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Tax and Investment by Multinational Enterprises

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An Empirical Analysis of Tax Sensitivities Within and Across Jurisdictions

By Tibor Hanappi and David Whyman

Abstract

This paper investigates two closely related questions concerning the responses of Multinational Enterprise (MNE) investment to corporate income taxation using a panel of unconsolidated subsidiary-level and consolidated group-level data from the ORBIS database. First, the paper provides new evidence on the heterogeneity of investment responses to taxation across multinational firms. This paper finds that profit shifting opportunities, access to credit, and market power at the group level are associated with decreased investment sensitivity to taxation among MNE subsidiaries. Second, a new empirical approach is used to investigate how tax changes at the host jurisdiction level affect investment at the MNE group level and whether there are propagation effects to foreign subsidiaries within the same MNE group. This paper finds that tax rates in one jurisdiction in which an MNE is active are positively associated with investment in its subsidiaries in other jurisdictions. This finding suggests that the well-documented negative relationship between taxation and MNE investment within a host jurisdiction masks the MNE rebalancing the location of its investment to other host jurisdictions in response to changes in cross-jurisdictional tax rate differentials rather than purely decreasing its investment globally.

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1. Introduction

1. Corporate income taxation can affect real economic activity in various ways. A key response to taxation at firm level is the investment response. Dating back to early applications of the neoclassical investment theory (Jorgenson and Hall, 1967[1]), empirical research has generally confirmed an inverse relationship between corporate taxes and investment. Conceptually, this effect can operate through two different channels. First, corporate taxes increase the cost of capital, thereby reducing the number of economically viable investment projects; and, second, they affect firms' cash flow negatively, thereby reducing investments by liquidity-constrained firms. The analysis presented in this paper focuses on the first channel.

2. This paper aims to investigate how the unique properties of Multi-National Enterprises (MNEs) lead to distinctive dynamics of the investment response to taxation at both the subsidiary and group level that are fundamentally different from those of non-MNE groups and standalone entities. Using unconsolidated firm-level and consolidated MNE group level data from the Bureau van Dijk ORBIS database, the paper proceeds in several steps. First, it highlights the differential responses to taxation of MNEs compared to domestic firms. Second, it explores how MNE subsidiaries' within-country investment responses to taxation vary substantially with a variety of factors at the group level. This part of the analysis follows an approach similar to Millot et al. (2020[2]), and explores how the tax sensitivity to investment at the firm level[1] varies depending on profit shifting opportunities, market concentration and liquidity constraints at the group level. The importance of group-level characteristics in entity-level responses motivates the analysis of cross-border spillovers on investment, which constitutes the third and last part of the analysis. In this section, a new empirical approach is used to investigate how tax changes at the host jurisdiction[2] level affect investment at the multinational enterprise (MNE) group level and whether there are propagation effects to other subsidiaries within the same MNE group.

3. The consideration of MNEs as being different from other types of businesses is one that is gaining increasing attention in the literature. MNEs are estimated to have contributed around one third of global GDP in 2016 (Cadestin et al., 2018[3]). Compared to non-MNEs, MNEs often have organisational structures spanning large numbers of jurisdictions, which could have significant effects on how they react to changes in taxation. Among other factors, the ability of MNEs to reduce taxation through profit shifting and other tax planning strategies could affect their investment behaviour (Beer, de Mooij and Liu, 2020[4]; Overesch and Heckemeyer, 2017[5]). Typically, MNEs are also more reliant on intangible assets (Bajgar and Javorcik, 2020[6]; Alsamawi et al., 2020[7]; Cadestin et al., 2021[8]), suggesting that they might benefit relatively more from tax incentives (Appelt et al., 2016[9]; Bilir and Morales, 2020[10]; Reurink and Garcia-Bernardo, 2021[11]) while also locating intangibles strategically to further reduce taxation (Beer, de Mooij and Liu, 2020[4]; Knoll et al., 2021[12]).

[1] Firm(-level), entity(-level), and subsidiary(-level) are used interchangeably throughout this paper. These three terms are intended to contrast with (MNE) group(-level).

[2] Throughout the paper the jurisdiction of the ultimate parent entity is referred to either as ultimate parent jurisdiction or headquarters jurisdiction. Other jurisdictions where the MNE group has subsidiaries are referred to as host jurisdictions.

4. There are various theoretical foundations for the notion that these firm characteristics may affect tax sensitivity of investment. First, in an environment of increased market concentration and therefore greater pricing power, MNEs' profits increasingly consist of economic rents rather than normal returns to investment; the corporate tax incidence could be theorised to fall more on economic rents and therefore induce less behavioural response in investment decisions (Kopp, 2019[13]). Second, in addition to having a lower cost of capital given the ability to finance investments through retained earnings, cash-rich MNE groups lacking in credit constraints would be better positioned to shoulder a higher tax bill without reducing investment (Millot et al., 2020[2]). Finally, the link between profit shifting opportunities and tax sensitivity of investment is the most straightforward: to the extent that MNEs are able to plan for a substantial share of the profit from an investment to be taxed outside of the host jurisdiction, the tax rate in the host jurisdiction would have a substantially smaller effect on the MNE's decision to invest in the host jurisdiction.

5. Our results show that MNE tax sensitivities are distinctively heterogenous within countries and that there are spillovers between countries, confirming the specific nature of MNE investment responses to taxation and the importance of considering group-level characteristics and cross-border spillovers when examining the investment response of MNE subsidiaries. Firstly, the empirical findings show that investment responsiveness varies significantly across domestic and multinational entities, and that MNE tax sensitivities tend to be lower than those of domestic firms. This difference tends to be larger if: (i) the entity is not liquidity constrained; (ii) there are profit shifting opportunities within the MNE group; and (iii) the MNE group has a high degree of market power. Secondly, the analysis suggests that tax increases at host jurisdiction level may not lead to statistically and quantitatively significant investment responses at the MNE group level, while showing some evidence of positive cross-border tax effects on investment by entities in other jurisdictions within the same MNE group. Taken together, these latter two findings are consistent with the interpretation that MNE groups relocate economic activity within the group in response to tax changes at the jurisdiction level. The findings further demonstrate that a cross-border analysis is necessary to understand the effect of tax on MNE investment.

