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Tax Avoidance and the Complexity of Multinational Enterprises

Manon Francois & Vincent Vicard

Highlights

- We investigate whether the complexity of the ownership structure of multinational enterprises facilitates profit shifting.
- We use firm-level cross-country data.
- Affiliates belonging to more complex MNEs are more likely to bunch around zero profit, which is consistent with complexity enabling tax avoidance by multinationals.
- Only the more complex MNEs shift profits away from their high-tax affiliates, while MNEs with flat ownership structures do not display such pattern.

RESEARCH AND EXPERTISE ON THE WORLD ECONOMY

Abstract

Does the complexity of the ownership structure of multinational enterprises' (MNEs) serve tax avoidance? We use firm-level cross-country data to show that affiliates belonging to more complex MNEs are more likely to bunch around zero profit, which is consistent with complexity enabling tax avoidance by multinationals. Our results show that only the more complex MNEs shift profits away from their high-tax affiliates, while MNEs with flat ownership structures do not display such pattern.

Keywords

Complexity, Firm organization, Multinational enterprises, Profit shifting, Tax avoidance.

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RESEARCH AND EXPERTISE ON THE WORLD ECONOMY

Tax avoidance and the complexity of multinational enterprises[1]

Manon Francois* and Vincent Vicard†

1. Introduction

Multinational enterprises (MNEs) organize their production through a network of tens or even hundreds of affiliates located in different countries. While MNEs and their foreign affiliates are a building block of global value chains and account for a large share of international trade and production,[2] little is known about how MNEs organize the ownership of their network of affiliates and its consequences.

MNEs may implement a flat ownership structure in which the headquarter holds affiliates directly, or more complex structures involving chains of ownership in which subsidiaries are owned by intermediaries that may be located in different countries.[3] The choice of ownership structure is shaped by the organization of production, i.e. the industry diversification of the MNE, its geographic footprint or the degree of fragmentation of its production process and its outsourcing decisions. It also reflects other determinants including internal financing, expropriation risks, past M&A history or tax motives (UNCTAD, 2016).[4] Notably, descriptive evidence shows that conduit entities in offshore financial centers or tax havens are central to complex ownership structures.[5]

In this paper, we posit that a complex ownership structure may serve tax avoidance and investigate whether being part of more or less complex MNEs affects profit shifting between subsidiaries. MNEs minimize their overall tax liabilities by shifting profits from high to low-tax subsidiaries using three main instruments: the manipulation of their transfer prices in trade in goods, debt shifting and the location of intangibles in

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[2]UNCTAD (2016) underline that less than 1% of MNEs have more than 100 affiliates, but these MNEs account for almost 60% of global MNE value added.
[3]Alabrese and Casella (2020) find that the country of location of the direct and ultimate owners differs for 40% of foreign affiliates, involving complex ownership structures with investment chains crossing borders.
[4]Lewellen and Robinson (2014) find that 51% of US multinationals have a flat ownership structure and 39% a highly complex one, but observable firm characteristics, such as size, age, industry, or diversification, explain only up to 37% of the variation in complexity across firms.
[5]Garcia-Bernardo et al. (2017) show how different offshore financial centers (OFCs) are used in complex structure of multinationals' ownership as conduit or sink for locating capital and revenues. Phillips et al. (2020) distinguish two types of affiliates in OFCs, stand-alone and in-betweeners, the later having control of a large share of the network of affiliates and allowing for aggressive tax planning strategies. See also Damgaard et al. (2019) and Delatte et al. (2022) for evidence of the role of tax havens as intermediaries using FDI data.

tax havens and export of associated services.[6] These instruments however do not require specific forms of ownership and can occur between any two affiliates of the MNE, directly or indirectly related. The organization of the ownership structure of the subsidiary network can however further support tax avoidance once profits have been shifted to low-tax affiliates. More complex structures facilitate tax treaty shopping through the use of intermediaries in conduit countries (Van't Riet and Lejour, 2018; Hong, 2021) or the use of hybrid financial instruments to reduce tax liabilities (Johannesen, 2014; Hardeck and Wittenstein, 2018), allowing to design tax-minimizing routing of dividends from subsidiaries up to the ultimate owner. As such, complexity would be a complement to the instruments of profit shifting. Ownership complexity is also associated with lower transparency over the activity of MNEs and more discretionary power to managers over other stakeholders (Balakrishnan et al., 2018; Atwood and Lewellen, 2019). From the perspective of tax authorities, such opacity increases the information burden for tracking tax obligations and the costs of coordination among national tax authorities.

We build a database combining consolidated data on the affiliate network of MNEs worldwide and financial information from unconsolidated accounts at the subsidiary level. We first use information on the network of affiliates owned by 66,539 MNEs drawn from Orbis, including more than 1.3 million affiliates worldwide. We measure the complexity of ownership structure as the average number of layers of ownership between each affiliate and the ultimate owner of the MNE. The raw data show a large heterogeneity in complexity, increasing in the size of MNEs, the number of industries in which they operate and their presence in tax havens. Interestingly, more complex MNEs exhibit a lower effective tax rate but are not more profitable overall according to consolidated financial accounts.

We then use micro-data on unconsolidated accounts of some 212,000 European affiliates of multinational firms to investigate how their reported profitability varies with corporate taxation and MNE complexity. Our identification strategy follows Johannesen et al. (2020) in comparing affiliates from the same sector and located in the same country that differ in the complexity of the group they belong to. Such multi-country setting allows to control for all country characteristics, including the corporate tax rate, likely to affect reported profit in different countries, using fixed effects. We focus on the incidence of zero reported profit, which has been shown to be an important margin of profit shifting.[7]

We first show a larger bunching around zero reported profit for affiliates belonging to more complex multinational enterprises, consistent with tax avoidance being enabled by complex ownership structures. Such effect is economically significant when compared to other measures of profit shifting using the tax rate differential. Our results are not driven by other dimensions of complexity of the network of affiliates, such as the number of countries or industries in which the MNE operates, nor by the size of the MNE or its mere presence in tax havens. We also find that the relevant dimension of complexity is at the MNE level, while the layer of the subsidiary itself in the network does not matter.

We then ask whether complexity works as an enabler of profit shifting away from high-tax affiliates and show that profit shifting is magnified within complex MNEs. Indeed, high-tax affiliates belonging to complex MNEs tend to bunch more than high-tax affiliates belonging to less complex MNEs. We further show that

[6] See section 2.

[7] Bilicka (2019) reports that most of the difference in reported profits between MNEs and domestic companies in the UK is related to the former reporting zero taxable profit.

only more complex MNEs shift profits away from their high-tax affiliates, while the probability of reporting zero profit does not depend on the tax rate differential for MNEs with flat ownership structures. Complexity therefore enables profit shifting activities.

Finally, looking at the pattern of profit shifting within MNEs, our analysis shows that affiliates directly held through tax havens are more likely to report zero profit than other affiliates in more complex MNEs. This suggests that the profit allocation within MNEs partly rests on the development of the ownership network in tax havens.

This paper contributes to the literature on profit shifting using firm-level data, which focuses on the incentives to shift profit, measured as the tax wedge between a given affiliate and other affiliates of the MNE (see e.g. Huizinga et al. (2008); Johannesen et al. (2020)).[8] We add to this literature by providing evidence on the types of MNEs more likely to shift profits.[9] Our results also emphasize that a relevant dimension of heterogeneity in profit shifting is the complexity of the ownership network at the MNE level, and not the position of the subsidiary alone in the network, in line with tax strategies being decided at the headquarter level. In this respect, our paper complements the existing literature that has focused on subsidiary-level characteristics likely to affect profit shifting: firms' organizational capacity (Bilicka and Scur, 2021) or size (Davies et al., 2018; Wier and Reynolds, 2022).

We also connect the literature on profit shifting to the literature on treaty shopping. Hong (2016) and Petkova et al. (2020) both provide evidence on the positive relationship between the existence of a tax-minimizing route and FDI and Hong (2021) shows that favorable tax treaty networks are positively associated with the use of equity holding companies. Van't Riet and Lejour (2018) show that treaty shopping reduces the tax liability on dividends by about 6 percentage points. We add to this literature by showing that ownership complexity supports profit shifting in line with complexity driven by chains of ownership allowing treaty shopping.

This paper is also related to the literature on MNEs organization. Altomonte et al. (2021) propose a knowledge-based model of business groups in which the optimal organizational structure depends on production and problem solving efficiency. Altomonte et al. (2012) show that affiliates belonging to MNEs whose network is more geographically widespread but less diversified exhibit better performance. We add to this literature by showing that beyond economic determinants, the choice of ownership structure by MNEs affects the reported profitability of affiliates located in different jurisdictions with different corporate tax rates. Directly related to ours, two papers in the accounting literature have investigated the tax determinants of foreign affiliate ownership. Dyreng et al. (2015) explore how US multinationals use foreign holding companies, and show that both tax and non-tax determinants affect the choice to use such intermediary and its location. Blouin and Krull (2019) investigate the introduction of the check-the-box regulation in the US in 1997 and find that it incentivized MNEs to alter their organizational structure to take advantage of the new regulation tax planning potential.[10] Our analysis complements those papers by showing the

[8] See Heckemeyer and Overesch (2017) for a literature review.

[9] At the MNE level, Wagener and Watrin (2014) show that complexity correlates with incentives to shift profits measured as presence in tax havens or the difference between the maximum and minimum statutory tax rate within the MNE, the more so for income-mobile firms.

[10] Additionally, Gumpert et al. (2016) provide evidence that German multinationals have an increasing probability of tax haven

consequences of alternative ownership choices at the MNE level on profit shifting.

The paper is organized as follow. We define our measure of complexity in Section 2 and introduce a conceptual framework to understand the relationship between complexity and tax avoidance. Section 3 provides descriptive evidence of the level of complexity across firms and the characteristics of complex MNEs. Section 4 presents our methodology and main results, with associated robustness exercises gathered in Section 5.

2. Conceptual framework

We propose that the complex ownership structure of multinational subsidiaries supports profit shifting by MNEs through reallocating profits away from high-tax affiliates toward low-tax affiliates. In this section, we discuss how ownership complexity relates to tax avoidance strategies and present our measure of complexity.

2.1. How complexity matters for tax avoidance strategies

The literature has convincingly shown that tax avoidance by multinational enterprises is significant globally: Tørsløv et al. (2022) find that 36% of MNEs profits are shifted to tax havens in 2015, reducing tax revenues in high-tax countries accordingly. MNEs engage in profit shifting through three main channels. They can use transfer prices on trade in goods (Bernard et al., 2006; Cristea and Nguyen, 2016; Vicard, 2015; Davies et al., 2018; Wier, 2020; Liu et al., 2020), intra-firm debt shifting (Huizinga et al., 2008; Fuest et al., 2011) and the location of intangibles assets in tax havens (Karkinsky and Riedel, 2012; Dischinger et al., 2014; Hebous and Johannesen, 2021) to shift profits from high to low-tax subsidiaries. Profits can be shifted between any two subsidiaries or between a subsidiary and the headquarter of the MNE. Using those three instruments of profit shifting therefore does not directly require any specific ownership structure of the firm or a direct ownership link between the two affiliates involved.

