance, the United Kingdom is found to account for 12.3% of US multinational companies' unrelated-party revenues outside of the US and 5.3% of the total consumption expenditures of in-sample partner jurisdictions, excluding the US here too. Revenue shares are based on the IRS' country-by-country data; final consumption expenditures are sourced from the UNCTAD data portal. "UPR" stands for unrelated-party revenues.

The misbalance between each country's share of total unrelated-party revenues and final consumption expenditures is especially striking for the three low-tax jurisdictions mentioned above. While Ireland and Singapore respectively account for 6.2% and 5.2% of the worldwide unaffiliated sales of US multinational companies based on country-by-country data, both countries only represent 0.3-0.4% of the final consumption expenditures observed in the sample. Similarly, Switzerland represents 4.5% of total revenues and 1.1% of the final consumption expenditures. This table therefore underlines the disproportionate weight of a few small economies in the distribution of US multinational enterprises' sales. On the other hand, apart from specific commercial partners (e.g. the United Kingdom, Canada, Mexico or Australia), the main industrialized countries (e.g. Germany, Japan, France or Italy) display a higher share of consumption expenditures than of unrelated-party revenues. So do most emerging economies like China, with 15.9% of total consumption expenditures for only 6.0% of unaffiliated sales, or India.

Figure 4.1 facilitates the visualization of these patterns. Countries' position on the x-axis is determined by their share of final consumption expenditures, while their position on the y-axis is given by their share of total unrelated-party revenues. Without any attempt at the estimation of a rigorous model, the regression line underlines the expected relationship between both variables.

With a correlation of 0.66, a high share of global final consumption expenditures is generally associated with a high share of US multinational companies' unrelated-party revenues.

Figure 4.1: Relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures

Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the IRS' country-by-country data; final consumption expenditures from the UNCTAD data portal.

A number of countries, the dots located well above the regression line, display a share of unrelated-party revenues that is disproportionately large relative to their share of final consumption expenditures. Highlighted by the color of these dots, two main groups appear: close commercial partners of the US (with NAFTA members in green and the UK at the very top of the graph) and tax havens, based on the classification Tørsløv, Wier, and Zucman (2018). The three low-tax jurisdictions mentioned above (Ireland, Singapore and Switzerland) appear well above the regression line, as well as Hong-Kong and the Netherlands. Importantly, such a discrepancy is not observed for all tax havens: the ones that stand out are the among the largest economies of the list and are geographically close to US multinational enterprises' key markets.

These constatations highlight a key limitation of country-by-country data when it comes to sales. The three revenue variables are based on the tax jurisdiction of the affiliate that registers the transactions in its income statement, instead of the ultimate destination of the goods or the country of residence of the ultimate service beneficiary. As a consequence, country-by-country data are distorted by the use of some low-tax jurisdictions as platforms. Based in these countries, US multinational companies' subsidiaries can operate their sales remotely. Overall, the 41 tax havens listed in Tørsløv, Wier, and Zucman (2018) and the UK Caribbean Islands account for 27% of

all unrelated-party revenues registered abroad by US multinationals and for less than 6% of final consumption expenditures.

Distinguishing industry groups

This explanation of the discrepancy between unrelated-party revenues and final consumption expenditures observed in tax havens is corroborated by the analysis of the IRS' industry-specific country-by-country data. Focusing on the distribution of unrelated-party revenues for each of the sectors allows to refine our analysis of the phenomenon. Table 4.5 below describes the relative importance of the 7 industry groups based on the share of total and foreign unrelated-party revenues for which they account in 2017.

Table 4.5: Distribution of total and foreign unrelated-party revenues by sector

Industry	Share of total UPR (%)	Share of foreign UPR (%)
Manufacturing	34.4	49.3
Trade	30.4	21.7
Finance	12.8	8.5
Management	8.3	7.7
Information	8.4	6.5
Technical services	2.6	3.4
Primary	3.0	2.8

Note: This table presents the distribution of US multinational companies' total and of foreign unrelated-party revenues by sector of activity in 2017. Foreign unrelated-party revenues exclude the unaffiliated sales registered by US multinational companies in their headquarter country. "Stateless entities" are also excluded. All figures are based on the IRS' country-by-country data broken down by industry group, without any adjustment. "UPR" stands for unrelated-party revenues.

For the different industry groups, we compute the correlation between partner countries' share of foreign unrelated-party revenues and of the final consumption expenditures observed in the sample. Except for "Primary" that displays a correlation close to 0, this correlation tends to be higher for the sectors of activities that rely on tangible transactions. Typically, "Manufacturing" and "Trade" come first and second, with correlations of respectively 0.62 and 0.52; on the contrary, the lowest correlations are obtained for "Information" (0.18) and "Technical services" (0.38). In Appendix 2.1, we further present a Figure 4.1-like chart for each sector of activity. The largest distortion indeed appears for the "Information" industry, for which Ireland eloquently concentrates 28% of US multinational companies' foreign unrelated-party revenues and only 0.4% of the final consumption expenditures observed in the restricted dataset.

The US multinational enterprises whose principal activity essentially relies on intangible transactions may therefore show a greater tendency to dissociate the distribution of their revenues in country-by-country data from the distribution of their destination-based sales. This supports the idea that a substantial part of this decorrelation is related to the use, by US multinational companies, of certain (generally low-tax) jurisdictions as sales platforms. Based in these countries, their subsidiaries can operate their sales from a distance, to ultimate users and customers located in another jurisdiction.

4.2.2 Global country-by-country data

Considering now the OECD's country-by-country report statistics, restricted to the 15 headquarter countries that provide a sufficiently granular bilateral breakdown (see Table 4.1), we investigate whether some partner jurisdictions still display a disproportionate concentration of extra-group sales relatively to the size of their domestic market. For the 20 largest partner jurisdictions based on unaffiliated transactions, Table 4.6 relates their share of foreign unrelated-party revenues (i.e., excluding domestic observations) and their share of final consumption expenditures.

Table 4.6: Relationship between the 20 largest partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, including non-US multinationals

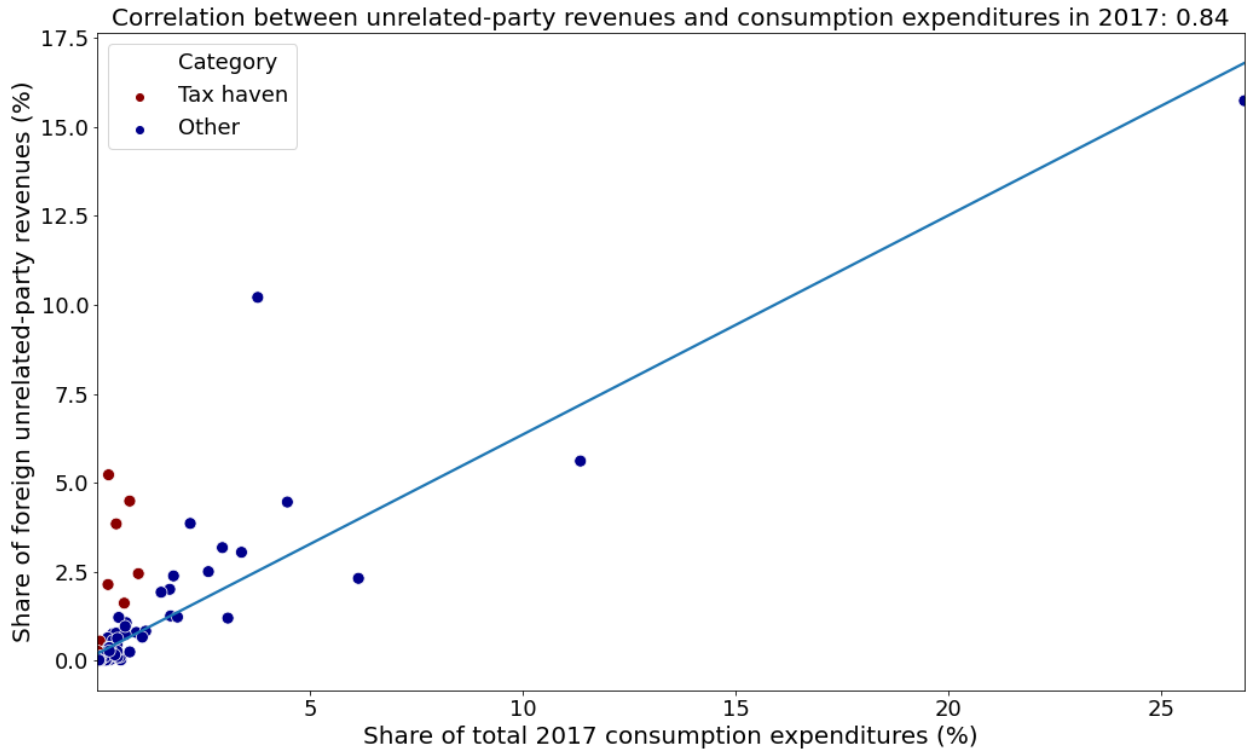| Partner jurisdiction	Share of foreign UPR (%)	Share of cons. exp. (%)
United States	15.7	26.9
United Kingdom	10.2	3.8
China (People's Republic of)	5.6	11.3
Singapore	5.2	0.3
Switzerland	4.5	0.8
Germany	4.5	4.5
Canada	3.9	2.2
Hong Kong, China	3.8	0.4
Brazil	3.2	2.9
France	3.0	3.4
Italy	2.5	2.6
Netherlands	2.4	1.0
Australia	2.4	1.8
Japan	2.3	6.1
Ireland	2.1	0.2
Spain	2.0	1.7
Mexico	1.9	1.5
Belgium	1.6	0.6
Korea	1.3	1.7
Russia	1.2	1.9