6. The new empirical evidence presented in this paper supports the view that the tax sensitivity of MNE entities indeed differs from that of domestic entities as well as across entities within MNE groups with different characteristics. It also supports the view that investment at the MNE group level may not respond strongly to tax changes at the jurisdiction level. Although the evidence suggests that lower tax sensitivities are observed for entities in MNE groups that are not liquidity constrained, or have either profit shifting opportunities or some degree of market power, the analysis leaves for future research the task of disentangling the relative importance of each of these factors. The analysis of cross border tax effects suggests that host jurisdiction tax changes motivate MNEs to relocate investment across jurisdictions; relocation could be another factor in explaining the lack of a significant investment impact at the MNE group level in response to tax changes at the jurisdiction level. These findings point towards the need for better recognition of the group- and entity-level variation in policy-relevant parameters such as the tax sensitivities of investment.

7. Considering the heterogeneity produced by the MNE's ability to utilize profit shifting opportunities as well as the positive cross-border tax effect produced by the MNE's ability to shift its distribution of substance across tax jurisdictions, the paper demonstrates that the investment effects of the MNE's unique exposure to a multiplicity of national tax rates (rather than the single national tax rate affecting non-MNEs) generates distinctive patterns in the MNE's tax sensitivity of investment. Furthermore, both of the other conditions generating entity-level heterogeneity explored in this paper (besides profit shifting opportunities, i.e. high liquidity, and market power), are also strongly correlated with MNE status even if not exclusive to MNEs. In general, this paper suggests that the design of tax policies dealing with MNEs specifically should consider a different set of projected responses than those dealing with non-MNEs.

8. The paper is organised as follows. The next section discusses relevant literature, Section 3 presents the data and relevant cleaning procedures. Sections 4 and 5 discuss the heterogeneity of

investment responses to taxation across domestic and multinational firms. Section 6 outlines cross-border tax effects within the MNE group, while Section 7 provides a conclusion.

2. Literature Review

9. This research is related to several existing strands of literature. First, there is substantial literature on investment responses to tax. Previous research using macroeconomic data has typically linked aggregate, i.e., jurisdiction level, data on foreign direct investment (FDI) to forward-looking effective tax rates (ETRs) capturing the main domestic corporate tax provisions (see Feld and Heckemeyer (2011[14]), for a review). Egger et al. (2009[15]) and Barrios et al. (2012[16]) expand this approach by including more international tax provisions such as withholding taxes and participation exemptions. Hajikova and Nicoletti (2006[17]) have a broader focus, extending to non-tax policies (e.g. relating to labour and product markets and border rules), which they find to significantly affect FDI flows, suggesting that focusing solely on tax factors can produce overestimated elasticities.

10. Second, this paper is related to an expanding literature highlighting heterogeneity in responses to investment. Within this literature, Vartia (2008[18]) shows that the tax sensitivity of investment differs across industries, while Schwellnus and Arnold (2008[19]) provide further evidence for the heterogeneity of these effects across different firm size and age groups. Millot et al. (2020[2]) analyse the relationship between the tax sensitivity of investment and profitability measured at the MNE group level, suggesting that firms in the most and least profitable MNE groups are relatively insensitive to tax increases.

11. Third, this paper links to the expanding literature on market concentration, which has argued that larger multinational or domestic groups are sometimes able to earn economic rents due to market power, for example as a consequence of winner-takes-most dynamics in globalised digital markets (Calligaris, Criscuolo and Marcolin, 2018[20]; De Loecker, Eeckhout and Unger, 2020[21]; Syverson, 2019[22]; Bajgar, Criscuolo and Timmis, 2021[23])

12. In addition to the vast tradition of econometric analyses of investment tax sensitivity that this paper draws upon, the fourth key literature is on cross-country spillover effects and distinctive structural and financial characteristics of MNEs. This literature is discussed in some detail below. Taken together, this literature coalesces around the idea that MNEs are distinct from non-MNEs in a number of important ways, critically their access to profit shifting and exposure to multiple national tax rates, and that these financial and structural distinctions may influence MNE behaviour related to investment both within and across countries.

13. In particular, a number of recent empirical studies have provided insights on how tax changes in a given jurisdiction can affect economic activities of MNE groups in other jurisdictions, going beyond the shifting of book profits. As an early example, Becker and Riedel (2012[24]) investigate effects of the statutory tax rate observed in the ultimate parent jurisdiction of an MNE group on the capital stock of its foreign subsidiaries, finding a negative relationship (Becker and Riedel, 2012[24]). In addition, the authors also find that the capital stock of the subsidiaries is more likely to decrease following a tax increase in the ultimate parent jurisdiction when the group's reliance on intangible assets is comparatively high. These findings suggest that MNEs may be reacting to corporate income taxation in one jurisdiction by adjusting investment in other jurisdictions. An MNE entity's exposure to tax rates in foreign jurisdictions represents a critical difference from a non-MNE entity.