Whatever their location inside the firm, profits are then routed as dividends to the headquarter and shareholders. Here the ownership structure of the MNE can be designed so as to minimize the tax incurred to remit dividends to the parent firm. By intermediating a conduit entity in-between the parent and its subsidiary, and locating it in a jurisdiction with favorable tax treaties with both the source country of the subsidiary and the country of the ultimate parent, an MNE can take advantage of specific provisions reducing its tax liability on dividends or other passive incomes. Such treaty shopping enables MNEs to take advantage of lower taxation by redirecting investment through a third country.[11] By doing so, they increase the complexity of their ownership network by setting foreign holding subsidiaries in countries that offer favorable tax regimes, instead of directly holding subsidiaries in which they operate real activities.

presence when their affiliates face higher corporate tax rates in their country of operation. Devereux and Griffith (1998) and Barrios et al. (2012) show that the statutory tax rate has a negative impact on the decision of setting up a subsidiary in a country. However, these papers do not address directly firm organization.

[11] One famous example of such treaty shopping is the Double Irish with a Dutch Sandwich scheme orchestrated by several US multinationals in the 2000s and 2010s. It involved two Irish subsidiaries, one tax resident in Bermuda and one tax resident in Ireland and fully owned by the former, and a Dutch subsidiary (Jones et al., 2018).

Tax treaties are bilateral agreements aiming at preventing double taxation and facilitating cross-border activities. At the global level, more than 3,500 bilateral tax treaties are in force, covering more than 80% of ownership links (UNCTAD, 2016). They provide for specific provisions defining the tax treatment of income earned abroad by residents of the two contracting authorities. By setting specific tax provisions at the bilateral level, tax treaties enable MNEs to design tax efficient chains of investments that minimize their tax liability when routing dividends up to the ultimate owner and managing cash within the firm. It is worth noting that routing dividends through a number of intermediary countries may generate tax liability at each stage, except for routes through countries that specifically provide tax provisions to avoid taxation, such as tax havens characterized by a network of favorable tax treaties (Palan et al., 2010).

Of particular interest in our case, tax treaties define the scope, rate and applicability of withholding taxes. Withholding taxes are taxes applied in the source country on dividend, interest, and royalty payments made to residents of a foreign country. Since withholding tax rates are defined by tax treaties, they depend on the location of the parent and the subsidiary.[12] Additionally, the EU parent-subsidiary directive imposes a zero withholding tax rate on dividends distributed by a subsidiary to its parent when both are EU residents, and provides for dividend participation exemption. Multinational corporations may therefore organize indirect ownership chains to exploit specific tax treaty provisions on withholding taxes. Van't Riet and Lejour (2018) show treaty shopping gains on dividend repatriation for two thirds of country pairs in their sample, and an average reduction of the tax liability on dividends by 6 percentage points thanks mainly to lower withholding taxes on indirect repatriation routes. Similarly, Hong (2016) finds a tax minimizing indirect route for 39% of country pairs in a smaller sample of 70 countries, and a treaty shopping reduction of 9.4 percentage points corresponding to three quarters of the withholding tax rate on dividends.

Controlled Foreign Corporation (CFC) rules are another relevant dimension of MNEs taxation. They are applied by the country of the parent company and attribute some passive income - e.g. dividends, interests, and royalties - of a low-taxed foreign subsidiary to its parent company for purpose of taxation. Depending on specific national legislations, CFC rules may not apply to subsidiaries located in countries with a double taxation treaty or to subsidiaries performing substantial economic activity. MNEs have therefore incentives to locate holding affiliates in countries that do not impose CFC rules. Within the EU, the applicability of CFC rules has been restricted to purely artificial schemes since 2006, as per the Cadbury-Schweppes ruling (Schenkelberg, 2020).

A separate dimension in which complex ownership structures may facilitate profit shifting is through the creation of opacity in the functioning of the MNE. Creating opaque schemes offers more discretionary power to managers that can implement corporate diversion (i.e., a transfer of wealth from shareholders to managers). At the same time, corporate diversion is associated with tax avoidance, especially when the cost

[12]For instance, the Netherlands have double tax treaties with over 90 countries. Although the number of tax treaties is not very different from the EU average, the main difference lies in its generosity. Over 80% of all tax treaties signed by the Netherlands offer a zero withholding tax rate on dividends, royalties and interests, against a standard withholding tax rate of 15% for dividends and of up to 25.8% for interests and royalties in 2022 (https://www.ey.com/en_gl/tax-guides/worldwide-corporate-tax-guide). In 2019, the Netherlands had approximately 12,400 conduit companies representing approximately 550% of their Gross Domestic Product (GDP). The amount related to interest, royalty and dividend payments that flow through these conduit companies annually represented about €170 billion between 2015 and 2019 (https://www.government.nl/documents/reports/2021/10/03/the-road-to-acceptable-conduit-activities).

of diversion is low (Desai et al., 2006, 2007). Cross-border ownership chains also blur the investor nationality (Alabrese and Casella, 2020) and make the identification of indirect ownership links more difficult. These phenomenon are reinforced by the use of tax havens that provide secrecy and thus increase the burden of information on tax and regulatory authorities and reduce their effectiveness.[13] As such, complex ownership structures may directly facilitate the use of regular instruments of profit shifting.

2.2. Measuring complexity

We are interested in the complexity of affiliate ownership at the level of a multinational enterprise. A complex ownership structure refers to an MNE organization in which the headquarter owns its subsidiaries through a chain of intermediaries, possibly spanning several countries, contrary to a flat or horizontal structure in which subsidiaries are held directly by the headquarter.

We use a simple measure of complexity defined as the mean number of layers of ownership over all affiliates of a multinational company, following UNCTAD (2016). The number of layers is the number of ownership links between the global ultimate owner (GUO) of the MNE and the affiliate. The ultimate owner is the individual or entity at the top of the corporate ownership structure.[14] An affiliate held directly by the ultimate owner is at layer 1 while a subsidiary held through one intermediary is at layer 2. Figure 1 illustrates the computation of our complexity measure.

Such a measure accounts for both the length of the chain of holdings and the number of affiliates at each layer of ownership as can be seen from Figure 1. The more vertical the structure, the higher the value of our complexity measure. A perfectly horizontal MNE (with at most one layer between the ultimate owner and each affiliate) will always have a complexity measure of 1, irrespective of the number of affiliates, while a MNE with 10 affiliates held through a single ownership chain with 10 vertical ownership links will have a score of 5.5. The complexity score also increases the further away from the ultimate owner the mass of subsidiaries are located in the ownership structure.

Orbis provides information on the ownership structure of affiliates up to 10 layers. In case of cross-ownership, we keep the shortest path from the affiliate to the ultimate owner. Table J8 in Appendix C shows that on average, multinational enterprises have 1.4 layers of ownership between their headquarter and their affiliates. We can however observe that there exists a large heterogeneity in the complexity of ownership structures. More that half of the MNEs in our sample have only one layer, which implies that they have a horizontal structure: one parent firm directly owns all of its affiliates. The top 25% firms, on the opposite, have on average 1.5 layers, with the more complex firms in our sample having a maximum of 10 layers of ownership.[15]

We also use three alternative measures of complexity of ownership network as robustness.[16] We use the

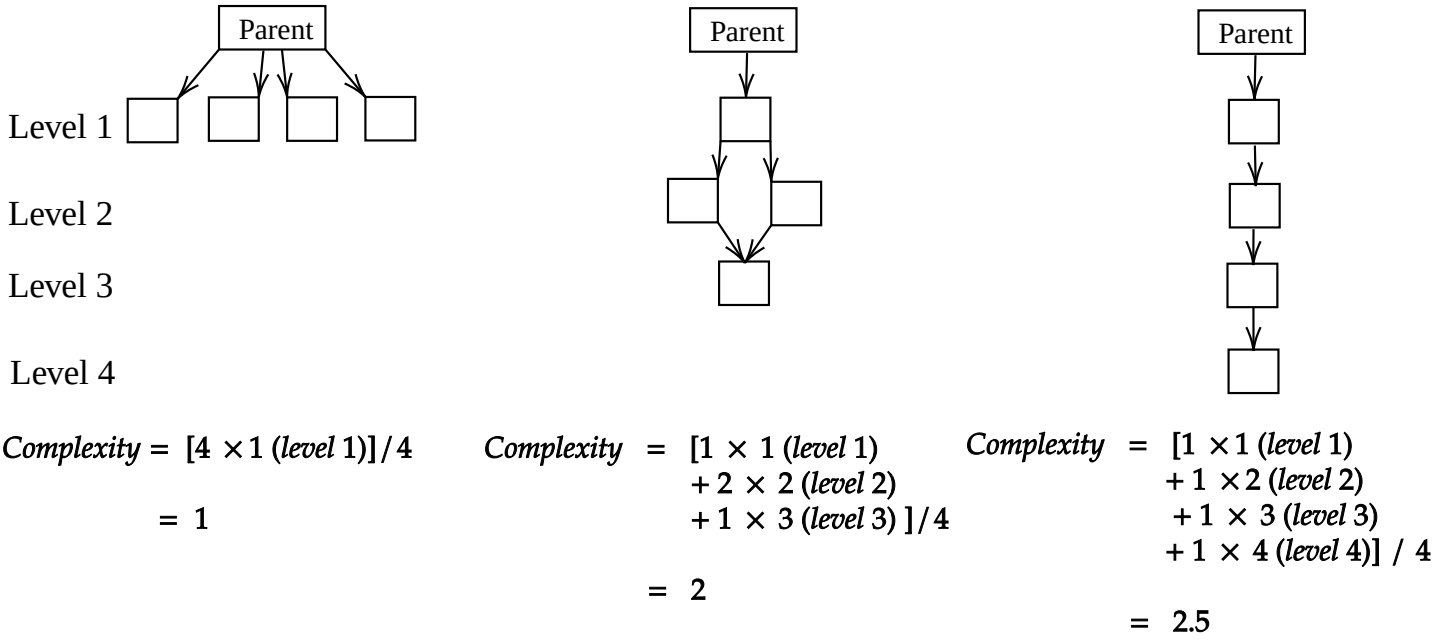
[13] Ajdacic et al. (2021) show that MNEs audited by one of the Big Four accountancy firms have a higher network complexity and that it increases the use of OFC and holding and management affiliates.

[14] The minimum percentage of control in the path from a subject company to its GUO must be at least 50.01%.

[15] It is possible for an MNE to have more than 10 layers. However, we do not observe those affiliates in our data.