Note: This table presents the 20 main partner jurisdictions for the multinational companies headquartered in 15 parent countries, based on the unrelated-party revenues booked by the latter. It displays each country's share of the total foreign unrelated-party revenues (i.e., excluding domestic observations) and its share of the final consumption expenditures observed in the sample. For instance, the United Kingdom is found to account for 10.2% of multinational companies' unrelated-party revenues outside their headquarter countries and 3.8% of the total consumption expenditures of in-sample partner jurisdictions. Revenue shares are based on the IRS' country-by-country data; final consumption expenditures are sourced from the UNCTAD data portal. "UPR" stands for unrelated-party revenues.

Although the phenomenon is slightly mitigated, we can draw similar observations as from Table 4.4. First, the largest economies in the sample (the US, China and Japan) are attributed a very low share of foreign unrelated-party revenues relatively to their share of final consumption expenditures (respectively 16% vs. 27%, 6% vs. 11% and 2% vs. 6%). Second, while the large extra-group sales attributed to the UK and Canada can be explained by their close commercial ties with the US, both shares are more or less in line for the other large partner countries in this selection (e.g., 4.5% for both indicators for Germany, around 3% for Brazil and France or circa 2.5% for

Italy). Third, although Ireland drops in the ranking compared with Table 4.4 (from 3rd with 6% of foreign unrelated-party revenues to 15th with 2%), the weight of some low-tax jurisdictions remains particularly striking. The importance of Singapore, Switzerland and Hong Kong (with the Netherlands and Belgium to a lesser extent) in the distribution of extra-group sales seems disproportionate with respect to the size of their market, for which final consumption expenditures serve as a proxy.

Additionally, Figure 4.2 illustrates the relationship between the distribution of foreign unrelated-party revenues and final consumption expenditures for all partner jurisdictions in the sample.

Figure 4.2: Relationship between all partners' shares of foreign unrelated-party revenues and final consumption expenditures, including non-US multinationals

Note: This figure presents the relationship between partner jurisdictions' share of multinational companies' foreign unrelated-party revenues (i.e., excluding domestic observations) and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into two groups: tax havens as listed by Tørsløv, Wier, and Zucman (2018) and non-haven jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the IRS' country-by-country data; final consumption expenditures from the UNCTAD data portal.

Here too, the line of best fit underlines the expected positive correlation between partner jurisdictions' share of foreign unrelated-party revenues and their share of the final consumption expenditures observed in the sample. We retrieve patterns comparable to Figure 4.1 with a few countries standing above the regression line and showing therefore a disproportionate concentration of multinationals' extra-group sales relatively to the size of their domestic market. Many of these, indicated by the red dots on the left end of the graph, are listed as tax havens by Tørsløv, Wier, and Zucman (2018). This may indicate that the use of low-tax jurisdictions as sales platforms is not specific to US multinational companies, such tax planning practices being employed by the firms headquar-

tered in the 15 parent countries retained.[4] However, the higher correlation between extra-group sales and the macroeconomic indicator (0.84 vs. 0.66 focusing on US multinationals) may point to a lower intensity of non-US firms' tax planning practices.

Three limitations associated with these computations should however be underlined. First, the coverage of parent jurisdictions is limited and rather biased towards Europe: out of 15 headquarter countries retained, 7 are Western European economies whereas there are only 3 Asian countries. Aggregating the revenues that their multinationals record may thus yield a distorted view of the global importance of each partner jurisdiction. Beyond continental representativeness, for instance, Canada strongly benefits from the inclusion of the two other NAFTA members (the US and Mexico) in the restricted sample. Second, the retained headquarter countries do not provide the same granularity in their bilateral breakdowns. Although it is less likely when focusing on the 20 largest partner jurisdictions as in Table 4.6 in particular, some countries can sometimes be "hidden" in aggregate partners which are not considered here. Third, the correlations presented in Figures 4.1 and 4.2 may not be directly comparable due to the presence of the US among the partner jurisdictions in the latter. Indeed, with 16% of foreign unrelated-party revenues and 27% of the final consumption expenditures observed in the sample, the US is given a large weight when computing the correlation of the two series: with China, it heavily drives down the slope of the line of best fit and as these two large partner jurisdictions are located close to the regression curve, correlation is mechanically inflated. Excluding the US from the set of partner jurisdictions, we find a correlation of 0.69 between partner jurisdictions' shares of foreign unrelated-party revenues and final consumption expenditures. For these three reasons, the results presented in this section should be considered as rather indicative.

4.3 Econometric Modelling

4.3.1 Methodology

In the following, we wish to test whether the distribution of multinationals' unrelated-party revenues depends on corporate income taxation. Based on the theoretical framework of Chapter 3, should we observe that corporate income taxation affects extra-group sales, we would reject the hypothesis according to which multinationals' sales shifting practices only consist of an "artificial" relocation of profits to low-tax jurisdictions (corresponding to the first form of sales shifting, as in Section 3.3.1) and this would support our proposed dichotomy. On the contrary, extra-group sales not responding to corporate income taxation may rather justify focusing on the first form of sales shifting. As a continuation of our descriptive study in Section 4.2, still based on country-by-country report statistics, we now test this hypothesis in a more rigorous causal framework to isolate the effect of taxation on unrelated-party revenues.

To do so, we consider the general model:

$$
\begin{aligned}
ln(X_{i,j,k,t}) = {} & \beta_0 + \beta_1 Tax_{j,t} + \beta_2 ln(GDP_{j,t}) + \beta_3 ln(FMA_{j,t}) \\
& + \beta_4 ln(Dist_{i,j}) + G_{i,j,t}\gamma + FE_{i,k,t} + \varepsilon_{i,j,k,t}
\end{aligned}
\tag{4.1}
$$

$X_{i,j,k,t}$ is the dependent variable, that enters the model in logarithmic form. In most cases, it corresponds to the unrelated-party revenues (UPR) observed in country-by-country report statistics. We consider alternative targets: the number of multinationals active in the partner jurisdiction

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4. As detailed in Section 3.5.4, these observations are robust to the exclusion of the US from the set of headquarter countries.

(# MNEs), related-party revenues (RPR) or profits before tax (PBT). For all of these variables, i designates the headquarter country of the multinational groups, j stands for the partner jurisdiction where the affiliates have their tax residence, k corresponds to the main sector in which the firm is active and t is the year index.