14. In a similar vein, Suárez Serrato (2018[25]) investigates tax increases at the subsidiary level and their impacts on other entities in the MNE group, notably in the jurisdiction where the MNE group's headquarters is located. In particular, the author studies the repeal of a US tax code provision that had

effectively allowed Puerto Rican affiliates of MNE groups headquartered in the US mainland to reduce their tax liability. The study is based on a difference-in-differences approach focusing on the MNE group level, showing that after the repeal of this provision, US MNE groups with Puerto Rican affiliates reduced their investment and employment in the US mainland (Suárez Serrato, 2018[25]). This approach takes advantage of spatial variation in the proportion of incorporated firms owned by groups with Puerto Rican affiliates to show that US counties with high proportions of such firms experienced a relative decrease in investment and employment following the repeal. Although it builds on data including groups present in only one jurisdiction, this finding exemplifies how MNE groups may be reacting to a change in tax provisions in a given location by adjusting their investment behaviour elsewhere.

15. De Mooij and Liu (2018[26]) assess how the availability of a particular profit shifting channel, transfer pricing, affects the sensitivity of investment to tax changes. They find that investment of MNE entities located in jurisdictions with strong transfer pricing regulations is more sensitive to tax changes, suggesting that being part of an MNE group that has the ability to engage in profit shifting may be a source of heterogeneity in investment responses to taxation at the entity level, as will be examined in Section 5. Despite significant tax effects found in the within-jurisdictional setting, De Mooij and Liu (2018[26]) do not find a significant investment response at the MNE group level following the implementation of transfer pricing anti-abuse rules in jurisdictions where there is an MNE group presence. This finding may indicate that decreases in investment within the jurisdiction where the rule change takes place may be, to some extent, offset by increases in investment in other jurisdictions in which the MNE operates. To this extent, this result would provide support for a cross-border reallocation from subsidiaries located in jurisdictions with stricter transfer pricing regulations to subsidiaries in locations with less strict regulations.

16. Other studies also speak to the idea that external conditions affecting MNE entities in one jurisdiction could affect MNE activities in other jurisdictions. For example, Bena, Dinc, and Erel (2020[27]) find that the effects of economic recessions can propagate from MNE entities in affected jurisdictions to other entities within the same MNE group that are located in unaffected jurisdictions. This study suggests that when an MNE has a subsidiary in a jurisdiction that is subject to an economic recession, investment and employment are significantly lower across the MNE's other subsidiaries compared to similar MNEs without subsidiaries in countries experiencing a recession. Building on this result, the authors hypothesise that these propagation effects are caused by either the connectivity of global value chains or financial constraints at the MNE group level. While not specific to tax issues, this study corroborates the notion that economic conditions in jurisdictions where an MNE operates can affect that MNE's activities across other locations.

17. Knoll et al. (2021[12]) investigate cross-border effects in the context of research and development (R&D) tax incentives. The authors observe that MNE groups seek to locate their R&D investment, to the extent possible, in jurisdictions where R&D tax incentives are more generous. As jurisdictions change the level of generosity of their R&D tax incentives, MNE groups are found to adjust by relocating their R&D investment from jurisdictions that have become comparatively less generous to those that have become comparatively more generous. As a result, the authors conclude that although more generous R&D tax incentives in a given jurisdiction might increase R&D investment there, this effect is likely to come at the expense of R&D investment in other jurisdictions where the MNE group has affiliates. At the global level, R&D tax incentives are thus found to have hardly any effect on overall R&D investment.

18. The analyses in Sections 4, 5, and 6 provide evidence suggesting that investment response to taxation varies significantly between MNEs and non-MNEs, is heterogenous along characteristics emblematic of MNE status, and leads to cross-border spillovers when MNEs are concerned.

3. Data sources and cleaning

19. The empirical analysis presented in this paper primarily builds on the ORBIS database maintained by Bureau Van Djik (BvD). ORBIS contains hundreds of millions of unconsolidated financial accounts as well as comprehensive information about ownership links among subsidiaries within MNE groups. This data provides granular information on how the activities of MNE groups vary across jurisdictions and how economic activity, profits, and taxation are located within the ownership structures of MNEs.[3]

20. The ORBIS database includes the following tables: financial, ownership links, contact information, industry classification, and entities. The ownership links and financial tables are the most important for the purposes of the analysis presented in this paper. Data from multiple tables is combined using subsidiary ID numbers to construct a sample sufficient for the analysis, albeit with some gaps in company coverage. A corporate group can be identified as the set of entities that have the same entity listed as their global ultimate owner (GUO)[4] in the ownership links table, according to a 50% ownership threshold.[5] An MNE group is then defined as one that has subsidiaries in more than one jurisdiction based on the available ownership links. This approach partially insulates the identification of MNE groups from issues of uneven jurisdiction coverage in the financial accounts tables.

21. Data from the financial table includes key economic indicators such as tangible and intangible fixed assets, profits, taxes paid, turnover, number and cost of employees, and various other metrics. The financial table contains records at both entity (unconsolidated) and group (consolidated) levels, with the latter being typically only available for a group's GUO entity (i.e., the ultimate parent entity). The ownership table is organised with its unit of observation as one ownership link between one subsidiary entity and one shareholder entity, and includes variables for the GUO of the subsidiary. Bringing together the information from the financial and ownership links tables, a partial entity-by-entity representation of MNE group structures can be constructed, consisting of information at the subsidiary as well as the MNE group level.

22. For the purposes of the following analyses, a baseline dataset at the subsidiary-year level is assembled, where each row contains unconsolidated financial data and a GUO relating to one subsidiary in one year. The investment rate is calculated at the subsidiary level from the financial data as an adjusted change in fixed assets (see Box 1). MNE group level variables can be added to the subsidiary-year dataset as well, including characteristics that do not vary across subsidiaries within an MNE group. Any relationship between a group level characteristic and firm-level investment in such a dataset would indicate that being

[3] The use of ORBIS in this project builds on prior OECD work undertaken with this dataset. Among several other projects, the analyses presented in the BEPS Action 11 final report as well as for the Economic Impact Assessment of the Pillar One and Pillar Two blueprint reports has relied on ORBIS data (OECD, 2020[2]). In addition, ORBIS has been the main data source for empirical studies of the tax sensitivity of investment (Millot et al., 2020[11]; Sorbe and Johansson, 2017[10])

[4] GUO and UPE (Ultimate Parent Entity) are used interchangeably. The two terms are considered to be equivalent given how GUOs are defined here.