[16] We do not consider more specific dimensions of ownership complexity, such as using shared ownership or joint ventures, ownership hubs where an affiliate controls several other affiliates or cross-shareholdings where one entity is owned (fully or partially) by the same entity in which it owns a stake. UNCTAD (2016) documents that the vertical dimension of complexity captured by our measure dominates for the largest MNEs.

Figure 1 – Measuring the complexity of ownership networks



maximum layer within the MNE (as accounted for in Wagener and Watrin (2014)), which considers only the verticality of the ownership structure. Second, we build on Ajdacic et al. (2021) and use an entropy measure that takes into account the maximum number of layer within the MNE, but also the number of subsidiaries at each layer. Such a measure increases with the number of layers but also with a more even distribution of affiliates at each layer, reflecting the idea that an MNE with one parent owning 99 affiliates directly and one indirectly is less complex than an MNE with one parent owning 50 affiliates, each owning another affiliate. Finally, we use a skewness measure of the distribution of affiliates across layers for MNEs that have at least two layers (from Altomonte et al. (2021)).[17]

3. Descriptive evidence

3.1. Data source

We use micro data from the Orbis database, maintained by Burean Van Dijk. It provides cross-country ownership and financial information (from the balance sheet and profit and loss accounts) for corporations, allowing to measure the global reach of MNEs through their network of affiliates and to analyze cross-country micro-data from financial accounts at the affiliate level. The information is adapted by Bureau Van Dijk to make it comparable across countries.

First, we focus on consolidated accounts and information on the MNEs' ownership network. We build a database with information for the year 2018 at the group level of multinational firms that have at least one affiliate in the European Union. We retrieve information on the networks of affiliates and the level of ownership for each affiliate so that we have a view on the structure of the group. The final sample includes 66,539 groups owning a total of 1,330,423 affiliates worldwide.

Table 1 shows descriptive statistics for the MNEs in our sample. The average MNE has 16 affiliates,

[17] Appendix 10 provides additional details on their computation; the results are presented in Section 5.1.

spread over 4 different countries and 3 different industries. The largest MNEs are present in more than 150 countries, emphasizing the importance of cross-border ownership links in such firms. Most MNEs do not have any presence in a tax haven: in our sample, 27% of all MNEs have at least one affiliate in a tax haven, in line with 20% for German MNEs reported by Gumpert et al. (2016). This also suggests the role of tax havens and OFCs as determinants of ownership structure.

Table 1 – Summary statistics

	Obs	Mean	Std. Dev.	Min	Max
Number of subsidiaries	66,539	16.09	48.57	1	949
Number of different countries	66,539	3.86	6.28	1	151
Number of different tax havens	66,539	0.46	1.08	0	21
Number of different industries	66,539	3.13	2.57	1	21
Diversification	66,525	0.27	0.34	0	1
Avg. tax rate	66,539	0.25	0.05	0	0.35
Tax rate GUO	66,514	0.25	0.05	0	0.35
Share in low-tax countries	66,514	0.28	0.45	0	1
Tax haven presence	66,539	0.27	0.45	0	1

Note: Diversification is the share of subisidiares working in the same sector as the Ultimate Owner. The average tax rate is the unweighted average tax rate across all subsidiaries of an MNE. The share of MNEs in low-countries is based on the bottom 25% of the distribution of tax rate of GUOs in our sample (tax rate around 21%). Tax haven presence is the share of MNEs that have at least one subisdiary in a tax haven.

Second, we build a database at the unconsolidated level. We focus on the affiliates of the MNEs in the consolidated database located in the European Union. We only consider affiliates that have unconsolidated accounts and basic financial information available. The final sample includes 212,516 affiliates.[18] We use the return on assets, measured as earnings before interest and tax plus financial profits divided by total assets, as our measure of profitability at the subsidiary level.

There are some limitations related to the use of Orbis: the coverage is uneven by country for financial information since reporting requirements differ across countries.[19] In particular, the coverage of Orbis is limited for balance sheet information in tax havens, some of which have no credit registry. Note however that Orbis does report information on the ownership structure of the MNE including tax haven affiliates even when no balance sheet information is available (Garcia-Bernardo et al., 2021).

Regarding the ownership information, we have the cross-sectional information as it is at the date of download of the data. Therefore, we do not have information about mergers, acquisitions or creation of affiliates. Finally, we use balance sheet data instead of tax return data. Bilicka (2019) shows that there exist a reporting difference for MNEs between their accounting reported information and their tax return information. We might therefore be underestimating the profitability effect of complexity.

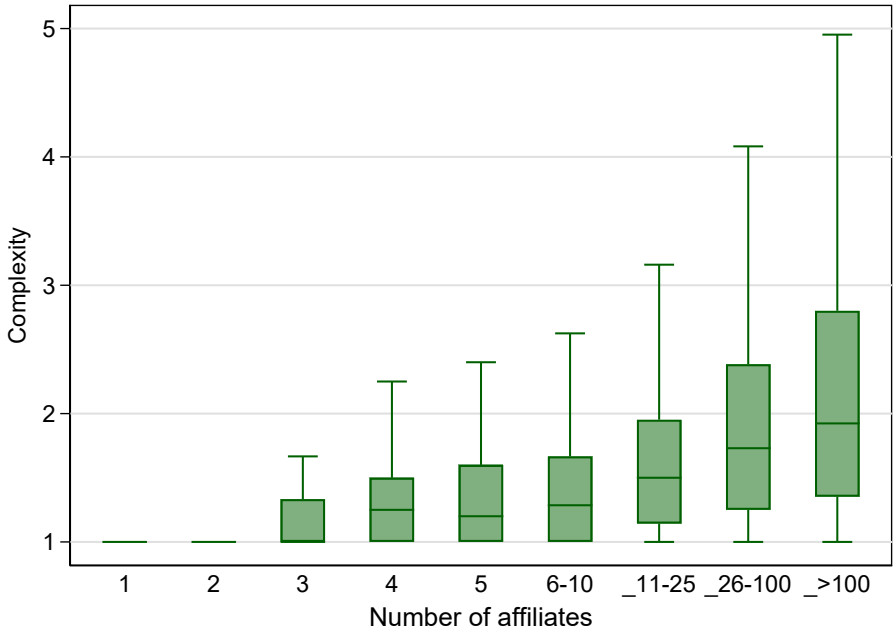
Statutory tax rate information comes from the Tax Foundation and the list of tax havens is from Hines and Rice (1994).

[18] Further information on data collection and cleaning is reported in Appendix 8.

[19] The coverage of financial information in the Orbis database is notably better for EU countries. Table H5 in Appendix 8 provides the detailed geographic allocation of affiliates with financial information included in our sample.

3.2. Complexity and size

The number of layers mechanically depends on the number of affiliates, especially when the number of affiliates is low. An MNE with one subsidiary has a maximum number of layers of one, an MNE with two subsidiaries has a maximum number of layers of two, etc., as shown in table I6 in Appendix 9. Yet, figure 2 shows that there is heterogeneity in the complexity of MNEs within bins of number of affiliates. The median complexity increases with the number of affiliates, from 1 for MNEs with less than four affiliates to just below 2 for MNEs with more than 100 affiliates, underlying that most affiliates are owned through at most 2 layers of control. The distribution of MNEs' complexity is however heterogeneous within bins of size: the 90th percentile exceeds 2 for firms with at least six affiliates and reaches 4 for the largest MNEs.



Note: Tukey box; whiskers represent adjacent values.

The complexity of MNEs' ownership structure as measured by the number of layers is therefore conditioned by the size of the network of affiliates. In the following, to account for this relationship between size and complexity, we will systematically condition on the number of affiliates using fixed effects by bins of size.[20] Table I7 shows that size fixed effects explain close to one third of the variance in complexity across MNEs, while industry and country fixed effects have a limited explanatory power.

3.3. The determinants of complexity of corporate structure

In this section, we explore how the complexity of corporate structure varies across MNEs along several characteristics. We regress complexity on a set of variables measuring different dimensions of subsidiary networks, including tax-related factors (a dummy for having at least one subsidiary in a tax haven) and non-tax factors (the geographical footprint of the firm and the sectoral diversification of a group). Diversification is defined here as the number of different industries (NACE 2-digit code) in which affiliates of the group operate. Results reported in column (1) of Table 2 show that, as expected, MNEs with a presence in a

[20] Figure .3 in Appendix 9 shows that complexity is also increasing in the size of the MNE as measured by the number of employees and total assets, although less so than in the number of affiliates, but the relationship is not mechanical.

tax haven have a more complex ownership structure, in line with tax haven affiliates serving as a conduit entities. More diversified MNEs also exhibit larger complexity levels, while the opposite is true regarding the number of countries in which the MNE operates.

In column (2), we add characteristics of the country of location of the global ultimate owner: an indicator variable equal to one when the origin country is a tax haven and its corporate tax rate. While the latter is not significantly associated to complexity, MNEs whose global ultimate owner is incorporated in a tax haven are significantly more complex.

Finally, in columns (3)-(5), we consider how complexity is correlated with different measures of performance of the firm using the consolidated financial information. More complex MNEs are more productive (measured as labor productivity in column (6)) but are not more profitable, as measured by the return on assets (column (7)). They also exhibit a lower effective tax rate (measured as tax paid divided by profits; column (8)), in line with our assumption that complexity may serve tax avoidance.

Table 2 – Determinants of MNE complexity

	(1) Complex.	(2) Complex.	(3) Complex.	(4) Complex.	(5) Complex.
Tax haven presence	0.08***	0.06***	0.06***	0.06***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Nb of diff. countries	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Diversification	0.14***	0.14***	0.11***	0.12***	0.12***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tax rate GUO		0.01			
		(0.04)			
GUO in a TH		0.10***			
		(0.01)			
Labor prod. (log)			0.02***		
			(0.00)		
Return on assets				0.01	
				(0.01)	
Effective tax rate					-0.07***
					(0.01)
Observations	66,539	66,514	15,436	36,215	30,727
R-squared	0.31	0.31	0.28	0.27	0.27

Note: The dependent variable is the complexity at the MNE level. Standard errors in parenthesis are robust to heteroscedasticity. Diversification is defined as the number of different industries (NACE 2-digit code) in which affiliate of the group operate.The return on assets, effective tax rate and labor productivity variables are trimmed for the 1^{st} and 99^{th} percentiles.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

While such relationships are correlations, and do not imply causation, they are informative in showing that both tax and non-tax factors are related to the complexity of the ownership network. Our empirical methodology below focuses on the reported profitability of affiliates of MNEs and the distribution of profits within the MNE. In interpreting our results, it is interesting to keep in mind that, at the consolidated level, more complex MNEs do not exhibit a lower return on assets.

4. Complexity and tax avoidance

4.1. Methodology

Our empirical strategy focuses on the propensity to report zero profit for a firm. When the cost to shift profit is fixed, or when the cost is variable but low enough, MNEs have incentives to shift all their profits away from high-tax affiliates to reduce their overall tax liabilities (Bilicka, 2019; Johannesen et al., 2020). Such bunching at zero profit may also result from non-tax incentives, so that we need to compare firms located in the same country and in the same industry that face different incentives or opportunities to shift profit, because of the characteristics of the MNE they belong to.