First, we test whether corporate income tax variables, that depend on the partner jurisdiction j and on the year t, can affect the dependent variable. As a consequence, in most estimations, β_1 is the key parameter of interest. Note that $Tax_{j,t}$ can designate various measures of the partner jurisdiction's tax rate on corporate income: the statutory rate, the Effective Average Tax Rate (EATR), or the Effective Marginal Tax Rate (EMTR). Based on our theoretical framework, we either expect a coefficient not statistically different from zero or a statistically significant and negative coefficient. Indeed, on the one hand, in Sections 3.2 and 3.3.1, aggregate extra-group sales do not depend on corporate income taxation in the destination country. On the other hand, in Section 3.3.2, Equation 3.27 indicates that the higher the tax rate is in a jurisdiction, the less likely multinational companies are to set up their foreign affiliates there and thus to export from there.

The dependent variable is then assumed to depend on the Gross Domestic Product (GDP) and the Foreign Market Access (FMA) of the partner jurisdiction. These two variables are indexed with respect to the partner jurisdiction j and the year t. As we expect large and well-connected countries to be more attractive for multinational firms, we expect positive estimates for the corresponding coefficients β_2 and β_3. The dependent variable is also assumed to depend on the distance (Distance) between the headquarter country and the partner jurisdiction, that may be seen as a proxy for the fixed cost of establishing a foreign affiliate. The higher the distance between both countries, the higher this cost is expected to be and the lower aggregate revenues or profits would be: we therefore expect β_4 to be negative.

We add several gravity variables as controls. In that regard, $G_{i,j,t}$ covers: a variable equal to 1 if and only if the observation is domestic, that is if and only if i and j are the same; an indicator variable for contiguity between i and j; common language dummies; a binary variable indicating the existence of a colonial relationship between i and j after 1945; a dummy for EU membership; an indicator variable for the existence of a regional trade agreement including i and j.

Eventually, $FE_{i,k,t}$ stands for a set of standalone or interacted parent country, time and industry fixed effects introduced or not depending on the sample considered.

4.3.2 Results

We first mobilize the IRS' aggregate tabulations of country-by-country reports, available for four income years from 2016 to 2019. We are looking for the determinants of unrelated-party revenues and in particular, for the effect of the corporate tax rate on their distribution. The main results are presented in Table 4.7.

Column 1 corresponds to our benchmark. Controlling for GDP, foreign market access, distance, the full set of gravity variables and year fixed effects, we find a statistically significant relationship between the statutory tax rate and unrelated-party revenues. The coefficient associated with the statutory corporate income tax rate is negative: the higher the statutory tax rate of the partner jurisdiction, the lower the unrelated-party revenues booked there by US multinationals. More precisely, we find a semi-elasticity of unrelated-party revenues to the statutory tax rate of -2 (coefficient of -0.0203). Said otherwise, when a partner jurisdiction's statutory tax rate is raised by 1 percentage point, the unrelated-party revenues booked there by US multinationals are expected to drop by 2% (they are multiplied by $e^{-0.0203} = 0.98$). This result contradicts the hypothesis according to which the distribution of unrelated-party revenues does not depend on corporate income taxation, which would support our proposed dichotomy of multinationals' sales shifting practices.

This result is relatively robust to the use of alternative measures of the partner jurisdiction's corporate income tax rate. Instead of the statutory corporate income tax rate, we use as explanatory variable the Effective Average Tax Rate (EATR, Column 2) or the Effective Marginal Tax Rate (EMTR, Column 3). In particular, at -1.6, the semi-elasticity of unrelated-party revenues to the EATR is close to the semi-elasticity to the statutory rate. This result means that when a partner jurisdiction's average effective tax rate increases by 1 percentage point, the unrelated-party revenues booked there by US multinationals are expected to drop by 1.6%. The EMTR is associated with a semi-elasticity of lesser magnitude (-0.01), but the estimated coefficient remains negative and significant at the 95% confidence level like the coefficient for EATR.

The signs of the coefficients associated with the GDP of the partner jurisdiction, its foreign market access and its distance with the US are consistent with our expectations. The three coefficients are relatively stable across the estimations, respectively around 1.2, 0.36 and -0.52. Extra-group sales increase with GDP and the foreign market access, while they decrease with distance. For instance, when a partner jurisdiction's GDP increases by 1% holding everything else constant, unrelated-party revenues are expected to increase by 1.2%.

Table 4.7: Influence of various corporate income tax rate measures on unrelated-party revenues

	(1) ln(UPR)	(2) ln(UPR)	(3) ln(UPR)
Statutory tax rate	-0.0203*** (0.005)		
EATR		-0.0163** (0.023)	
EMTR			-0.00978** (0.028)
ln(GDP) - WOE	1.207*** (0.000)	1.204*** (0.000)	1.186*** (0.000)
ln(Foreign Market Access)	0.346*** (0.000)	0.357*** (0.000)	0.386*** (0.000)
ln(Distance)	-0.536*** (0.000)	-0.518*** (0.000)	-0.502*** (0.000)
Constant	-2.575* (0.056)	-2.706** (0.047)	-2.498* (0.063)
Gravity control variables	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	508	508	508
R-squared	0.837	0.836	0.836
Adj. R-squared	0.833	0.832	0.831

p-values in parentheses

Using robust standard errors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table presents the results of the benchmark specification, using the IRS' aggregate country-by-country report statistics from 2016 to 2019. Estimation is done via Ordinary Least Squares (OLS); time fixed effects and gravity control variables are systematically included. "UPR" stands for unrelated-party revenues, "ln(GDP) - WOE" for the logarithm of the Gross Domestic Product sourced from the IMF's World Economic Outlook, "EATR" for the Effective Average Tax Rate and "EMTR" for the Effective Marginal Tax Rate.

More generally, the tax environment of the partner jurisdiction seems to play a significant role in the distribution of unrelated-party revenues. In Table 4.8, we introduce additional variables describing partner jurisdictions' tax environment.

Table 4.8: Influence of the partner jurisdiction's tax environment on unrelated-party revenues

	(1) ln(UPR)	(2) ln(UPR)	(3) ln(UPR)	(4) ln(UPR)
Statutory tax rate	-0.0203***	-0.0182***	-0.0101*	-0.00710
	(0.005)	(0.008)	(0.085)	(0.233)
TWZ tax haven classification			1.583***	
			(0.000)	
H&R tax haven classification				1.377***
				(0.000)
TIEA enforced		1.145***	0.513***	0.957***
		(0.000)	(0.002)	(0.000)
DTC enforced		-0.0591	0.00405	-0.0631
		(0.693)	(0.975)	(0.631)
# DTC enforced / 100		0.628*	0.400	0.651**
		(0.095)	(0.181)	(0.031)
ln(GDP) - WOE	1.207***	1.152***	1.230***	1.198***
	(0.000)	(0.000)	(0.000)	(0.000)
ln(Foreign Market Access)	0.346***	0.383***	0.125**	0.189***
	(0.000)	(0.000)	(0.044)	(0.002)
ln(Distance)	-0.536***	-0.123	-0.0917	-0.0278
	(0.000)	(0.357)	(0.405)	(0.812)
Constant	-2.575*	-5.081***	-8.769***	-8.362***
	(0.056)	(0.001)	(0.000)	(0.000)
Gravity control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	508	508	508	508
R-squared	0.837	0.852	0.882	0.875
Adj. R-squared	0.833	0.847	0.878	0.870

p-values in parentheses

Using robust standard errors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table presents the results of an alternative specification, with additional variables describing partner jurisdictions' tax environment. We first introduce dummy variables indicating classification as a tax haven, either by TWZ / Tørsløv, Wier, and Zucman (2018) or by H&R / Hines and Rice (1994). Other dummy variables indicate whether the partner jurisdiction has signed a Tax Information Exchange Agreement (TIEA) or a Double Taxation Convention (DTC) with the US. Eventually, "# DTC signed / 100" corresponds to the number of DTCs signed by the partner, scaled by 100. We use again the IRS' aggregate country-by-country report statistics from 2016 to 2019. Estimation is done via Ordinary Least Squares (OLS); time fixed effects and gravity control variables are systematically included. "UPR" stands for unrelated-party revenues and "ln(GDP) - WOE" for the logarithm of the Gross Domestic Product sourced from the IMF's World Economic Outlook.