[5] A subsidiary is considered part of a corporate group if it is at least 50% directly owned by the GUO entity itself or by other subsidiaries that themselves are part of the corporate group. In this manner, the 50% ownership threshold is recursive rather than multiplicative.

part of a group with that particular characteristic was associated with the subsidiary's investment rate. It is this hypothesis that underlies the analysis of the variation in tax sensitivities across entities that follows.

Box 1. Computation of the investment variable

The investment rate variable is intended to represent real changes in the level of fixed assets in an entity (or corporate group) over time. Investment is calculated as the change in fixed assets plus (positive) depreciation. Prior to this calculation, however, fixed assets and depreciation must be adjusted for price differences across jurisdictions, years, and industries. In alignment with Millot et al. (2020[2]), the adjustment occurs as follows:

- Fixed assets and depreciation are each converted to local currency (fixed asset values in ORBIS are provided in Euros at BvD's exchange rates) in order to return to the original source values prior to BvD's currency conversion
- The subsequent values are divided by a jurisdiction and industry specific gross fixed capital formation deflator from OECD STAN (in order to adjust for price differences across time)
- The subsequent value is further divided by a relative price adjustment factor to achieve purchasing power parity (in order to adjust for price differences across jurisdictions)
- The resulting quantity is reconverted back to Euros using constant 2005 exchange rates

In Orbis, fixed assets are defined as the sum of tangible fixed assets, intangible fixed assets, and other fixed assets. Since the disaggregation into tangible and intangible assets is not always available, fixed assets are by far the best-covered variable, with missing variables making up only 2.1% of all observations in the raw sample. Fixed assets are therefore used to capture investment in this analysis. In comparison, tangible fixed assets are missing for 14.3% of observations and intangible fixed assets for 15.5%.

23. ORBIS coverage is not universal, particularly at the subsidiary level. Not every MNE subsidiary or domestic entity is present in the dataset, and coverage is uneven across jurisdictions and years. This is especially clear in light of recent evidence benchmarking Orbis against CBCR (Bratta, Santomartino and Acciari, 2021[28]). Therefore, this paper takes measures to narrow down available financial records to only those where confidence in their quality is high. A series of basic cleaning steps are undertaken (see Box 2). As in Millot et al. (2020[2]), the baseline dataset is restricted to entities' financial records from the years 2007-2016 and to 17 host jurisdictions where ORBIS coverage is considered to be highest: Austria, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Japan, Luxembourg, Netherlands, Portugal, Slovenia, Spain, Sweden, and the United Kingdom.[6] The final selection of jurisdictions is also affected by the availability of effective marginal tax rate (EMTR) data stretching back to 2007, required to match the available firm-level data from ORBIS. The EMTR data is from a ZEW project for the EU Commission that relies on the methodology developed by Devereux and Griffith (Spengel, 2020[29]; Devereux and Griffith, 1999[30]; Devereux and Griffith, 2003[31]). However, no restrictions are applied with regard to the location of the ultimate parent entity (i.e., the GUO) of MNE subsidiaries within the 17 covered jurisdictions. The final baseline sample consists of 234,300 entity-year observations from 11,543 distinct corporate groups. This sample is somewhat larger than that used by Millot et al. (2020[2]),

[6] Because Japan specifically is listed in Bureau van Dijk's materials as a poorly covered jurisdiction, we subject all regression results in this paper to an additional sensitivity test of the removal of Japanese observations from the sample. For all regressions, we find that the direction and statistical significance of results is unchanged due to the removal of the Japanese observations. These results are available upon request. While it would be beneficial to include data on subsidiaries located in the US in our analyses, the costly efforts of performing adjustments on a separate high-quality US microdata source in order to harmonise and align its data with Orbis are left for future work.

likely as a result of updates to the database by Bureau van Dijk since that paper was conducted and also due to slight differences in cleaning methods. Descriptive statistics regarding the baseline dataset are provided in Annex B. A sample of domestic groups is added to the baseline sample for a single regression specification in order to compare MNEs to non-MNEs directly. This non-MNE sample uses the same cleaning procedure as the MNE baseline sample.

24. It has been noted that significant differences exist between data on jurisdiction level tax payments from ORBIS and administrative tax return data, implying that ORBIS data on its own is not well-suited to estimate aggregate revenue effects of tax changes at jurisdiction level. However, as outlined in this paragraph, both research questions addressed in this paper focus on behavioural responses of MNE entities to taxation, not aggregate revenue effects. For this analysis it is therefore not strictly necessary to match aggregate revenue figures; the main requirement for the validity of this analysis is that there is no systematic omission of MNE entities *within* the MNE groups covered.

Box 2. Data cleaning procedures

A sequence of cleaning steps is applied to the ORBIS database in order to arrive at the baseline sample used in this paper. This approach largely follows the cleaning procedures set out by Kalemli-Ozcan et al. (2015[32]), Millot et al. (2020[2]), and Sorbe and Johansson (2017[33]). The changes in the distribution of observations across jurisdictions are visualised step by step in Figures B.4 and B.5 in Annex B. Beginning with the table of unconsolidated financial accounts, the following observations are dropped.