We follow Johannesen et al. (2020) and estimate the probability of bunching around zero profit of firm i held by a multinational enterprise j, located in a country c and operating in sector k:

$$\mathbb{1}_{zero_i} = \beta_0 + \beta_1 Tax_{ij}^{for} + \beta_2 Complex_j + \theta_k + \theta_c + \theta_s + \epsilon_i, \quad (1)$$

where $\mathbb{1}_{zero_i}$ is a dummy variable for firms reporting zero profit, measured as a return on assets between -0.5% and 0.5%. $Complex_j$ is our measure of complexity of the MNE j to which affiliate i belongs. Tax_{ij}^{for} is the unweighted average tax rate of all affiliates and the GUO but affiliate i within the MNE. θ_c and θ_k are country and industry (NACE 2-digit) fixed effects respectively. Finally, θ_s are fixed effects by bins of MNE size measured as the number of affiliates, with bins $s = [1; 2; 3; 4; 5; 5/10; 11/25; 26/100; > 100]$.[21]

The model is a cross-sectional specification for the year 2018. The introduction of country fixed effects controls for all country-specific characteristics likely to explain the average profitability of firms and probability of reporting zero profit (including the effective tax rate, specific tax regimes or the average book-tax difference in a country). Equation 1 is estimated through OLS, with robust standard errors clustered at the MNE level in line with our variable of interest.

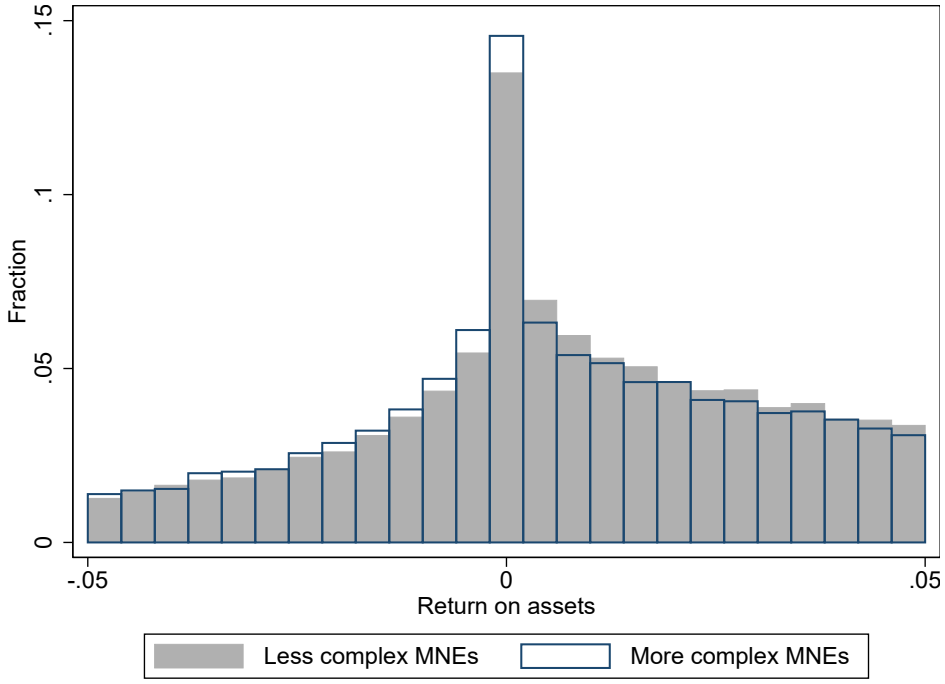
We focus on affiliates of MNEs, disregarding domestic firms that have no opportunity to shift profits to foreign affiliates. Our identification comes from comparing affiliates in a given country and industry belonging to MNEs of similar size in terms of the number of affiliates but differing in terms of their average tax rate (and so incentives to shift profits) and complexity (opportunity to shift profits).

Before turning to empirical results, we present graphical evidence of bunching at zero profit specific to more complex MNEs. Figure 3 reports the distribution of returns on assets for our sample of European affiliates, distinguishing more complex MNEs (complexity above the median) and less complex MNEs (complexity below the median). It shows a clear bunching at zero of the reported return on asset for all corporations: about 10.2% of affiliates on the whole sample report close to zero profits (defined as above as a return on assets between -0.5% and 0.5%).[22] But bunching at zero profit is more prevalent among affiliates of more complex MNEs: 10.6% of them report zero profit against 9.8% for affiliates in less complex MNEs.

[21] This dimension of fixed effect accounts for the relationship between the maximum number of layers and the number of affiliates as emphasized in section 3. We therefore compare MNE with similar size in terms of number of affiliates but different levels of complexity.

[22] See Table H4. The figure differs slightly from what appears on the figure due to the size of the bins on figure (3).

Figure 3 – Distribution of return on assets (percent, 2018)



Note: Less (more) complex MNEs are affiliates belonging to a MNE below (above) the median of complexity. Sample restricted to ROAs between -5% and 5%.

4.2. Complexity and bunching at zero profit

Results from estimating equation (1) are shown in Table 3. Columns (1) and (2) reproduce the results of Johannesen et al. (2020) on our sample of European affiliates. It confirms that an increase in the parent tax rate (column (1)) or average tax rate of other affiliates within the group (column (2)) decreases the likelihood of bunching around zero reported profits. The magnitude of the coefficients are in line with what Johannesen et al. (2020) find for high income countries, with a significance level above 1% but below the 10% threshold.

Table 3 – Zero profit and complexity

	(1) $\mathbb{1}_{zero}$	(2) $\mathbb{1}_{zero}$	(3) $\mathbb{1}_{zero}$	(4) $\mathbb{1}_{zero}$	(5) $\mathbb{1}_{zero}$	(6) $\mathbb{1}_{zero}$
Tax rate GUO	-0.099**		-0.091***		-0.091***	
	(0.042)		(0.023)		(0.023)	
Avg. foreign tax rate		-0.131*		-0.127***		-0.126***
		(0.068)		(0.030)		(0.030)
Complexity			0.005***	0.006***	0.007***	0.007***
			(0.002)	(0.002)	(0.002)	(0.002)
Subsidiary Level					-0.002	-0.002
					(0.001)	(0.001)
Observations	212,496	212,516	212,496	212,516	212,496	212,516
R-squared	0.044	0.044	0.045	0.045	0.045	0.045
CountryFE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryFE	Yes	Yes	Yes	Yes	Yes	Yes
SizeBinFE	No	No	Yes	Yes	Yes	Yes

Note: This table reports OLS estimates of eq. (1) on cross-sectional data for the year 2018. *Av. foreign tax rate* is the unweighted average tax rate across the GUO and all subsidiaries of multinational firm j but subsidiary i. *Subsidiary Level* is the layer at which the subsidiary is located, i.e. the number of ownership links between the Ultimate owner and subsidiary i. Standard error in parenthesis robust to heteroscedasticity and clustered at the subsidiary country level in columns (1) and (2) and the multinational corporation level in others columns.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In columns (3) and (4), we augment the model by adding our measure of ownership network complexity. Complexity has a positive and significant impact on the likelihood of reporting zero profits. Corporations belonging to more complex MNEs are therefore more likely to report zero profits than other corporations in the same country and industry. Note that adding our complexity measure leaves the coefficient on parent tax rate (column (3)) or average tax rate (column (4)) broadly unchanged but improves the precision of their estimates.

Our point estimate in column (4) implies that increasing average complexity of the MNE by one layer increases the likelihood of reporting zero profits by 0.5pp. Considering that the baseline rate of bunching around zero profits is 10.2%, increasing average complexity of the MNE by one layer increases bunching at zero by about 5.4%. As a benchmark, a 10 percentage point decrease in the average foreign tax rate increases the share of corporations reporting zero profits by around 10 percent. The effect of complexity on tax avoidance is thus economically significant.

In columns (5) and (6), we add a variable measuring the subsidiary position in the ownership tree (*Subsidiary Level)* of the MNE to assess whether the relevant dimension of complexity pertains to the ownership organization of the MNE as a whole or to the distance of the subsidiary itself to the headquarter. The insignificant coefficient on the subsidiary level confirms that the relevant dimension is the complexity at the MNE level, which does not systematically affect affiliates further away from the ultimate owner. This is consistent with the idea that tax planning is a strategic decision of the MNE and is defined for the whole group and not subsidiary by subsidiary.

4.3. Complexity as an enabler of profit shifting

We then ask the question: does complexity in ownership network work as an enabler of profit shifting away from high-tax affiliates? To assess this, we add an interaction term between complexity and the average tax rate of all affiliates but affiliate i as follows:

$$\mathbb{1}_{zero_i} = \beta_0 + \beta_1 Tax_{ij}^{for} + \beta_2 Complex_j + \beta_3 Tax_{ij}^{for} \times Complex_j + \theta_k + \theta_c + \theta_s + \epsilon_i. \quad (2)$$

We expect the MNE complexity to magnify the impact of the tax rate of foreign affiliates, i.e. β_3 to be negative. Results are reported in column (1) of Table 4. It shows a negative coefficient on the interaction between tax rate of other affiliates and complexity: complexity magnifies the difference in the probability to report zero profit between high and low-tax affiliates. Such result is consistent with complexity playing a facilitating role in profit shifting.