In Column 2, we first examine the effect of tax information exchange agreements and double taxation conventions on the distribution of unrelated-party revenues. We compare our estimates and their interpretation with the central results of Laffitte and Toubal (2022), who also study the effect of the broader tax environment on US multinationals' foreign to total sales ratio. First, the variable indicating whether a Tax Information Exchange Agreement (TIEA) was enforced between the US and the partner jurisdiction is associated with a large, positive and strongly significant coefficient. This differs from the observations of Laffitte and Toubal (2022), who obtain a negative relationship between the existence of a treaty of information exchange and the foreign sales ratio. Second, we find no statistically significant effect of the enforcement of a Double Taxation Convention (DTC) between the US and the partner jurisdiction on the unrelated-party revenues booked there. Laffitte and Toubal (2022) also obtain such a result, the existence of a DTC having no effect on the foreign to total sales ratio: they relate this finding to an earlier study by Blonigen and Davies (2004), who do not identify any robust impact of double taxation agreements on FDI. Third, the coefficient associated with the number of DTCs enforced by the partner jurisdiction is positive, but it is smaller than the estimate for the enforcement of a TIEA and it is imprecisely estimated. Again, this result is consistent with the findings of Laffitte and Toubal (2022), who interpret this regressor as controlling for treaty shopping opportunities. Additionally, the reduced magnitude of the coefficient associated with the statutory corporate income tax rate (from a semi-elasticity of -2 based on Column 1 to -1.8 based on Column 2) may indicate that, without controlling for them, the marginal effect initially estimated indirectly reflects other characteristics of the partner jurisdiction's environment.

When introducing a dummy for the classification of the partner country as a tax haven, be it based on the list by Hines and Rice (1994) or by Tørsløv, Wier, and Zucman (2018), the statutory tax rate seems to lose most of its explanatory power. Tax haven classification on the contrary is associated with a very large, positive and strongly statistically significant effect on unrelated-party revenues.[5] For a given statutory corporate income tax rate, holding GDP, the foreign market access, distance and all the other gravity control variables constant, unrelated-party revenues are more than 4 times higher in a tax haven than in a non-haven jurisdiction ($exp(1.5) = 4.5$). This result underlines the disproportionate weight of some low-tax sales platforms in the mapping of US multinational companies' sales and suggests that a partner jurisdiction's tax haven status encompasses a broader set of factors of attractiveness than the mere statutory tax rate. Considering the classification of Tørsløv, Wier, and Zucman (2018) in Column 3 in particular, the effect of the enforcement of a TIEA is reduced significantly (from a coefficient of 1.145 to 0.513) and that of the number of DTCs enforced by the partner jurisdiction is not statistically significant anymore at the conventional levels of confidence.

In Table 4.9, we consider other dependent variables than the unrelated-party revenues, respectively the number of US multinational companies active in the partner jurisdiction, related-party revenues and profits before tax.

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5. Laffitte and Toubal (2022) raise a somewhat similar observation when studying the determinants of the foreign to total sales ratio of US multinational companies. In their benchmark specification, increasing the statutory tax rate by 1 percentage point is expected to reduce the foreign to total sales ratio by about 0.57 percentage point, this effect being statistically significant at the 95% confidence level. When the tax haven dummy variable is introduced, the coefficient comes closer to zero (from -0.570 to -0.277) and its degree of statistical significance is reduced. On the contrary, the tax haven classification indicator is associated with a positive coefficient, statistically significant at the 99% confidence level. However, in our case, contrarily to Laffitte and Toubal (2022), it is of a completely different order of magnitude than the coefficient associated with the statutory tax rate.

Table 4.9: Effect of the statutory corporate income tax rate on various dependent variables

	(1) ln(UPR)	(2) ln(# MNEs)	(3) ln(RPR)	(4) ln(PBT)
Statutory tax rate	-0.0203***	-0.0139***	-0.0476***	-0.0458***
	(0.005)	(0.001)	(0.000)	(0.000)
ln(GDP) - WOE	1.207***	0.592***	1.189***	1.107***
	(0.000)	(0.000)	(0.000)	(0.000)
ln(Foreign Market Access)	0.346***	0.0521	0.291**	0.340***
	(0.000)	(0.184)	(0.011)	(0.001)
ln(Distance)	-0.536***	-0.266***	-1.029***	-1.100***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-2.575*	-7.857***	1.819	3.678*
	(0.056)	(0.000)	(0.380)	(0.086)
Gravity control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	508	509	500	461
R-squared	0.837	0.806	0.672	0.661
Adj. R-squared	0.833	0.801	0.664	0.651

p-values in parentheses

Using robust standard errors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table presents the results of the benchmark specification with the statutory corporate income tax rate as tax-related regressor, but varying the dependent variable. We use again the IRS' aggregate country-by-country report statistics from 2016 to 2019. Estimation is done via Ordinary Least Squares (OLS); time fixed effects and gravity control variables are systematically included. "UPR" stands for unrelated-party revenues, "# MNEs" for the number of multinational companies active in a given jurisdiction, "RPR" for related-party revenues, "PBT" for profits before tax and "ln(GDP) - WOE" for the logarithm of the Gross Domestic Product sourced from the IMF's World Economic Outlook.

First, consistently with the effect of the tax rate on the productivity threshold in our theoretical framework, we find that the number of multinationals active in a jurisdiction decreases with its statutory corporate income tax rate, this relationship being strongly statistically significant. With -0.014 in Column 2 versus -0.020 in Column 1, the corresponding coefficient is also of a smaller magnitude than the effect on unrelated-party revenues. This difference may indicate that the latter is driven not only by the extensive margin (less multinationals entering a partner country would imply lower unrelated-party revenues being booked there), but also by an intensive margin (conditional on entry, multinationals tend to record lower unrelated-party revenues in a relatively high-tax jurisdiction). Second, we find that the relative influence of the tax rate and the foreign market access is quite different for unrelated-party and for related-party revenues: while the intra-group sales are less sensitive to foreign market access than the extra-group sales (both in terms of magnitude and statistical significance of the coefficient), they react more to taxation. This is consistent with our theoretical framework in which paper profit shifting is operated via related-party transactions, organised specifically in response to corporate income tax rates. Eventually, profits before tax display a semi-elasticity to the statutory corporate income tax rate that is comparable

to the one obtained for related-party revenues. Foreign market access also seems to be a strong determinant of the distribution of US multinationals' pre-tax profits.

We estimate a large semi-elasticity of profits before tax to the statutory corporate income tax rate, around - 4.6. This result means that when a partner jurisdiction's statutory tax rate is raised by 1 percentage point, the pre-tax profits booked there by US multinationals are expected to drop by 4.6% (more precisely, they are multiplied by $e^{-0.0458} = 0.955$). Let us insist on the fact that, for several reasons, this estimate cannot be directly compared with the benchmark -0.8 or -1 semi-elasticity of pre-tax profits to corporate income tax rate differentials identified so far in the literature. We investigate these reasons based on the meta-analysis of Beer, Mooij, and Liu (2020), who find a benchmark semi-elasticity of -0.974.[6] First, as they aim at estimating the magnitude of multinationals' profit shifting behaviour, these estimates are obtained by controlling for the real economic activity of the firm in the country. We do not control for economic activity indicators in the same way, as we wish to include multinationals' real responses to taxation in our estimates. In Beer, Mooij, and Liu (2020)'s preferred specification (cf. Table 2), the absence of controls for real economic activity is associated with a positive and strongly significant coefficient of 0.454: we should thus compare our result to a semi-elasticity of at least $-(0.974 + 0.454) = -1.428$. Second, such surveys and meta-analyses have often underlined the larger semi-elasticities estimated on aggregated data rather than firm-level samples (the latter being usually considered as superior to study and size profit shifting). Still based on the Table 2 of Beer, Mooij, and Liu (2020), we should also account for the absence of firm and country fixed effects and for the use of macro-level data: this gives a benchmark semi-elasticity of $-(1.428 - 0.211 + 0.472 + 1.082 + 0.354) = -3.125$. Our own estimate thus comes closer to the benchmark order of magnitude. Third, Beer, Mooij, and Liu (2020) identify a positive effect of time on estimated semi-elasticities: for instance, they find that a value of around -1.5 would apply in 2015, versus -1 in their benchmark. Our sample being very recent, from 2016 to 2019, time may also play a role in explaining the large semi-elasticity that we estimate. Fourth, we focus on US multinational companies, which are known to be particularly tax aggressive, while literature surveys may include non-US parent countries.