- Those outside the 2007-2016 year range or outside the following host jurisdictions: Austria, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Japan, Luxembourg, Netherlands, Portugal, Slovenia, Spain, Sweden, and the United Kingdom;
- Those without an MNE GUO at the 50% ownership threshold listed in the ownership links file;
- Those with missing values for necessary variables (e.g. fixed assets and depreciation) or where the account's audit status indicates accounting discrepancies (a status other than "unqualified");
- All entities that lack records for at least 7 years out of the 10 year sample range;
- Those with NACE codes outside the business sector and excluding financials;
- Those without a value-added growth value in the STAN database for the subsidiary industry, or those where the growth rate exceeds +/- 30%;
- Those where post-tax profit does not equal pre-tax profit minus taxation (with a 10% tolerance), and those constituting the top and bottom 1 percentile of MNE group profitability;
- Those where values for fixed assets are extreme (either negative or exceeding $500 billion);
- All entities where any observation fails any of the following tests in any given year:
  - Turnover to employees ratio is winzorised at the 99.9% level;
  - Assets to employees ratio is winzorised at the 99.9% level;
  - Profits exceed turnover
  - Turnover or number of employees is negative;
  - Components of fixed assets do not sum up to fixed assets (with a 10% tolerance);
- Those financial records that do not align precisely with a calendar year;
- Duplicates at entity-year level, prioritising observations with non-missing values in key variables and preferable accounting practice (IFRS and local GAAP are preferred);
- Those constituting the top and bottom 10% of values of investment rate.

In addition to the above steps applied to the baseline sample, additional cleaning steps are implemented for the purposes of the analyses at MNE group level. These cleaning steps are necessary to ensure that only those MNE records are retained where there is confidence that a large majority of an MNE group's activities are covered. This additional cleaning covers the following steps.

- Dropping all records where the consolidated fixed assets value is more than twice as high or below 50% of the sum of the unconsolidated fixed assets within a given year.
  - To conduct further robustness checks, additional samples are generated by modulating these upper and lower bounds, and regression results are largely equivalent in statistical significance and direction (see Figures F.1-4).
- Dropping all GUOs that exhibit year-on-year changes in the percentage of fixed assets located in the parent jurisdiction. The tolerance for a year-on-year change in domestic fixed asset proportion is 20%. In robustness tests, this proportion is varied within the range of [10%,100%], and regression results are largely equivalent in statistical significance and direction (see Figures F.1-4).

4. Investment responses of domestic and multinational entities

25. This section seeks to establish the contours along which the MNE investment response differs from the non-MNE investment response. This section therefore compares domestic and multinational firms to see whether they respond differently to a given tax change. If tax sensitivities would indeed differ across these two groups of firms, this finding would provide some initial evidence for the existence of significant variation in investment responses across the full distribution of firms – an important result given the policy relevance of this parameter estimate. For this purpose, the paper compares entities that are part of an MNE group to others that operate only in a purely domestic context. The difference in investment responses across these two groups is identified using the following fixed effects specification on the baseline sample supplemented with non-MNEs.

$$\begin{aligned} Firm\ investment\ rate_{f,t} & \\ &= {EMTR^{Host}}_{c,t-1} X\ MNE\ dummy_f + industry\ growth_{c,t-1,s} \\ &+ firm\ fixed\ effects_f + year\ fixed\ effects_t \\ &+ industry\ X\ year\ fixed\ effects_{s,t} \end{aligned} \quad (1)$$

26. In Equation (1), *s* denotes the sector, *t* is time (i.e., the year), *c* is the firm's host jurisdiction, and *f* is firm. Investment is calculated as change in fixed assets corrected for depreciation and adjusted for inflation, price, and currency differences (see Box 1). The MNE indicator is equal to one if the entity is part of any MNE group and zero if it is part of any non-MNE group or a standalone entity. Industry growth is computed from STAN value-added volumes on a 2-digit NACE (revision 2) sector level. This proxy for demand accounts for different growth rates across industries that would be expected to impact firm-level investment rates positively. In this specification, interacting the MNE indicator with the lagged host jurisdiction EMTR variable ($EMTR^{Host}$) allows for a direct comparison of the tax effect on investment by multinational and domestic firms.

Table 1. MNEs are less sensitive to EMTRs than non-MNEs

Dependent variable: firm-level investment

	(1)
Industry growth	0.029***
	(0.005)
$EMTR^{Host}$ X non-MNE	-0.138***
	(0.026)
$EMTR^{Host}$ X MNE	-0.093***
	(0.016)
Observations	545,095
R^2	0.384
Adjusted R^2	0.268

Note: Firm, year, and industry-year fixed effects are included. ORBIS unconsolidated data is from the following well-covered jurisdictions from the years 2007-2016, as per Millot et al. (2020[2]): Austria, Denmark, Estonia, Finland, France, Germany, United Kingdom, Greece, Hungary, Ireland, Japan, Luxembourg, Netherlands, Portugal, Slovenia, Spain, Sweden. To the "baseline" sample described in the data section above, non-MNEs from the same jurisdictions and years are added. (*) indicates significance at the p<0.1 level, (**) at the p<.05 level, and (***) at the p<.01 level.

27. The baseline results in Table 1 suggest that domestic firms respond more strongly to tax changes than MNE entities, holding other factors constant. While domestic firms exhibit a 1.4 percentage point decrease in investment for a 10 percentage point increase in host jurisdiction EMTR, MNE entities only exhibit a 0.9% decrease in investment, based on the regression results in Table 1. The MNE investment response to taxation is approximately one third smaller in magnitude than the response of other entities. While this result is qualitatively the same as in Millot et al. (2020[2]), the estimated tax sensitivity for MNE entities appears to be somewhat smaller, i.e., an effect size for MNE entities of -0.09 is found, compared to -0.13 in the earlier study.