Table 4 – Complexity and profit shifting

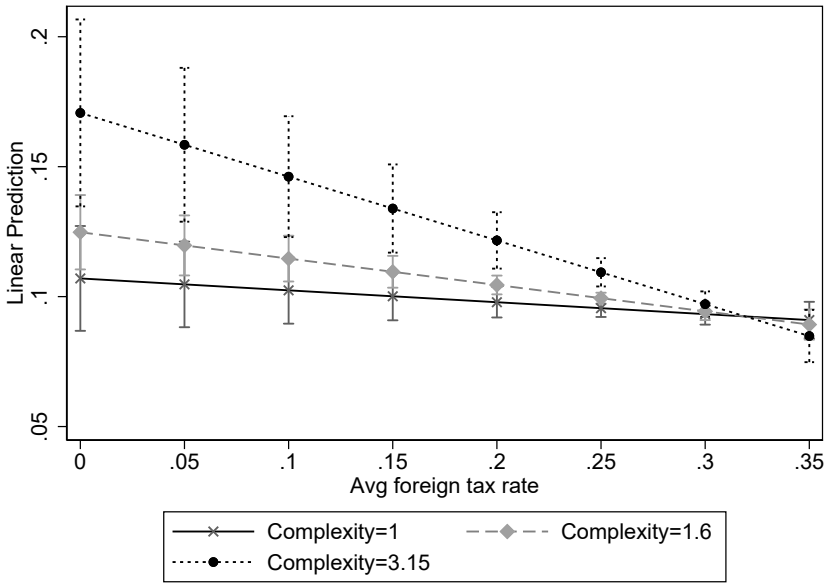
	(1) $\mathbb{1}_{zero}$	(2) $\mathbb{1}_{zero}$	(3) $\mathbb{1}_{zero}$	(4) $\mathbb{1}_{zero}$
Avg. foreign tax rate	0.030	-0.123***	-0.123***	0.785***
	(0.070)	(0.029)	(0.029)	(0.236)
Complexity	0.028**	0.006***	0.004**	
	(0.011)	(0.002)	(0.002)	
Complexity×Avg. foreign tax rate	-0.087**			
	(0.039)			
Held by a TH		0.004	-0.025*	-0.035**
		(0.004)	(0.013)	(0.017)
Complexity × Held by a TH			0.016**	0.020**
			(0.007)	(0.008)
Observations	212,516	212,516	212,516	195,173
R-squared	0.045	0.045	0.045	0.218
CountryFE	Yes	Yes	Yes	Yes
IndustryFE	Yes	Yes	Yes	Yes
SizeBinFE	Yes	Yes	Yes	Yes
MneFE	No	No	No	Yes

Note: This table reports OLS estimates of eq. (2) on cross-sectional data for the year 2018. *Av. foreign tax rate* is the unweighted average tax rate across the GUO and all subsidiaries of multinational firm j but subsidiary i. *Held by a TH* is a dummy equal to 1 if subsidiary i is held by a firm located in a tax haven. Standard error in parenthesis robust to heteroscedasticity and clustered at the multinational corporation level in others columns. All specifications include country FE, NACE-2-digit sector FE and size bins FE.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

To illustrate the impact of complexity on profit shifting, we plot in Figure 4 the linear prediction of reporting zero profit depending on the average tax rate of other affiliates within the group, and the 95% confidence intervals. We consider 3 cases: affiliates belonging to an MNE at the 10th percentile of complexity ($Complex_j = 1$), at the median level ($Complex_j = 1.6$) and at the 90th percentile ($Complex_j = 3.15$). Predicted zero profit decreases sharply with the average tax rate faced by other affiliates within the MNE for MNEs at the 90th percentile of complexity. More complex MNEs report significantly more zero profits in high-tax affiliates than in low-tax affiliates. While such negative relationship, although flatter, is still

present for MNEs at the median of complexity, it flattens completely for less complex MNEs at the 10th percentile.

Figure 4 therefore shows that complexity in the ownership network of affiliates works as an enabler of profit shifting away from high-tax affiliates; and that profit shifting between affiliates prevails only in sufficiently complex MNEs.



Note: 95% confidence intervals. The complexity levels correspond to the 10th, 50th and 90th percentile level of complexity in the sample.

4.4. Profit shifting within complex MNEs

Finally, in this section, we investigate how the structure of affiliate ownership affects profit allocation within the MNE. Given the role of intermediaries located in tax havens in tax avoidance schemes, we hypothesize that affiliates held through a tax haven are more likely to report zero profit than other affiliates in more complex MNEs. To test this, we estimate the following:

$$zero_i = \beta_0 + \beta_1 tax_{ij}^{for} + \beta_2 Complex_j \times THhold_{ij} + \beta_3 THhold_{ij} + \theta_c + \theta_k + \theta_j + \epsilon_i, \qquad (3)$$

where $THhold_{ij}$ ("*Held by a TH*" in Table 4) is a dummy equal to one if firm i is held directly by an affiliate in a tax haven. Note that such a specification controls for any potential omitted variable bias at the level of the MNE through the MNE fixed effects θ_j. Here we exploit differences among affiliates within MNEs to fully control for the characteristics of the multinational enterprise and consider the role played by chains of ownership through tax havens together with complexity in enabling tax avoidance.

Results are presented in columns (2)-(4) of Table 4. We introduce $THhold_{ij}$ and its interaction with complexity in turn. Column (2) underlines that on average affiliates held through tax havens are not different from other affiliates. Column (3) however shows that all MNEs are not alike in their internal allocation of profits: affiliates held through a tax haven are more likely to bunch at zero profit when they belong to a complex MNE. The coefficient on the interaction term is positive and significant. Finally,

column (4) confirms that such result is robust to the inclusion of MNE fixed effects, i.e. is not driven by other unobserved characteristics of more complex MNEs.

Such allocation of profit between affiliates of more complex MNEs underlines that chains of ownership going through tax havens are central to tax avoidance strategies.

4.5. Confounding factors at the MNE level

The complexity of the ownership network may also be correlated with other tax and non-tax characteristics of the MNE, as underlined in Section 3.3. In Table 5, we control for such confounders at the MNE level and show that complexity is the relevant MNE characteristic with regard to tax avoidance.

We first test whether the location of the global ultimate owner matters. In particular, Table 2 underlines that MNEs whose global ultimate owner is located in a tax haven are more complex. In column (1), we control for a dummy indicating whether the global ultimate owner is located in a tax haven. We find that subsidiaries from such MNEs indeed have a larger probability of reporting zero profit. Such effect does however not drive the impact of complexity on the propensity to report zero profit.

Next we control for the size of MNEs since due to the fixed cost nature of profit shifting (Bilicka, 2019; Davies et al., 2018; Wier and Reynolds, 2022), larger firms are more likely to shift profits and they are also more complex on average. We control for size using the logarithm of the number of employees (column (2)) and the logarithm of total assets (column (3)) at the MNE level. Size has a negative effect on the propensity to bunch at zero profit, suggesting that larger MNEs are also more profitable on average. The coefficient on complexity remains qualitatively and quantitatively similar. It confirms that the complexity of ownership structure is the relevant dimension of heterogeneity in profit shifting across MNEs, and is not driven by a correlation with the size of MNEs, which by itself does not appear as a relevant dimension of heterogeneity in profit shifting behavior.

Finally, in column (4), we control for the labor productivity of the MNE. Even though more productive MNE have on average a more complex ownership structure (as shown in Table 2), we want to more fully control for the impact of productivity (measured as value added divided by the number of employees) on reported profitability. We observe that affiliates of more productive MNEs tend to bunch less at zero profit. Again, controlling for this, our result on complexity remains similar.[23]

5. Robustness and alternative specifications

In this section, we provide robustness analysis for our benchmark results.

5.1. Omitted variable – Other dimensions of complexity

We assess whether our results are driven by other dimensions of complexity of the MNE and its network. Complex ownership structure may reflect other determinants of firm organization, which could explain the

[23]Note that the lower and less precisely estimated coefficients in column (2) and (4) are related to the restricted sample on which the number of employees and labor productivity are available.

Table 5 – Confounding factors

	(1) $\mathbb{1}_{zero}$	(2) $\mathbb{1}_{zero}$	(3) $\mathbb{1}_{zero}$	(4) $\mathbb{1}_{zero}$
Avg. foreign tax rate	-0.115***	-0.065*	-0.099***	0.032
	(0.030)	(0.035)	(0.033)	(0.042)
Complexity	0.005***	0.004**	0.006***	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
GUO in a TH	0.010***			
	(0.004)			
MNE nb of employees (log)		-0.001**		
		(0.000)		
MNE total assets (log)			-0.002***	
			(0.001)	
MNE labor productivity (log)				-0.002
				(0.001)
Observations	212,516	139,165	180,078	90,267
R-squared	0.045	0.037	0.044	0.033
CountryFE	Yes	Yes	Yes	Yes
IndustryFE	Yes	Yes	Yes	Yes
SizeBinFE	Yes	Yes	Yes	Yes

Note: This table reports OLS estimates on cross-sectional data for the year 2018. *Av. foreign tax rate* is the unweighted average tax rate across the GUO and all subsidiaries of multinational firm j but subsidiary i. Standard error in parenthesis robust to heteroscedasticity and clustered at the subsidiary country level in columns (1) and (2) and the the multinational corporation level in others columns. All specifications include country FE, NACE-2-digit sector FE and size bins FE.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

larger bunching at zero profit of more complex MNEs to the extent that such dimensions affect their overall profitability. To deal with such potential omitted variable bias, we introduce, in Table 6, several alternative measures of complexity as controls: the presence in tax havens, the number of different industries in which the MNE operates and the number of different countries of location of affiliates to account for the geographical spread of the MNE.

Among these variables, the sectoral diversification is positively associated with bunching at zero, reflecting the fact that more productive firms may be more likely to manage activities in diversified industries. On the opposite, the geographical footprint and, surprisingly, the presence of the MNE in a tax haven and the number of tax havens in which the MNE is present are negatively associated to the probability to report zero profit. The negative coefficient associated with the number of tax havens is, however, reversed once we control for the geographical and sectoral spread of the MNEs (column (6)). In all specifications of Table 6, the coefficient on our complexity measure remains significant and of similar magnitude.

Table 6 – Zero profit and different dimensions of complexity

	(1) $\mathbb{1}_{zero}$	(2) $\mathbb{1}_{zero}$	(3) $\mathbb{1}_{zero}$	(4) $\mathbb{1}_{zero}$	(5) $\mathbb{1}_{zero}$	(6) $\mathbb{1}_{zero}$
Avg. foreign tax rate	-0.131***	-0.135***	-0.133***	-0.125***	-0.132***	-0.128***
	(0.030)	(0.030)	(0.030)	(0.029)	(0.030)	(0.030)
Complexity	0.006***	0.005***	0.006***	0.005***	0.005***	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
TH	-0.013***		-0.012***			-0.014***
	(0.003)		(0.003)			(0.003)
Nb diff. TH		-0.002**	-0.001			0.002*
		(0.001)	(0.001)			(0.001)
Nb diff. ind.				0.002***		0.003***
				(0.001)		(0.001)
Nb diff. countries					-0.000***	-0.001***
					(0.000)	(0.000)
Observations	212,516	212,516	212,516	212,516	212,516	212,516
R-squared	0.045	0.045	0.045	0.045	0.045	0.046
CountryFE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryFE	Yes	Yes	Yes	Yes	Yes	Yes
SizeBinFE	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table reports OLS estimates of eq. (1) on cross-sectional data for the year 2018. *Av. foreign tax rate* is the unweighted average tax rate across the GUO and all subsidiaries of multinational firm *j* but subsidiary *i*. *TH* is a dummy variable equal to 1 if MNF *j* has at least one affiliate located in a tax haven. *Nb diff. TH* is a variable equal to the number of different tax havens an MNF is located in. *Nb diff. ind.* represents the sectoral diversification of the MNF. *Nb diff.countries* represents the geographical spread of the network of subsidiaries of the MNF. Standard errors in parenthesis robust to heteroscedasticity and clustered at the multinational corporation level. All specifications include country FE, NACE-2-digit sector FE and size bins FE.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.2. Alternative measures of ownership network complexity

Another robustness check relates to our measure of the complexity of the ownership structure of the MNE. We use the average number of layers of ownership as our benchmark measure of complexity, due to its simplicity and the fact that it accounts for both the length of ownership chains as well as the number of affiliates at each layer. We use here alternative measures of complexity: the maximum level of layers of ownership within the MNE ownership network, a Shannon entropy measure and an (inverse) skewness measure (see Appendix 10). Results are presented in columns (1)-(3) of Table 7. All complexity measures display a positive and significant coefficient, in line with our benchmark results. The significance level is however lower for the skewness measure (column (3)), which is the less correlated with our benchmark complexity measure (the correlation is 40% against more than 80% for the other two measures). It confirms that the number of layers of ownership is a relevant dimension of complexity for tax purposes.