4.3.3 Complementary remarks

Non-linear relationship

In Table 2.1 in the Appendix, we highlight the non-linear relationship between the corporate income tax rate and unrelated-party revenues, which appears in particular with the statutory tax rate (Column 1). The relationship between unrelated-party revenues and the statutory tax rate would actually involve a second-order functional form, rather than the constant semi-elasticity identified so far. With this additional specification, we find that the negative effect of a 1 percentage point increase in the statutory rate on unrelated-party revenues is larger when the tax rate is small. For instance, with an increase in the tax rate from 5% to 6%, unrelated-party revenues are expected to change by roughly $-0.0769 + 2 * 5 * 0.00138 = -0.0631 = -6\%$ versus $-0.0079 = -0.8\%$ with an increase from 25% to 26%. This result echoes the findings of Dowd, Landefeld, and Moore (2017) and Bratta, Santomartino, and Acciari (2021), who study the non-linear response of pre-tax profits to the tax rate, based on firm-level data.

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6. Beer, Mooij, and Liu (2020) instead discuss semi-elasticities in absolute values (i.e., 0.974 in their benchmark). We align their findings with our own results by considering negative semi-elasticities, but the interpretation is fundamentally the same.

Alternative samples

Alternatively, we consider the IRS' split of US country-by-country report statistics per industry group. The specification is close to our benchmark, but we introduce Sector x Year fixed effects to control for unobserved characteristics. Results are presented in Table 2.2 in the Appendix. We find a weakly significant negative relationship between the unrelated-party revenues and the statutory tax rate and we cannot reject the nullity of the coefficient associated with the EATR. However, when allowing for a non-linear functional form by adding the squared statutory tax rate to the set of regressors, we obtain estimates that are closely comparable to the first column in Table 2.1. Additionally, Tables 2.3 and 2.4 apply the benchmark models in each industry group sub-sample. In Table 2.4, when we allow for a non-linear relationship, we find that the unrelated-party revenues respond to the statutory tax rate in four industry groups: "Information", "Technical services", "Manufacturing" and "Finance" (although at a lower statistical significance level for the latter).

Eventually, we consider similar regressions on the third sample, that is the OECD's tabulated country-by-country report statistics. All industry groups are aggregated and we only consider the parent countries that report 60 unique partner jurisdictions or more, which results in a bilateral sample of country-by-country data with 15 headquarter countries. We introduce Parent country x Year fixed effects to control for unobserved characteristics. However, possibly due to the limited time coverage of the dataset (two income years only, 2016 and 2017), this additional analysis does not allow to conclude on the response of unrelated-party revenues to the corporate income tax rate for other headquarter countries. Results are presented in Table 2.5 in the Appendix.

Potential selection bias

Although they provide a granular bilateral breakdown (145 unique partner jurisdictions), the IRS' aggregated country-by-country report statistics are restricted to the set of countries where a sufficient number of US multinational companies are active. Two cases arise for a partner jurisdiction to be absent from the dataset: either the jurisdiction does not host the tax residence of any affiliate, in which case there is simply no information to include in the data, or the number of active multinational companies is so low that the aggregated country-by-country report statistics would break taxpayers' confidentiality, in which case information is aggregated at the continental level (under "Other Africa", "Other Europe", etc.). Said otherwise, the location decision of multinational companies and thus, the extensive margin that drives the geographical distribution of their unrelated-party revenues determine selection into the sample.

The fact that we do not control for the number of active multinational companies in our benchmark model corresponds to the hypothesis that we test following our theoretical framework, but this form of endogenous selection may bias our estimates and question our conclusion. More rigorously, we may want to estimate a Heckman selection model, in which a first-stage model would determine selection into the sample (reflecting whether or not there are enough active multinational companies active in the jurisdiction) and a second-stage model would then estimate the effect of taxation on unrelated-party revenues while accounting for selection. First experiments were run in that sense, but it remains difficult to construct a convincing exclusion restriction.

Chapter 5

Policy Implications

In this chapter, we provide tools to analyse the implications of our findings and proposed dichotomy for policy-makers. Section 5.1 briefly highlights why such a distinction in the sales shifting practices of multinational companies is relevant for the regulator. Then, in Section 5.2, we present the adjustment of country-by-country revenue variables that we develop to reflect the final destination of the transactions, rather than the location of multinational companies' sales platforms.

5.1 Discussion

In Chapters 1 and 3, we introduce a dichotomy between two types of sales shifting practices for multinational companies. On the one hand, multinational companies can "artificially" concentrate their sales in low-tax jurisdictions, generally by manipulating their intra-group transactions. On the other hand, multinational companies' real activity also responds to corporate taxation, via location choices for instance: as they may find it optimal to set up their export platforms in relatively lower-tax jurisdictions, the distribution of extra-group sales is also endogenous to taxation. We highlight two implications of this distinction for policy-makers and a key shortcoming of the data sources generally used to analyze these issues.

First, the acceptability of these two forms of sales shifting may be very different for the regulator. Indeed, the disconnection between the geographical distribution of corporate income and multinational companies' real economic activity is often pointed at as an "abnormal" phenomenon and has motivated stricter regulations of profit shifting practices. For instance, this notion of disconnection is part of the OECD's definition of BEPS or of the explicit objectives of Pillar One.[1] The view that the effective taxing rights over multinational companies' profits should be linked more closely to their revenue-generating activities (or to the more challenging concept of value creation) through new multilaterally agreed rules has gained a strong political momentum over the last decades. But some forms of sales shifting are not necessarily associated with such a disconnection. Let us consider the case of a multinational company that, as in the Panel C of Figure 3.1, sets up an affiliate in a foreign jurisdiction, where it benefits from various corporate income tax reliefs: production takes place locally and the goods are exported from the low-tax jurisdiction to unaffiliated entities in the markets eventually served. The location of the activities is partly motivated by tax planning purposes and therefore, the firm operates the second form of sales shifting; sales are

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1. See the press release associated with the October 2021 joint agreement: "It will re-allocate some taxing rights over MNEs from their home countries to the markets where they have business activities and earn profits, regardless of whether firms have a physical presence there" (https://www.oecd.org/tax/beps/international-community-strikes-a-ground-breaking-tax-deal-for-the-digital-age.htm)

concentrated in a relatively low-tax jurisdiction, but there is no disconnection of corporate income and productive activities. Regulators' perception of similar tax planning practices is likely to differ from the treatment of pure paper profit shifting operations.

Second, regulations may be more or less effective to hinder the different forms of sales shifting practices. Typically, the 15% global minimum tax as per the OECD's and the G20's Pillar Two would not affect each tax planning margin to the same extent. The first type of sales shifting practices induces a disproportionate concentration of profits in some jurisdictions relatively to the real economic activity occurring there. The Pillar Two global minimum tax would thus fully apply to such low-taxed income, imposing an effective tax rate close to 15%. Oppositely, pursuing the example given above for the second form of sales shifting practices, if profits are booked in the jurisdiction where production takes place and from which goods are exported, the substance-based income exclusion could shield the low-taxed income from the 15% minimum rate. Indeed, in the first year of implementation of the new rules, 10% of the local payroll expenses and 8% of tangible fixed assets will be carved-out from the tax base to which top-up taxes apply. Even ex post the minimum tax, the profits booked in the export platform could be taxed at an effective rate well below the 15% threshold.[2] That being said, depending on the goals set by policy-makers, other forms of regulation would more likely curtail both tax planning margins. For instance, Pillar One aims at attributing taxing rights over multinational companies' income to market jurisdictions, where final consumers or users are located. Even if these firms concentrate their production and sales in a few low-tax export platforms, taxation would still occur in downstream jurisdictions, making such location choices irrelevant for tax planning purposes. If market size and the location of potential customers are exogenous to multinational companies' decisions, adopting this criterion to allocate taxing rights would lead to minimal distortions. In practice however, the proposal would only apply to a portion of a few large and very profitable multinational companies' profits.[3]

The empirical analysis of Pillar One-like regulations that involve an apportionment of the taxing rights based on revenue-generating activities or more broadly on value creation is limited by the absence of statistical sources on multinational companies' destination-based sales. For instance, Kadet et al. (2021) propose to introduce a Minimum Effective Tax Rate (METR) for multinational companies. For a given effective tax rate threshold, the idea first consists in identifying firms' "non-effectively taxed" profits (NETs) in each jurisdiction where they are active. NETs are then summed at the group level and the taxing rights over these profits are allocated among the jurisdictions in which the multinational has a taxable presence, based on employees, assets and destination-based extra-group sales. Eventually, each taxing country can apply its own corporate tax rate over its share of the aggregated NETs. To simulate the distributive effects of this proposal, the authors rely on the profit, turnover, tangible assets and payroll matrices prepared in OECD (2020). Kadet et al. (2021) underline two limitations of these data for turnover, which are notably based on country-by-country report statistics: not only do they include intra-group transactions, but "sales revenues are [also] attributed to the recipient entity, and do not reflect the sourcing rules developed for Pillar One". In the following, we describe a possible methodology to adjust the country-by-country revenue variables and approximate a destination-based distribution of extra-group sales. The data, code and results are made widely available to facilitate the use of this new database for tax reform simulations and policy analysis (for an application to tax reform simulations, see Appendix 3.6).