5. Effects of MNE group-level characteristics on investment

Second portion of the analysis

28. The previous section provided evidence that when comparing the MNE and non-MNE average within-country investment response, the MNE investment response is smaller than the non-MNE investment response. Next, the analysis zooms in on MNE firms, evaluating potential drivers of the MNE investment response. To do this, the analysis examines certain characteristics emblematic of MNE status, specifically high profitability, liquidity, market dominance, and profit shifting opportunities.

29. Various possible explanations could be driving the different investment impact of taxation across multinational and domestic firms. As outlined above, there are a number of structural economic differences distinguishing the multinational sector from other sectors of the economy, which are often related to the fragmentation of production and location of assets and economic activities across jurisdictions. Given that tax sensitivities across domestic and multinational firms appear to be different, the next step of the analysis focuses on investment by multinational entities in order to provide insights as to whether MNE group-level characteristics affect investment responses. Since domestic entities are not linked to other entities abroad in the same way as those within an MNE group, the empirical relevance of MNE group-level characteristics would support the view that interdependencies within the group could be responsible for some of the differential tax impacts. In particular, a similar regression specification is used as before, while interacting additional characteristics associated with the MNE group as a whole with the EMTR variable. To study whether MNE group-level characteristics affect investment responses at the entity level, domestic entities are removed from the sample, leaving the baseline sample as defined above (see box 2). This empirical strategy provides a simplified approach to capture the impacts of MNE organisational structure on entity-level behaviour. If characteristics of the MNE group as a whole affect investment, this finding would provide support to the idea that MNE entities respond differently to tax changes than domestic entities. The setup is as follows.

$$\begin{aligned} Firm\ investment\ rate_{f,t} \\ = {EMTR^{Host}}_{c,t-1} X\ [MNE\ group\ indicator]_g + industry\ growth_{c,t-1,s} \\ + firm\ fixed\ effects_f + year\ fixed\ effects_t \\ + industry\ X\ year\ fixed\ effects_{s,t} \end{aligned} \quad (2)$$

30. In Equation (2), *s* denotes the sector (2-digit NACE revision 2 codes), *t* is time (year), *c* is subsidiary's host jurisdiction, *f* is firm (or entity) and *g* stands for the MNE group. *MNE group indicator* is a placeholder for the MNE group-level characteristic with respect to which the heterogeneity of investment response to taxation is being evaluated. In some cases this indicator is a binary variable (such as group presence in a zero-tax jurisdiction), and in other cases it is a continuous variable binned into several categories (such as quintiles of group book-tax differences). The following portion of the paper uses this

framework to conduct a series of regressions where each specification is used to evaluate a different MNE characteristic (*MNE group indicator)*, in interaction with the lagged host jurisdiction EMTR ($EMTR^{Host}$).

31. Some MNE characteristics relate to certain financial metrics or ratios, while others relate to characteristics of the MNE group structure. The characteristics can be primarily categorised into three channels: credit constraints, market concentration, and profit shifting. The full set of MNE characteristics are listed below. A detailed summary of the approach and the resulting regression tables is provided in Annex A. A second version of each regression is included containing the lagged investment rate as a regressor in order to account for persistence in investment behaviour (as explained in Annex A).

32. The MNE characteristics chosen are liquidity (credit constraints), market concentration (and markups), and profit shifting. These characteristics are important because they may be more prevalent amongst MNEs. MNEs may have better access to finance globally and therefore may be more liquid (Manova, Wei and Zhang, 2015[34]). Their size means they may be more likely to be "dominant actors" in their markets compared to non-MNEs, and finally they are able to access cross-border tax planning activities in ways domestic firms cannot (Cadestin et al., 2018[35]; Sorbe and Johansson, 2017[33]). Above, it was found that the MNE investment response to taxation is smaller than the non-MNE investment response to taxation. In as much as the results below show that the MNE investment response continues to shrink in tandem with these various characteristics more likely to be prevalent amongst MNEs, they would further indicate how MNEs are systematically different from non-MNEs in their investment behaviour.

5.1 Credit constraints

33. One MNE group indicator along which investment sensitivity to taxation can be measured is group-level liquidity. Less liquid MNE groups may be credit constrained, thus being forced to forego investment opportunities that would otherwise be economically viable. Given that taxation is expected to affect investment through the cost of capital, subsidiaries of credit constrained MNE groups would respond more to taxation in their investment behaviour. Following the approach outlined by Millot et al. (2020[2])[7], this paper computes liquidity indicators, averaged across years within each group, according to three potential ratios: current assets to fixed assets, cash flow to fixed assets, and cash and cash equivalents to fixed assets. For each of the three liquidity indicators, the MNE group characteristic is constructed as an indicator variable for whether the group liquidity ratio is above or below the respective median value. Given this set-up, it is expected that subsidiaries of MNE groups with below-median liquidity are relatively more sensitive to EMTR changes, while subsidiaries of MNE groups with above-median liquidity are relatively less sensitive to EMTR changes (Table A.2).

5.2 Mark-ups and market concentration

34. Another MNE group indicator along which tax sensitivities are evaluated is MNE group-level mark-ups. Following Sorbe and Johansson (2017[33]), mark-ups are proxied as the ratio of group EBITDA over group turnover, averaged for each group across the years for which subsidiaries of the group are present

[7] The first MNE characteristic along which investment sensitivity to taxation is measured is group-level profitability. Group-level profitability is computed as the ratio of group-level pre-tax profit divided by group-level turnover, averaged for each group across all years that subsidiaries from that group are present. This profitability construction essentially replicates that of Millot et al. (2020[2]) who found that subsidiaries of highly profitable and unprofitable groups are less sensitive to taxation. Highly profitable groups might be expected to be less sensitive to taxation due to their greater financial resources, while unprofitable groups may experience little or no tax liability. Therefore, the expectation is that the analysis will produce a similar finding to that in Millot et al. (2020[2]). See Table A.1 for the result.

in the baseline sample. The MNE group indicator is constructed for each subsidiary as a categorical variable splitting the group-level mark-ups into deciles. Unprofitable subsidiaries are dropped from the baseline sample. This follows Sorbe and Johansson (2017[33]), and represents one way to proxy the degree of pricing power held by a group within its market. High pricing power tends to indicate a monopoly or oligopoly position in a given market. In these cases, corporate tax incidence would be expected to fall to a larger extent on economic rents rather than the normal return on investment, potentially leading to a smaller tax effect on investment (Kopp, 2019[13]; Millot et al., 2020[2]). Following this argument, it would be expected that subsidiaries of groups in higher mark-up deciles are less sensitive to taxation in their investment behaviour (see Table A.3 for results).