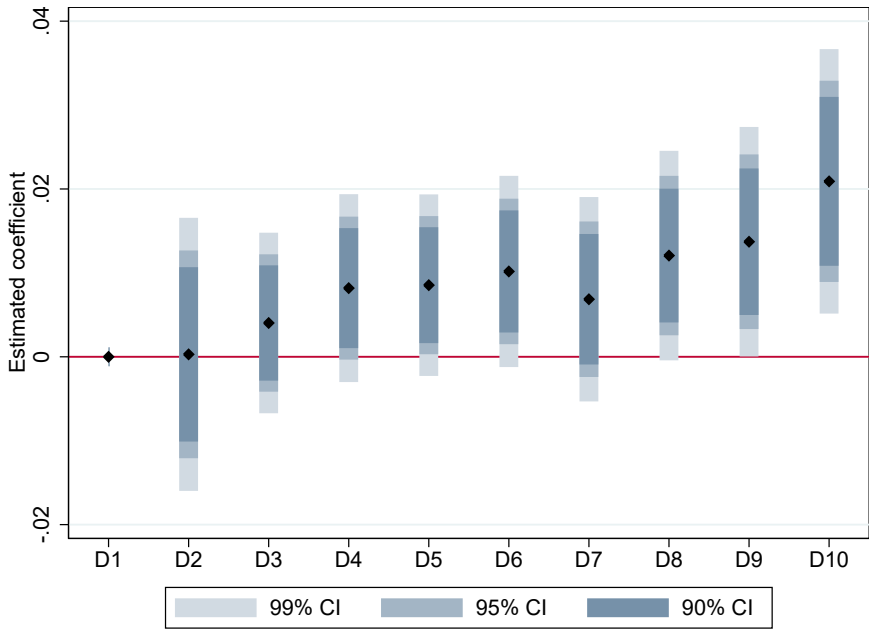
5.3. Other robustness tests

In Table 7, we also test whether our results are robust to controlling for common shocks across industries and countries by including country×sector fixed effects (see column (4) in Table 7). We also analyze the

effect of changing the level of clustering. In the benchmark results, standard errors are clustered at the multinational firm level in line with since the likelihood that one affiliate reports zero profit is likely to be correlated with the likelihood that another affiliate within the group bunches around zero profit. We show that our results are robust to clustering at the country level and at the country×MNE level in columns (5) and (6).

As a third robustness check, we remove the size fixed effect and focus on affiliates belonging to MNEs with more than 10 (respectively 50) affiliates in columns (7) and (8) to show that our treatment of the systematic relationship between the number of affiliates and complexity through fixed effects by bins of size does not drive our results. Focusing on large MNEs in terms of number of affiliates ensures that such complexity is not systematically affected by the MNE size (see Table I6). In all these instances, results remain qualitatively similar to the benchmark estimates.

A fourth robustness looks at the linearity in the effect of complexity on bunching at zero profit. We estimate Equation 1 using deciles of complexity of the MNE. Results are presented in Figure 5, which plots the estimated coefficients by decile of increasing complexity and their confidence interval. It shows that the impact of complexity on the probability to report zero profit is insignificant for low levels of complexity but increases with the level of complexity, especially for subsidiaries belonging to highly complex MNEs. The impact of MNE complexity is however not driven solely by these highly complex MNEs.



Note: This figure shows the estimated coefficient on the variable "Complexity" divided in deciles. The regression results are reported in column (4) of Table K10.

In Appendix 11, we additionally show that our results are robust to changing the definition of our dependent variable $\mathbb{1}_{zero}$ using alternative thresholds or definitions (Table K9). We also show in Table K10 that our results are robust to removing outliers.

Table 7 – Robustness tests

	(1) $\mathbb{1}_{zero}$	(2) $\mathbb{1}_{zero}$	(3) $\mathbb{1}_{zero}$	(4) $\mathbb{1}_{zero}$	(5) $\mathbb{1}_{zero}$	(6) $\mathbb{1}_{zero}$	(7) $\mathbb{1}_{zero}$	(8) $\mathbb{1}_{zero}$
Avg. foreign tax rate	-0.123***	-0.125***	-0.138***	-0.124***	-0.127*	-0.127*	-0.151***	-0.222***
	(0.029)	(0.029)	(0.037)	(0.029)	(0.066)	(0.066)	(0.040)	(0.067)
Complexity (max)	0.004***							
	(0.001)							
Shannon Entropy		0.014***						
		(0.003)						
Skewness			0.002*					
			(0.001)					
Complexity				0.006***	0.006**	0.006**	0.004**	0.006**
				(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
Observations	212,516	212,516	179,580	212,500	212,516	212,516	158,197	86,676
R-squared	0.045	0.045	0.045	0.055	0.045	0.045	0.046	0.056
Country FE	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Size Bin FE	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Industry × Country FE	No	No	No	Yes	No	No	No	No
Cluster	MNE	MNE	MNE	MNE	Country	MNE & Country	MNE	MNE

Note: This table reports OLS estimates on cross-sectional data for the year 2018. *Av. foreign tax rate* is the unweighted average tax rate across the GUO and all subsidiaries of multinational firm j but subsidiary i. *Skewness* is defined as the opposite of the standard skewness measure of the distribution of affiliate across layers. A positive value of skewness implies that more affiliates are located at layers further away from the GUO. Standard error in parenthesis robust to heteroscedasticity and clustered at the multinational corporation level in columns (1), (2), (3), (4), (7) and (8), at the subsidiary country level in column (5) and at both the multinational corporation and subsidiary country levels in column (6). All specifications include country FE, NACE-2-digit sector FE.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.4. Alternative specification

In this section, we estimate two alternative specifications using as the dependent variable either the log of profits or the return on assets as follows:

$$Y_i = \beta_0 + \beta_1 tax_{ij}^{for} + \beta_2 Complex_j + \beta_3 X_i + \theta_s + \theta_c + \theta_k + \epsilon_i. \quad (4)$$

Y_i is either the logarithm of reported profits or the return on assets. X_i are a set of non-tax factors – the logarithm of employment and the logarithm of fixed assets – which determine profits under the assumption of Cobb-Douglas production function and no differences in productivity across MNEs. The tax factor tax_{ij}^{for} represents the incentive to engage in profit shifting and $Complex_j$ is our complexity variable. As in Equation 1, we add fixed effects by size bins (number of affiliates), country c and industry k (NACE 2-digit). Standard errors are clustered at the multinational firm level.

Equation 4 is the standard framework used to study profit shifting when $\log profits_i$ is the dependent variable (e.g. Hines and Rice (1994), Huizinga and Laeven (2008), Dharmapala (2014)). Note however that $\log profits_i$ is not defined for negative or zero reported profit, so that results using this variable may suffer a selection bias (in line with the results of the previous section showing that the probability of reporting zero profit depends on the complexity of the MNE network as well as the average tax rate of the MNE). We improve on this standard specification by using as dependent variable the return on assets (ROA) instead, which can be estimated in level and is defined over positive as well as negative or zero

profits (Vicard, 2022; Bilicka and Scur, 2021). In the sample with information on employment, 31% of observations have zero or negative values for profits. ROA is computed as profits divided by total assets and is trimmed for the top and bottom 1%. When using the ROA as dependent variable, the logarithm of fixed assets is excluded from control variables X_i.

Table 8 reports the results. We alternatively use the unweighted average tax rate across all affiliates of multinational firm *j* but subsidiary *i* and the tax rate of the GUO of the MNE. In all specifications, complexity has a significant and negative coefficient, as expected: affiliates of more complex MNEs report lower profits or return on assets than other affiliates in the same country and sector. The point estimates imply that an increase in complexity by one layer decreases profits by 2.8% and the return on assets by 0.03 to 0.04 percentage points, which represents an reduction of 7% to 9%.

Table 8 – Profits and complexity - alternative specification

	(1) Profit (log)	(2) Profit (log)	(3) ROA	(4) ROA
Complexity	-0.028***	-0.028***	-0.004**	-0.003**
	(0.011)	(0.011)	(0.002)	(0.002)
Tax rate GUO		0.119		0.105***
		(0.174)		(0.024)
Avg. foreign tax rate	-0.641**		0.162***	
	(0.250)		(0.030)	
Nb of employees (log)	0.443***	0.442***	0.017***	0.017***
	(0.006)	(0.006)	(0.001)	(0.001)
Fixed assets (log)	0.292***	0.292***		
	(0.004)	(0.004)		
Observations	86,540	86,538	125,640	125,636
R-squared	0.517	0.517	0.021	0.021
CountryFE	Yes	Yes	Yes	Yes
IndustryFE	Yes	Yes	Yes	Yes
SizeBinFE	Yes	Yes	Yes	Yes

Note: This table reports OLS estimates of eq. (4) on cross-sectional data for the year 2018. *Av. foreign tax rate* is the unweighted average tax rate across the GUO and all subsidiaries of multinational firm *j* but subsidiary *i*. The ROA variable is trimmed to remove the 1^{st} and 99^{th} percentiles. Standard errors in parenthesis are robust to heteroscedasticity and clustered at the multinational corporation level. All specifications include country FE, NACE-2-digit sector FE and size bins FE.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6. Conclusion

This paper investigates the impact of complex ownership structures of multinational enterprises on tax avoidance. Using a cross-country dataset of European affiliates, we show that corporations belonging to more complex groups report lower profits than similar affiliates in the same country and industry. Such pattern holds for high-tax affiliates, confirming that complexity facilitates profit shifting between affiliates.

Our analysis extends the literature on profit shifting using micro-data in documenting a dimension of heterogeneity in profit shifting behavior across MNEs: only the more complex MNEs shift profit away from

their high-tax affiliates, while MNEs with a flat ownership structure do not show such tax sensitivity in their reported profits. Our results complement papers showing other dimensions of heterogeneity, across countries (Johannesen et al., 2020) and across corporations depending on the quality of their management (Bilicka and Scur, 2021) or size (Wier and Reynolds, 2022).

Such evidence of heterogeneity in profit shifting provide relevant insights for designing anti-avoidance policies. Tax authorities need quality information on the ownership structure of multinational enterprises to better understand profit shifting schemes. A first improvement is the introduction of Country-by-Country reports that requires all MNEs with previous year consolidated revenues above €750 million to disclose some financial information in each country in which they have an affiliate. However, there is no information regarding the ownership structure of the MNEs and its complexity. Our results show that such information would be valuable to tax administrations.