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2. See Devereux et al. (2021) and Becker and Englisch (2021) for a further discussion of the substance-based income exclusion (or "carve-outs"). Baraké et al. (2021b) integrate these tax base deductions in their revenue estimates.

3. Beyond technical difficulties, the recent slowdown of the multilateral negotiation process around Pillar One relatively to Pillar Two may hint at the acceptability criteria of policy-makers and their preference for tax competition regulation.

5.2 Adjusted Country-by-Country Data

5.2.1 Data

In this section, we describe the data sources on which the adjustment of country-by-country revenue variables relies. Country-by-country report statistics are discussed in Section 4.1.1 above.

Data on the activities of US multinational enterprises

First, we leverage data provided by the Bureau of Economic Analysis (BEA) on the worldwide activities of US multinational companies (see BEA (2016-2019a)). These statistics compiled since 1977 give an annual overview of the finances (balance sheet details, aggregated income statements. . .) and operations (destination of goods and services supplied, employee compensation, capital expenditures. . .) of US multinational companies and their foreign affiliates.

In particular, we focus on the BEA's revised statistics from 2016 to 2018 and preliminary statistics for 2019 related to the majority-owned affiliates of US multinationals.[4] Tables II.E1 to II.E17 provide detailed information on the "goods and services supplied" by US multinationals. These can be assimilated to sales but their scope is narrower than that of revenue variables in country-by-country data. The precise definitions of goods and services supplied can be found in Appendix 3.1.1 of the present report.

For 75 partner jurisdictions (of which 18 regional aggregates) where they operate, Table II.E2 allows to split the sales registered by the majority-owned affiliates of US multinational companies based on their ultimate destinations. Total goods and services supplied are first provided in millions of current USD. These are then split between sales to the US and sales to foreign countries. The latter amount is again distributed between sales to the host country (where the affiliate is active) and sales to any other country. Eventually, all aggregates are split between sales to affiliated companies and sales to unrelated parties. The schema in Appendix 3.1.2 summarizes this series of disaggregations.

These data allow to shed light on the issue mentioned above for country-by-country data. The total goods and services registered by the majority-owned affiliates of US multinational enterprises in a given jurisdiction are not all directed to the host country. On average in 2017, 59% of the goods and services supplied are attributed to the host country, with respectively 12% and 29% of sales directed to the US and to any other country. This ratio of goods and services supplied to the host country to total goods and services supplied strongly varies from a partner jurisdiction to another: the minimum is of 6% for Barbados and the maximum of 96% for Venezuela. These differences highlight the use by US multinational companies of certain countries as platforms, where only a limited share of sales is actually directed to the local market.[5]

For most partner countries, they also allow to distinguish sales to affiliated and to unaffiliated entities. On average, related-party sales account for 30% of the total revenues. Here too, the global average hides substantial heterogeneity: 57% of the sales registered in Barbados are associated with intra-group transactions, while it is the case for only 7% of the sales recorded in Chile.

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4. Most of the descriptive statistics of the following paragraphs are presented for the 2017 income year to align them with the latest income year available in the OECD's country-by-country report statistics.

5. Laffitte and Toubal (2022) define the "foreign sales ratio" as the ratio of the foreign sales (to the US or to any other country) to the total sales registered in a given jurisdiction: this variable then constitutes the key objective of their empirical analysis.

Trade statistics

Second, to distribute the sales that are ultimately directed to any country other than the host jurisdiction and the US, we use bilateral trade statistics. More precisely, we combine the UN Comtrade database for merchandise flows (see United Nations (2016-2019)) and the Balanced Trade in Services (BaTIS) dataset for service flows (see OECD-WTO (2016-2019) and Liberatore and Wettstein (2021)). The latter analytical statistics were designed so as to correct for recurrent asymmetries in international trade data.

On the one hand, the UN Comtrade database constitutes the reference statistical source for customs-based merchandise trade flows (see United Nations (2016-2019)). These data follow the United Nations (2011) standard and reflect the physical cross-border movement of goods. We download the relevant data from the UN Comtrade online portal.[6] For the year 2017, focusing on imports, the resulting dataset involves 234 unique partners and 169 unique reporters while, on average, each reporter is associated with 167 partners.

On the other hand, BaTIS data cover 206 reporting countries, from 2005 to 2019. For each pair of reporting and partner countries, several information are available. First, one can choose between the exports from the reporting country to the partner jurisdiction and imports by the former from the latter. Second, several values are proposed: the reported amount, additional estimates and a "final balanced value" that aims at correcting for bilateral asymmetries. Last, these data are available for a wide range of service categories. All amounts are presented in current USD. For the year 2017, considering exports, final balanced values and commercial services, the dataset covers 201 unique partner jurisdictions and on average, each reporting country is associated with 200 destinations.[7]

Important considerations regarding the choice of trade statistics are detailed in Appendix 3.2. More details are also provided about how we prepare and combine the two datasets (for merchandise and service flows).

Auxiliary data sources

First, as an alternative to the UN Comtrade database on merchandise flows, the code for the adjustment allows to use the OECD's Balanced International Merchandise Trade Statistics (BIMTS, see OECD (2016-2019a) and Fortanier and Sarrazin (2016)). BIMTS cover over 160 reporting countries. For each of these, the dataset provides its "Balanced Trade Value", i.e. its exports corrected for bilateral asymmetries, to a variety of partner countries in current USD. Data are available for 12 years, from 2007 to 2018, and a wide variety of commodity categories. In 2017, focusing only on the total of all commodities, the dataset covers 162 unique partners and on average, each reporting country is associated with 135 destinations.

Second, as an alternative to the UN Comtrade and BaTIS databases specific to the US, the code for the adjustment also allows to use the US International Transactions Accounts (ITAs) maintained by the BEA. In particular, the current account in these quarterly statistics theoretically records the

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6. The process followed to collect these data is described in details in this online repository: https://github.com/pechouc/comtrade_data_selection.

7. In the work of Liberatore and Wettstein (2021), the most extreme differences between reported trade values and final balanced values are observed for Bermuda. The balanced exports of services of Bermuda are 41 times larger than its reported exports, meaning that other countries register much larger imports of services from Bermuda than Bermuda does in its exports. Similarly, the balanced imports of services of Bermuda are 18 times larger than its reported imports, meaning that other countries register much larger exports of services to Bermuda that Bermuda does in its imports. To some extent, the same appears for the Cayman Islands and Barbados. For these countries, we therefore rely on the values reported by their partners: for their exports, we take partner countries' reported imports from Bermuda, the Cayman Islands and Barbados and their imports correspond to partner countries' reported exports.

exports of goods and services from US residents to non-residents based on changes in ownership. On the data portal of the BEA, we focus on Table 1.5 "U.S. International Trade in Goods and Services by Area and Country" (see BEA (2016-2019b)). From 1999 to 2020, it provides several indicators that break down by sector and nature of transactions the US exports and imports of goods and services to and from 90 partners. The latter include 18 continental aggregates or regional organizations and 72 destination countries (UK Caribbean Islands being aggregated as a single partner jurisdiction). Appendix 3.2.2 provides a more detailed discussion of the strengths and weaknesses of these data for the purpose of our computations.