35. Like mark-ups, market concentration could mediate MNE entities' sensitivity to taxation. For each MNE subsidiary in the baseline sample, market concentration is measured as the percentage of turnover controlled by the top 10 firms in the subsidiary's jurisdiction-industry in ORBIS. When calculating this percentage, industry is defined at the level of 2-digit NACE code groupings and excludes all jurisdiction-industries with less than 100 firms. A similar measure was also applied in an examination of market concentration by Sorbe and Johansson (2017[33]). In order to ensure the robustness of the measure, market concentration is also computed in this fashion as the percentage of turnover controlled by the top 5 and top 20 firms ("turnover percentage"). For each measure of market concentration, the MNE group indicator is constructed as a categorical variable denoting the tercile of the in-sample subsidiary's jurisdiction-industry's turnover percentage. Unlike mark-ups, the measure refers not to the market power of the MNE group, but rather to the level of concentration of the jurisdiction-industry in which the subsidiary operates. Therefore, the in-sample subsidiary with a high market concentration rating might not itself be in an oligopoly or monopoly position, but rather be operating alongside other (out-of-sample) firms that themselves occupy monopoly or oligopoly positions. However, the greater distance from the ideal of perfect competition in a highly concentrated market may still result in rents to all actors involved in that market. Therefore, as with mark-ups, the expectation is that subsidiaries in more concentrated jurisdiction-industries are less sensitive to taxation in their investment behaviour (see Table A.4 for results).

5.3 Profit Shifting

36. Profit shifting is another channel through which tax sensitivities might be affected (Sorbe and Johansson, 2017[36]). A number of MNE group indicators are used to evaluate the relationship between profit shifting opportunities and the tax sensitivity of investment. The first indicator of profit shifting evaluated is book-tax differences. Book-tax differences measure the difference between the statutory tax rate (STR) in a jurisdiction and the backward-looking effective tax rate (ETR) of a given firm. This measure is calculated at firm level[8] as cash taxes paid in ORBIS subtracted from the product of pre-tax profits and the STR of the host jurisdiction. To apply this measure consistently, unprofitable firms, firms with negative cash taxes paid, and firms where taxation exceeds profit are excluded from the baseline sample when analysing this channel. The MNE group indicator is constructed as a categorical variable denoting the quintile of each subsidiary's book-tax differences. An important driver of high book-tax differences may be the use of tax planning strategies that reduce backward-looking ETRs (Bilicka, 2019[37]). Accordingly, it is expected that MNE entities in higher quintiles might make greater use of tax planning, and may therefore be less responsive to taxation in their investment behaviour (see Table A.5 for results). However, it is worth noting that there a variety of factors aside from tax planning activities that can result in elevated book-tax differences. For example, MNEs in certain jurisdictions, industries, or those engaged in certain types of activities (such as R&D) may benefit from more tax credits or allowances than others, lowering their ETRs farther from the STR. As a result, the relationship between book-tax differences and investment tax sensitivity alone is not solely an indicator of the relationship between profit shifting and investment tax

[8] This firm-level book tax differences indicator takes the place of the MNE group indicator in equation (2)

sensitivity. For this reason, the result of the book-tax differences regression ought to be interpreted carefully and in context of the other indicators of profit shifting discussed below and analysed in Annex A.

37. While most of the financial indicators discussed in the previous paragraph have been used in firm-level regressions in previous research, relatively little research has been undertaken to quantitatively determine the effect of specific MNE group structures on investment responses to taxation. Specifically, whether or not the MNE group contains an intermediary within its organisational structure is of specific interest, as it is sometimes hypothesised that intermediaries may play an important role in profit shifting activities. Philips et al. (2020[38]) analyse the existence of intermediaries among large MNE groups using ORBIS. In that paper, an MNE subsidiary is defined as an intermediary if its ownership links connect it with upstream and downstream affiliates within the same MNE group that are each located in separate jurisdictions other than its own. As a further condition, the authors impose that an intermediary must have no ownership links within its own jurisdiction.[9] Following the same approach, an indicator variable is developed in order to evaluate whether subsidiaries of MNEs that have intermediaries in zero-corporate income tax (CIT) jurisdictions are less sensitive to EMTR changes in the host jurisdiction, with a focus on zero-CIT jurisdictions because of the tax avoidance role that may be played by jurisdictions with low tax rates. However, as zero-CIT jurisdictions do not tend to be well-covered in the ORBIS database's financial table, the ORBIS ownership linkages table is used for this purpose in order to identify which MNEs have a presence there. An indicator variable is constructed that takes a value of 1 if an MNE subsidiary is part of a group that has at least one intermediary in a zero-CIT jurisdiction according to the ownership linkages table, and a value of zero otherwise (see Table A.6).