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Appendix

8. Data

A. Orbis data: extraction

A.1. Consolidated data:

We download financial information of Global Ultimate Owners (GUO) that have affiliates in the European Union. We drop MNEs with no financial information and duplicates. All information was downloaded on March 4th and 5th 2021. We then downloaded the ownership information for these 75505 GUOs. We ask

Table H1 – GUO - Financial database

GUO with affiliates in the EU27	738,130
Shareholders with foreign affiliates located anywhere	171,915
Drop firms with no financial information	75 881
Drop duplicates	75,505

for the ownership level of affiliates that are owned up to level 10. Information was downloaded on March 17th 2021. The initial database contains about 4 millions affiliates for the 75505 GUOs. We remove MNEs that either have no affiliates or have one affiliate that is in the same country as the GUO. We remove duplicates for affiliates that have the same ID, same GUO and same level. We also drop them if they have the same GUO but different level of ownership. In that case, we keep the lowest level of ownership. For affiliates that appear several times with different GUOs, we download directly from Orbis the ID of the GUO and the main shareholders and match this information with our initial information. We only keep observations for which we have a match. Finally, we drop firms for which the maximum number of layers is larger than the number of affiliates that we observe in the database. The final sample includes 1,330,423 affiliates owned by 66,539 different GUOs.

Table H2 – GUO - Ownership database

GUO with ownership network	3 961 883
Drop firms with no financial information	3 961 152
Drop firms for which the only affiliate is in the same country as the GUO	3 961 102
Drop firms with 0 subsidiary	3 960 908
Drop duplicates in terms of GuoID SubID and level	3 861 259
Drop duplicates in terms of GuoID SubID (we keep the observation with the lowest level)	3 284 454
Drop duplicates in terms of SubID after merging with ownership info from Orbis	1, 383,523
Drop if levelmax>nb sub	1,383,339
Drop NACE Rev2 Code between O and U	1,330,423

When we downloaded the ownership information of the 75,505 GUOs, we asked Orbis to give us the list of affiliates of each GUO up to level 10, which means that the ownership chain could contain up to 10 layers. We also asked for the total number of affiliates. When several levels are requested on Orbis, the number

of affiliates is limited to 1,000 per company. For those companies, it is impossible for us to compute the mean number of layers in the corporate group since we cannot observe all affiliates. We therefore decide to focus on companies for which we believe we have the right number of affiliates. We count the number of affiliates at each layer by company. We store the number of affiliates of level $n-1$, assuming that the maximum number of layers is n. In the analysis, we only consider groups for which the sum of $n-1$ level affiliates and the total number of affiliates declared by Orbis is lower than 1,000.

A.2. Unconsolidated data:

We start from the 1,330,423 affiliates. We keep those that are in the EU (570,678). We retrieve information for 328,785 affiliates for which we have unconsolidated accounts. We drop firms if total assets, employment, sales or tangible fixed assets is negative in one of the years studied. We also drop affiliates for which the number of affiliates in their MNE is unsure. The final sample contains 212,516 affiliates.

Table H3 – Affiliate database

Final list in the ownership network	1,330,423
Keep only affiliates in the EU27	570,781
Information available in Orbis	328,785
Cleaning	212,516

Figure A.1 – Distribution of MNEs across number of affiliates

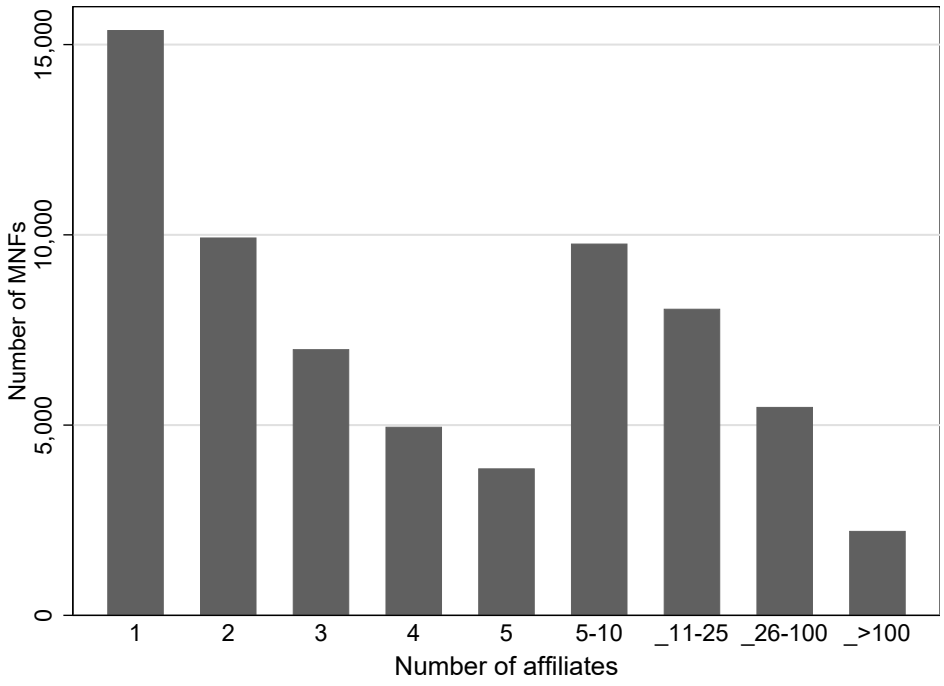


Table H4 – Descriptive statistics of the main variables

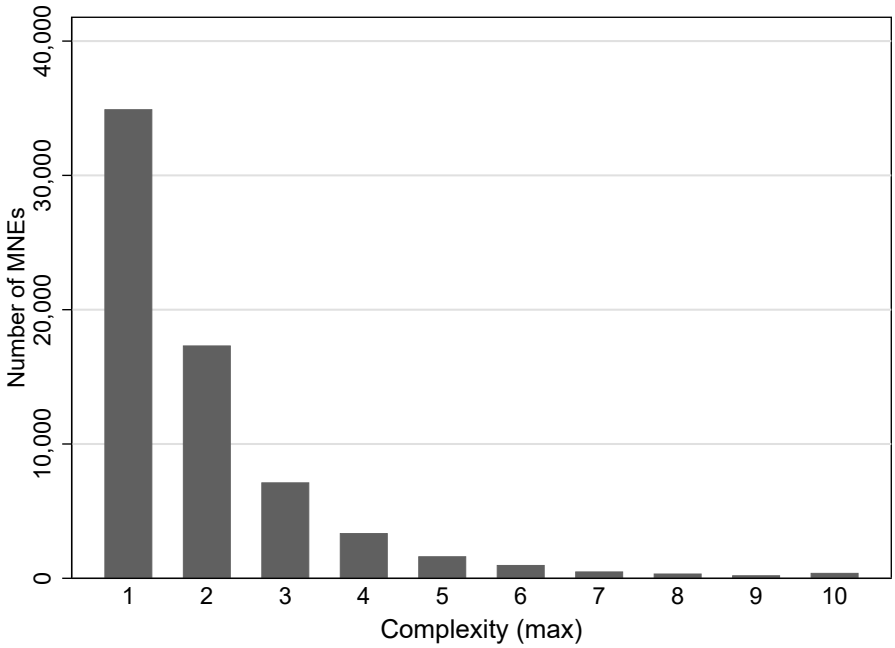
	Obs.	Mean	Std. Dev.	Min	Max
Consolidated data - GUO information					
Labor prod.	16,223	0.15	0.37	-0.53	4.74
Effective tax rate	30,727	0.16	0.28	-1.81	2.01
Return on assets	36,215	3.37	18.43	-143.34	78.09
Tax rate GUO	66,514	0.25	0.05	0	0.35
Diversification	66,539	3.13	2.57	1	21
Tax haven presence	66,539	0.27	0.45	0	1
Nb of diff. tax havens	66,539	0.46	1.08	0	21
Nb of diff. countries	66,539	3.86	6.28	1	151
Complexity	66,539	1.34	0.60	1	10
Nb of affiliates	66,539	16.09	48.57	1	949
Unconsolidated data - Subsidiary information					
Profits*	212,517	2.74	91.29	-4,757.94	20,017.72
Costs of employees*	132,522	5.2	31.4	-13.86	4,494.4
Total assets*	212,517	54.45	596.86	0	72,062.94
Fixed assets*	193,424	37.20	489.62	-0.2	56,050.48
EBIT*	212,517	2.08	80.09	-2,589.3	19,817.61
Number of employees	133,553	110.69	650.71	0	92,768
Share of affiliates in a TH	212,517	0.14	0.34	0	1
Zero profit (dummy)	212,517	0.1	0.3	0	1
ROA	208,265	0.90	28	-277.78	80.75
Avg. foreign tax rate (including the GUO)	212,517	0.25	0.04	0	0.35
Tax rate GUO	212,497	0.25	0.05	0	0.35
Tax rate SUB	212,517	0.25	0.06	0.09	0.35
Complexity	212,517	1.89	1	1	9.53

Note: Data is for the year 2018. Profits is the sum of EBIT and financial profit/loss. All financial variables with a (*) are in millions of euros. The effective tax rate, the return on assets (ROA) and the labor productivity variables are trimmed for the top and bottom 1%. The average foreign tax rate is the unweighted average tax rates across all subsidiaries and the GUO in MNE j except firm i. Zero profit is a dummy equal to 1 if a subsidiary declares a return on assets between [-0.005;0.005].