Third, in the extension of our adjustment to non-US multinational companies, we mobilize the OECD's Analytical AMNE database, compiled by Cadestin et al. (2018). In particular, we focus on the information that these statistics provide on the activities of domestically-owned companies.[8] These data cover a sample of 60 countries from 2005 to 2016 and include estimations of the gross output, gross value-added, exports and imports of domestically-owned firms. Importantly, they allow to distinguish the domestic branches of multinational companies and purely local firms. In the absence of more recent data, we concentrate on 2016 figures and assume that they remain valid for the following years.

5.2.2 Methodology

In this section, we broadly present the methodology used to adjust the revenue variables in country-by-country data, based on the ultimate destination of the sales. More details can be found in the appendix (Chapter 3), to which we refer when relevant. We first describe the methodology employed for US country-by-country report statistics and then present the tentative extension to other headquarter countries in Paragraph 5.2.2.

Splitting revenues intro three types of sales

The first step consists in splitting each of the three revenue variables ("Unrelated party revenues", "Related party revenues" and "Total revenues") in three different amounts: sales directed to the host country, sales directed to the US and sales directed to any other country.

We start by reorganizing the BEA data on the destination of the goods and services supplied by the majority-owned affiliates of US multinational firms, following the schema of Appendix 3.1.3. For each partner jurisdiction present in this dataset, we then have: the totals of sales to affiliated partners, to unaffiliated partners and to all partners, split across three types of final destination of the transaction. We can compute the relative share of each type of destination (the US, the host country or any other country) in unaffiliated, affiliated and total sales.

Excluding US-US sales, 86 partner jurisdictions in the IRS' data are absent from BEA statistics, accounting for 4% of all foreign total revenues. Plus, for some countries, the BEA data are incomplete and do not allow to properly split unaffiliated and affiliated sales based on their destination. For these, we impute the relevant shares at the level of the corresponding continent (Africa, Americas, Asia-Pacific and Europe).

Appendix 3.1.4 gives a detailed example of these computations for one of the partner jurisdictions present in the IRS and the BEA datasets.

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8. See OECD (2016) and, more specifically, the file "analytical_amne_domesticMNEs.xlsx" that can be downloaded from the OECD's website.

Already attributed sales

Combining the three revenue variables of the IRS' country-by-country data with the relative shares computed from BEA statistics, we obtain a split of unrelated-party revenues, related-party revenues and total revenues in three types of ultimate destination: the US, the host country and any other country.[9] Unrelated-party revenues, related-party revenues and total revenues directed to the US or to the host country (i.e., to the partner jurisdiction in the IRS dataset) are associated with their ultimate destination. They can already be considered as destination-based sales.

Distributing sales to third countries

We use trade statistics to distribute the sales that are not directed towards the US, nor towards the host country (where the affiliate is active).[10]

For each partner jurisdiction in the IRS' country-by-country data, we have a distribution of its exports or a proxy for it. Two remarks are in order. First, in all these cases, we eliminate the US from export destinations: the sales that are ultimately directed to the US have already been attributed using BEA data. Second, for each reporting country, we eliminate from the distribution of exports the destinations that represent less than 0.5% of total transactions. We indeed assume that US multinationals are not likely to operate such niche operations and rather attribute them to domestic firms.

We use this distribution to estimate the ultimate destinations of unattributed sales. For instance for France, unrelated-party sales to other countries amount to 21.2 billion USD in 2017; Germany representing 15% of French exports, we conclude that US multinationals register 3.2 billion USD of sales via their French subsidiaries that are ultimately directed to Germany.

The case of US-US sales

So far, we have estimated a destination-based mapping of the sales registered by US multinationals via their affiliates in foreign partner jurisdictions. BEA data allowed to split each revenue variable of the IRS' country-by-country data in three categories and unallocated sales were distributed thanks to trade statistics.

However, Table II.E2 of BEA data on the activities of US multinationals does not allow to distribute the revenues registered by US multinationals directly in the US, that may actually be associated with exports and be ultimately directed to other, foreign countries. Instead, we use Table I.O1 that describes the sales of US parents based on their destination and type for each sector of activity. Without allowing to distinguish between unrelated-party and related-party revenues ("U.S. persons" are not split between intra- and extra-group transactions), we find that 12% of total US-US sales are in fact directed to another country in 2017.

We can therefore split the three US-US revenue variables between local operations and exports. The former are already associated with their ultimate destination and consistently with the methodology detailed above, we use trade statistics to distribute the latter. Besides, we exclude destinations that represent less than 0.5% of US exports of services, the absence of such a restriction producing disproportionate adjustments for small economies.

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9. From then on, the total revenue columns do not match the sum of the corresponding unrelated-party and related-party revenue columns. It is the case in the original country-by-country data of the IRS, but we have computed from BEA statistics and applied different percentages to distribute each of the three revenue variables.

10. The selection and preparation of trade data are presented in Appendix 3.2.

Tentative extension to non-US multinationals

As explained in Section 4.1.1, in the OECD's country-by-country report statistics, the granularity of bilateral breakdowns strongly varies among the 38 parent jurisdictions. Excluding those that only provide a split between domestic and foreign activities, we could apply our methodology to the remaining 34 headquarter countries. Based on continental averages, we can split the revenues attributed to aggregate partners and distribute them to hypothetical destinations, but this involves substantial approximation. Therefore, in the benchmark extension of the computations to non-US multinationals, we focus on the 15 parent jurisdictions that report at least 60 unique partners in their country-by-country reports. They are listed above, in Table 4.1, with their respective number of partner jurisdictions.

We now describe the methodology used to adjust the revenue variables reported by the 14 non-US parent jurisdictions. We start by splitting the revenue variables into local and foreign sales. This differs from the adjustment of US multinational companies' revenues, as the BEA's data allowed to distinguish three types of transactions: local sales, sales directed to the US and sales directed to any other country. We extrapolate the information provided by the BEA, assuming that the split between local and foreign sales observed for US multinationals also holds for non-US companies. For instance, in 2017, 71% of the total sales of goods and services registered in France by US multinationals were associated with local transactions, while 4% were directed to the US and 25% to a third country. From there, we assume that the total revenues booked by, say, German multinationals in France are split between 71% of local sales and 29% (4% + 25%) of foreign sales. As for the adjustment of US revenue variables, using the BEA's data, we can apply different shares for unrelated-party, related-party and total revenues.

We apply a specific methodology for the domestic observations and mobilize the Analytical AMNE database of the OECD (see OECD (2016) and Cadestin et al. (2018)). Taking the example of Spain, these data suggest that using the split observed in the BEA's data, which would attribute 38% of the revenues booked in Spain by Spanish multinational companies to foreign destinations, could under-estimate the importance of domestic sales. Indeed, exports only account for 18% of the local gross output of Spanish multinationals in 2016 according to the Analytical AMNE database. We therefore split domestic revenues based on these statistics rather than by applying the local sales percentages of US multinational companies. This however comes with limitations: we have only one split for unrelated-party, related-party and total revenues; the latest statistics in the Analytical AMNE database correspond to the 2016 income year, while we take 2017 as benchmark in country-by-country report statistics.

From there, local sales are already associated with their final destination and sales generated abroad are allocated to their approximated final destinations using the same trade statistics as for US multinational companies' revenues.

5.2.3 Assessment

Section 3.4 of the Appendix provides a detailed assessment of our proposed adjustment. Building upon the descriptive statistics of Section 4.2, we mainly evaluate its effect on the weight of low-tax sales platforms and the extent to which it improves the consistency of unrelated-party revenues with market size indicators. We briefly summarize these results in the following.

First, we consider the impact of the adjustment on US multinational companies' largest partner jurisdictions. Compared with Table 4.4, the highest-ranking countries have been recomposed, especially in favor of NAFTA members (Canada moving from second to first, Mexico from eleventh to sixth), the largest economy of the sample (China moving from fourth to third) or France (from

tenth to seventh). Oppositely, smaller low-tax jurisdictions like Ireland, Switzerland and Singapore then display revenue shares that are more in line with the size of their economies. Figure 5.1 illustrates this evolution for all partner jurisdictions. The correlation between unrelated-party revenues and final consumption expenditures has increased substantially: before the adjustment, it was of 0.66 and it reaches 0.79 after the destination-based adjustment.