Table H5 – Distribution of subsidiaries by country - Subsidiary database

Country	Freq.	Percent
Austria	2,932	1.38
Belgium	16,164	7.61
Bulgaria	2,845	1.34
Cyprus	160	0.08
Czech Republic	7,523	3.54
Germany	9,640	4.54
Denmark	10,904	5.13
Estonia	2,715	1.28
Spain	23,130	10.88
Finland	4,753	2.24
France	28,878	13.59
Greece	957	0.45
Croatia	2,475	1.16
Hungaria	5,613	2.64
Ireland	4,416	2.08
Italy	26,315	12.38
Lithuania	918	0.43
Luxembourg	4,058	1.91
Latvia	2,005	0.94
Malta	1,381	0.65
Neitherlands	2,605	1.23
Poland	11,006	5.18
Portugal	8,639	4.07
Romania	6,883	3.24
Sweden	18,818	8.85
Slovenia	1,418	0.67
Slovakia	5,366	2.52
Total	212,517	100

Figure A.2 – Number of MNEs by maximum number of layers



9. Measuring complexity

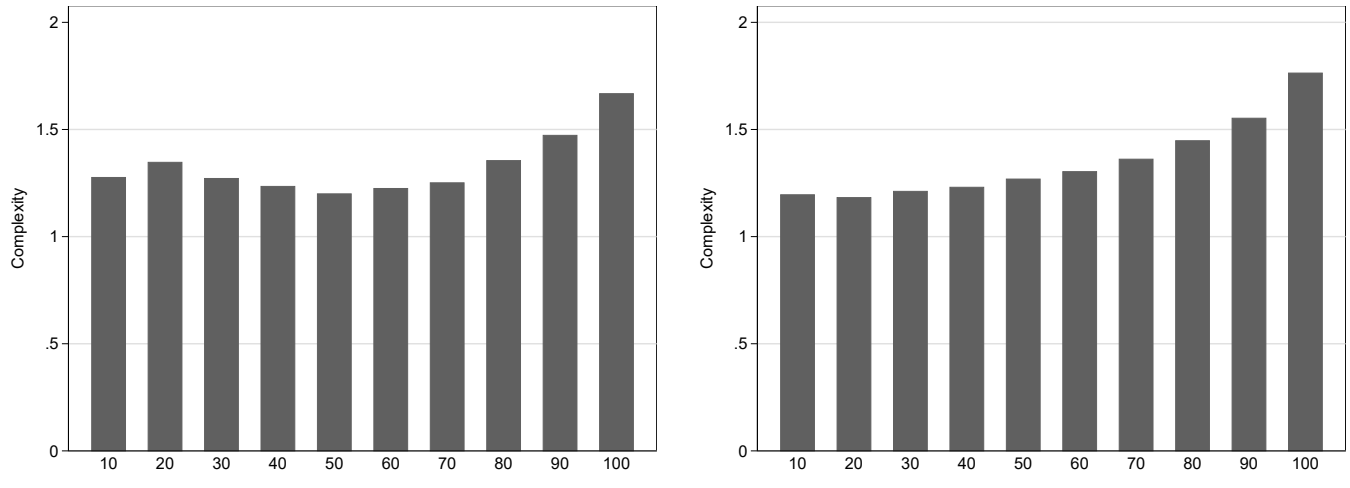
Table I6 – Maximum number of layers by number of affiliates

Max. nb of layers	Number of affiliates 1	2	3	4	5	6-10	11-25	26-100	>100	Total
1	15,370	7,495	4,150	2,419	1,504	2,676	1,055	210	11	34,890
2	0	2,423	2,502	2,118	1,831	4,665	2,866	855	42	17,302
3	0	0	330	373	442	1,841	2,426	1,472	224	7,108
4	0	0	0	34	66	436	1,118	1,326	348	3,328
5	0	0	0	0	7	105	344	752	396	1,604
6	0	0	0	0	0	25	138	419	374	956
7	0	0	0	0	0	6	50	180	238	474
8	0	0	0	0	0	1	17	102	200	320
9	0	0	0	0	0	3	8	60	118	189
10	0	0	0	0	0	0	23	89	256	368
Total	15,370	9,918	6,982	4,944	3,850	9,758	8,045	5,465	2,207	66,539

Figure .3 reports how complexity varies with other measures of the size of the firm than the number of affiliates: the number of employees and total assets. While larger firms tend to be more complex, the relationship between complexity and size is not as directly related using these alternative measures of size. The average number of layers is somewhat stable across employment size deciles up the 8th decile, and increases only for large MNEs belonging the the 9th and 10th deciles of employment; it is increasing with total assets particularly from the 5th decile.

We also investigate the source of variation in complexity, by country of origin, sector or size bins in terms of number of affiliates. Table I7 reports the R2 from regressing our complexity measure on fixed effects by size bin, sector and country. Column (1)-(3) show that country and sector fixed effects have little explanatory power (R2 of 4% and 2% respectively), while the size fixed effect explains 31% of the variation in complexity.

Figure .3 – Complexity by alternative measures of firm size



(a) Employment **(b) Total assets**

Note: Employment and total assets are categorized in deciles.

Table I7 – Determinants of MNE complexity

	(1) Complex.	(2) Complex.	(3) Complex.
Observations	66,539	66,539	66,539
R-squared	0.04	0.02	0.31
CountryFE	Yes	No	No
IndustryFE	No	Yes	No
SizeBinFE	No	No	Yes

Note: The dependent variable is the complexity at the MNE level. Standard errors in parenthesis are robust to heteroscedasticity. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

10. Alternative measures of complexity

We consider three alternative measures of complexity of the MNEs' ownership network. First, we consider the highest level of layer per group which we call "Complexity (max)". Figure A.2 confirms the finding above and shows that most multinational firms have a flat ownership structure: half have a full horizontal ownership structure with only one layer of ownership (52.4%), while another quarter have a maximum of 2 layers of ownership (25.8%). On the other end of the spectrum, 6.0% of multinationals hold their affiliates through up to 5 layers or more.

Second, we use a Shannon Entropy measure as in Ajdacic et al. (2021) computed as follows:

$$\text{Shannon entropy} = -\sum_i F_i \log F_i$$

where i is the layer number and F_i the fraction of affiliates at i's level. This measure enables to operationalize the measure of complexity by combining the width and depth of the structure. A firm can own affiliates through an ownership tree, where it directly holds subsidiary A that itself owns subsidiary B and so on. But complexity can can also occur horizontally: the relations within the group do not only occur between a parent (or immediate shareholder) and its affiliate but also between affiliates that are at the same level. This measure increases with the number of layers and with a more even distribution of the number of affiliates per layer.

Third, we consider the skewness of the distribution of affiliates across layers as in Altomonte et al. (2021). A positive skewness implies a right-skewed distribution and therefore there are more affiliates at layers close to the GUO. When skewness is negative, the distribution is left-skewed and there are more affiliates far (in terms of the number of layers) from the GUO. This measure is defined only for MNEs that have at least 2 layers and is therefore not available for all MNEs.

The maximum number of layers and the shannon entropy measure correlate with levelmean at over 80%, the skewness somewhat less at about 40%.

Table J8 – Summary statistics - Complexity

	Skewness	Entropy	Complexity (Max)	Complexity (Mean)
p25	0	0	1	1
Median	0.52	0	1	1
Mean	0.68	0.36	1.94	1.34
p75	1.33	0.67	2	1.5
Obs.	31637	66539	66539	66539

11. Robustness

A. Changing the definition of zero

We consider different definitions the our main dependent variable $zero_i$ in Table K9. In the benchmark results, $zero_i$ is a dummy variable equal to 1 if the return on assets is between -0.005 and 0.005. ROA below -0.005 and above 0.005 are thus treated the same way. We first consider only MNEs that exhibit positive or null profits in column (1). In column (2), we set the dummy $zero_i$ equal to 1 if the subsidiary has a ROA below 0.5% and we therefore consider a negative profit as a zero profit. This allows to account for the possibility that firms use loss carryovers as an instrument to optimize taxes. Finally, in columns (3) and (4), we set the dummy $zero_i$ equal to 1 if the ROA is between -0.01 and 0.01 and between -0.001 and 0.001 respectively. Table K9 shows that our results are robust to all the above specifications of our dependent variables.

Table K9 – Alternative definitions of zero profit

	(1) $\mathbb{1}_{zero}$	(2) $\mathbb{1}_{zero}$	(3) $\mathbb{1}_{zero}$	(4) $\mathbb{1}_{zero}$
Avg. foreign tax rate	-0.176***	-0.430***	-0.186***	-0.120***
	(0.039)	(0.055)	(0.035)	(0.025)
Complexity	0.005**	0.020***	0.007***	0.004***
	(0.002)	(0.004)	(0.002)	(0.002)
Observations	137,937	212,516	212,516	212,516
R-squared	0.056	0.055	0.048	0.050
CountryFE	Yes	Yes	Yes	Yes
IndustryFE	Yes	Yes	Yes	Yes
SizeBinFE	Yes	Yes	Yes	Yes

Note: This table reports OLS estimates on cross-sectional data for the year 2018. In column (1), we restrict the sample to firms that exhibit positive or null profits. In column (2), we set the dummy $zero_i$ equal to 1 if the subsidiary has a ROA below 0.5% and we therefore consider a negative profit as a zero profit. In columns (3) and (4), $zero_i$ equals 1 if ROA$\in [-0.01, 0.01]$ and ROA$\in [-0.001, 0.001]$ respectively. Standard errors in parenthesis are robust to heteroscedasticity and clustered at the multinational level. All specifications include country FE, NACE-2-digit sector FE and size bins FE.
*** p<0.01, ** p<0.05, * p<0.1.

B. Outliers

Our measure of complexity is very skewed to the left. We therefore deal with potential outlier issues in Table K10. We first run a Cook's distance test that measures the aggregate change in the estimated coefficients when each observation is left out of the estimation. We run the estimation after removing the top 1% data points that have the most weight in the estimation. We then focus on the role of affiliates belonging to the most complex MNEs. In column (2), we remove from the sample the affiliates that are in the top 10% in terms of complexity. In column (3), we interact our complexity measure with a dummy variable equal to 1 if the affiliate belongs to an MNE in the top 10% in terms of complexity. The coefficient on complexity is not affected by the changes. Finally, in column (4), we compute the effect of complexity on profit shifting by deciles of complexity. We observe that the effect of complexity on tax avoidance is larger for affiliates belonging to more complex groups than for affiliates belonging to MNEs that are less complex.

Table K10 – Dealing with outliers

	(1) $\mathbb{1}_{zero}$ Cook's test	(2) $\mathbb{1}_{zero}$ Top 10	(3) $\mathbb{1}_{zero}$ Top 10	(4) $\mathbb{1}_{zero}$ Non-par.
Avg. foreign tax rate	-0.115***	-0.086***	-0.127***	-0.126***
	(0.028)	(0.030)	(0.030)	(0.029)
Complexity	0.006***	0.007***	0.007***	
	(0.002)	(0.002)	(0.002)	
Top10			0.004	
			(0.019)	
Top10×Complexity			-0.002	
			(0.005)	
Complexity D2				0.000
				(0.006)
Complexity D3				0.004
				(0.004)
Complexity D4				0.008*
				(0.004)
Complexity D5				0.009**
				(0.004)
Complexity D6				0.010**
				(0.004)
Complexity D7				0.007
				(0.005)
Complexity D8				0.012**
				(0.005)
Complexity D9				0.014***
				(0.005)
Complexity D10				0.021***
				(0.006)
Constant	0.214***	0.110***	0.121***	0.125***
	(0.018)	(0.008)	(0.008)	(0.008)
Observations	210,390	191,406	212,516	212,516
R-squared	0.053	0.042	0.045	0.045
CountryFE	Yes	Yes	Yes	Yes
IndustryFE	Yes	Yes	Yes	Yes
SizeBinFE	Yes	Yes	Yes	Yes

Note:This table reports OLS estimates of eq. (2) on cross-sectional data for the year 2018. *Av. foreign tax rate* is the unweighted average tax rate across the GUO and all subsidiaries of multinational firm j but subsidiary i. Standard error in parenthesis robust to heteroscedasticity and clustered at the multinational corporation level in others columns. All specifications include country FE, NACE-2-digit sector FE and size bins FE. *** p<0.01, ** p<0.05, * p<0.1.