Figure 5.1: Post-adjustment relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures
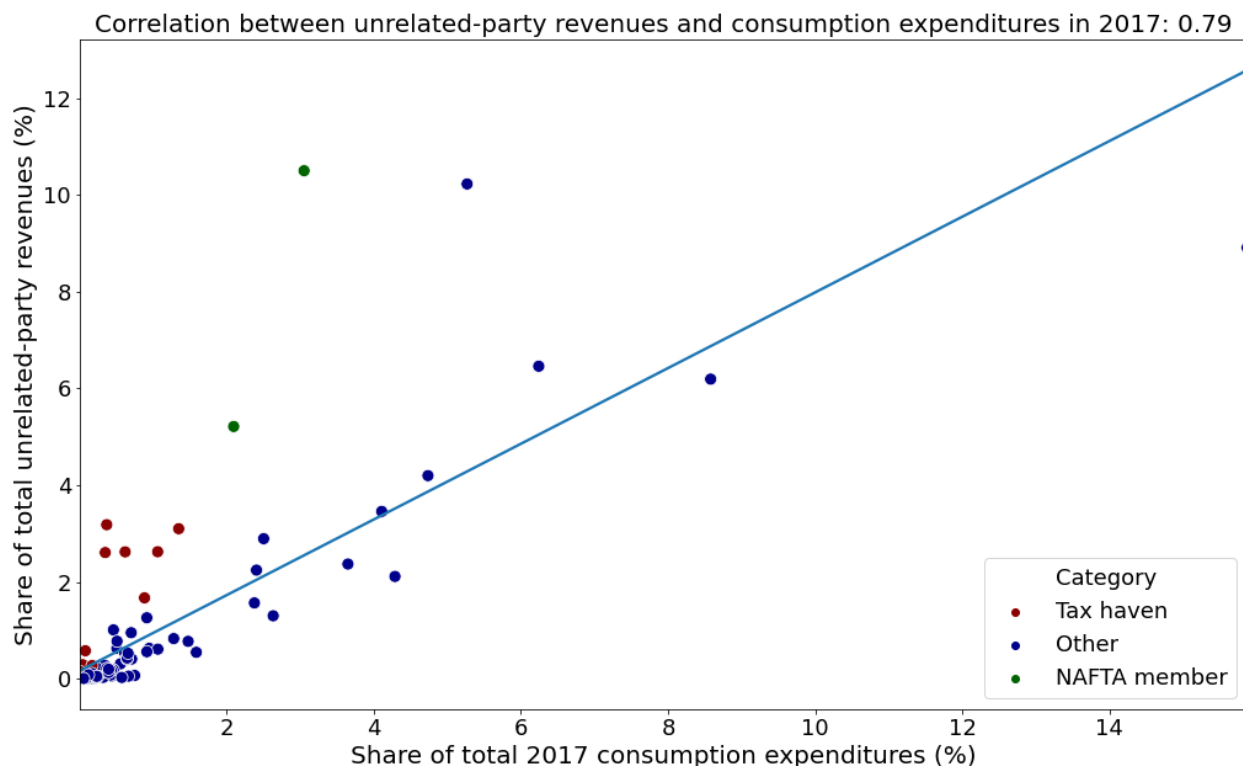
Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of final consumption expenditures. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the adjusted country-by-country data; final consumption expenditures from the UNCTAD data portal.

Second, except for one non-haven country, all of the 10 largest losers from the adjustment are listed as tax havens by Tørsløv, Wier, and Zucman (2018). Focusing more specifically on the evolution of these jurisdictions, we find that their aggregate weight moves from 27% of foreign unrelated-party revenues in the IRS' country-by-country report statistics to 18% in the adjusted mapping of sales. Most of the tax havens listed by Tørsløv, Wier, and Zucman (2018) in our sample (24 out of 29) see their unrelated-party revenues decrease. These results, which are broadly robust to the inclusion of non-US multinationals, corroborate the idea that the adjustment operates a re-balancing of extra-group sales from potentially low-tax sales platforms to other, larger economies where ultimate consumers and users are more likely to be found.

In Section 3.4.6 of the Appendix, we discuss the potential limitations of the destination-based adjustment, while Sections 3.5 and 3.7 provide a series of robustness checks.

Chapter 6

Conclusion

In this work, we document the sales shifting practices of multinational companies and gather evidence in favor of a dichotomy between "paper" or real sales shifting. In Chapter 3, we illustrate this conceptual distinction in a new theoretical framework, from which we deduce our empirical strategy. The responses of intra-group transactions to corporate income taxation identify the first form of sales shifting practices, while an effect on extra-group sales would correspond to "real" sales shifting. In Chapter 4, to justify our proposed dichotomy, we thus test for the potential influence of corporate income taxation on the distribution of multinational companies' unrelated-party revenues. Simple descriptives based on aggregated country-by-country report statistics highlight the concentration of unrelated-party sales in tax havens (27% of the foreign total in US data, 21% when including other headquarter countries), which is disproportionate relatively to the size of local markets (less than 6% of final consumption expenditures). Controlling for market size and partner countries' foreign market access, we find a semi-elasticity of unrelated-party revenues to the local statutory corporate income tax rate of -2 (i.e., a one percentage point increase in the tax rate is associated with a 2% reduction in extra-group sales). We therefore reject the hypothesis according to which only multinational companies' intra-group transactions respond to taxation: these findings corroborate our initial conceptual distinction. This dichotomy has important policy implications, that we analyse in Chapter 5. To foster further research and reform simulations in this direction, we develop an adjustment of country-by-country revenue variables aimed at reflecting the final destination of the transactions. These results would likely benefit from further refinement, and we highlight three directions in which future work could be pursued.

Building upon the Melitz (2003) and Chaney (2005) general equilibrium model of trade, our theoretical framework could account for both the shifting practices of multinational companies and their real responses to taxation. Combining these two phenomena is key to provide accurate policy recommendations and as recently underlined by Beer, Mooij, and Liu (2020), little is known so far about how these two tax planning margins interact.[1] However, when introducing multinational companies' location decision and the possibility to set up export platforms, we lose tractability, which hinders the capacity of our model to generate relevant insights. Further work may allow to connect this theoretical framework to the literature on export platforms. In particular, Tintelnot (2016) extends major models of trade and achieves tractability by considering each firm as a continuum of products, with product-location-specific productivity draws. Extending the resulting model with corporate income taxation could be a possibility to circumvent computational issues.

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1. Beer, Mooij, and Liu (2020): "There is little attention in the literature on the interaction between profit shifting and the reallocation of real activities by MNCs. Existing research has focused largely on quantifying either the scale of profit shifting or the impact of taxes on the location of FDI. Yet, profit shifting may interact with investment and thus have complex and unexpected welfare implications, with important policy implications".

We then study the impact of corporate income taxation on the distribution of multinational companies' unrelated-party revenues in aggregated country-by-country report statistics. Using these data may involve a sample selection issue, as partner jurisdictions with no or too few active multinational companies are excluded: the location decision of multinational companies and thus, the extensive margin that drives the geographical distribution of their revenues are endogenous to selection into the sample. In principle, a first approach to cope with this issue would consist in verifying the robustness of our findings to the use of firm-level country-by-country reports. Some researchers have had access to these data, but the opportunities remain limited. Another approach could be related to the way previous studies have dealt with zeros in trade matrices. For instance, Rubinstein, Helpman, and Melitz (2008) develop a Heckman-based procedure with a first stage that accounts for selection into trade partners and a trade flow equation in the second stage. In our case, the first stage would reflect whether there is a sufficient number of multinationals active in the jurisdiction for it to be recorded in country-by-country report statistics and the second stage would then provide a de-biased estimate of the effect of corporate taxation on unrelated-party revenues. The challenge however lies in the construction of a credible exclusion restriction.

Eventually, regarding our proposed adjustment of country-by-country report statistics, additional work remains to make the resulting database readily accessible. Refining the documentation of the code, developing flexible accesses to the data and preparing additional visualisations could allow to foster further research or reform simulations. Drawing attention to this adjusted database may also be a way to collect feedback and improve upon the current limitations of the computations. As a consequence, in the short to medium term, we aim at releasing an online Application Programming Interface (API) that will give access to the adjusted country-by-country revenue variables, as well as a dedicated visualisation platform.

Chapter 7

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