38. In addition to intermediaries, two simpler group structure indicators of profit shifting opportunities are used: whether the group has at least one subsidiary in an investment hub, and whether the group has at least one subsidiary in a zero-CIT jurisdiction.[10] Due to their low tax rates, zero-CIT jurisdictions may be important subsidiary locations for MNE groups engaging in tax planning schemes with the goal of reducing group-wide tax liability. Investment hubs are defined as jurisdictions with a total inward FDI position above 150% of GDP (OECD, 2020[39]). Holding other factors constant, MNE groups with subsidiaries in investment hubs or in zero-CIT jurisdictions are expected to be more likely to engage in tax planning. According to this line of reasoning, smaller tax sensitivities may be observed among subsidiaries of groups with at least one subsidiary in a zero-CIT jurisdiction or at least one subsidiary in an investment hub. Similarly to intermediaries, the ORBIS ownership linkages table is used to construct indicators for whether or not an MNE subsidiary is part of a group with a presence in either an investment hub or a zero-CIT jurisdiction (see Tables A.7 and A.8)

39. An important caveat in interpreting the results on profit shifting is that coverage gaps in ORBIS may impede an examination of profit shifting. Recent evidence benchmarking ORBIS against CbCR microdata found that ORBIS contained substantially fewer MNEs, especially in investment hubs and the US (Bratta, Santomartino and Acciari, 2021[28]). Further, the same paper found that the estimate of the intensity of profit shifting is non-linear with respect to the incentive to shift profits. Because entity-level data from the ORBIS sample underweights US MNEs and subsidiaries in investment hubs, which have been found to be the most intensely involved in profit shifting, the results presented here may underestimate the impacts of profit shifting, and how it mitigates the tax sensitivities of investment.

40. It is also important to note that MNE-level characteristics regarding the existence of a subsidiary (with the exception of book-tax differences and market concentration) refer to whether or not the subsidiary in the sample is part of a group that also has *another* subsidiary that meets the certain characteristic, as defined below. For example, the indicator "subsidiary in zero-CIT jurisdiction" refers to whether the

[9] Specifically, a subsidiary in jurisdiction A is an intermediary if it is owned exclusively by subsidiaries in jurisdiction B, and itself owns only subsidiaries in another jurisdiction, C.

[10] Note that this indicator is agnostic as to whether the subsidiary is an intermediary.

subsidiary within the sample (located in one of 16 European jurisdictions or Japan) is part of a group that has a *different* subsidiary located in a zero-tax jurisdiction. In other cases, continuous MNE characteristics are transformed into categorical variables in order to interact them with the EMTR. These transformations sometimes require that additional restrictions be placed on the sample, including limits to profitable firms only or to profitable MNE groups only.

5.4 Summary

41. The results from these regressions are broadly indicative of several main findings (see Annex A and Table F.1 for detailed results). First, the results suggest significant heterogeneity in entity-level responses across different MNE groups; for most of the indicators discussed above, the results from the baseline regression suggest entities from MNE groups in different categories have responded differently to taxation, although in some cases no statistically significant difference can be detected between the coefficient estimates (e.g., for some of the liquidity indicators as well as the markup and investment hub indicators). These results suggest that, for example, subsidiaries of MNE groups that have intermediaries in zero-CIT jurisdictions show no significant investment response to taxation. By contrast, this is not the case for subsidiaries of MNE groups without an intermediary in a zero-CIT jurisdiction.

42. In the large majority of cases, the results point in the expected direction, even if using multiple different definitions of a given channel. MNE subsidiaries appear to be less responsive to taxation if they are part of an MNE group that is not credit constrained (Table A.2), is highly profitable (Table A.1) or lossmaking (Table A.1). Lower tax sensitivities of investment were also found among MNE subsidiaries that had higher levels of potential profit shifting indicators, such as high book-tax differences (Table A.5). Similarly, subsidiaries of MNE groups with subsidiaries and intermediaries in zero-tax jurisdictions also seem to experience lower tax sensitivity (Tables A.6-A.8). In addition, entities are also found to be less responsive if they are within a highly concentrated industry (Table A.4). All of these results tend to show that as the characteristic emblematic of MNE status intensifies, investment sensitivity to taxation decreases at the entity level.

43. As it is likely that many of these characteristics may be in part correlated with one another, identifying which characteristics are the drivers behind this variation in tax sensitivities is left for future research. The results found using the baseline sample are confirmed in a dynamic specification in some but not all of the above cases. In most cases, the host jurisdiction EMTR effect differential observed with the dynamic specification is estimated to be broadly the same or slightly larger than in the baseline, although in some cases no statistically significant difference can be detected (Table F.1). In addition, it is worth noting that the finding of decreased investment sensitivity in non-hub subsidiaries of groups with subsidiaries in investment hubs in the baseline specification does not hold up in the dynamic specification (Table A.7).

44. Taken together, these findings suggest that the characteristics of the MNE group as a whole affect the investment responses of entities within the group, even if statistically significant differences cannot be detected in each of the possible specifications. This finding is as expected given that MNE groups optimise their activities across all jurisdictions in which they are active. Compared to MNEs, corporate groups that are active in only one jurisdiction face a limited set of possible responses to a given policy change, e.g., in terms of their production, marketing and distribution activities as well as regards profit shifting and the strategic location of intangible assets. Interdependencies within MNE groups could therefore mediate the impact of tax changes in a given jurisdiction, potentially explaining a part of the observed difference in investment responses across domestic and multinational entities.

45. The findings up to this point have compared the within-country response at the entity level of MNEs and non-MNEs, and found significant differences related to MNE status. Moreover, the results have highlighted the importance of group-level factors in explaining entity-level responses. In the next section

of the paper, this question is further explored by examining how impacts of taxation flow from one part of the group to another. For a non-MNE, the entity-level response and the global investment response to taxation point in the same direction, though their magnitudes are different. However, given the multiplicity of tax rates that MNEs are exposed to, the same might not be true for MNEs at the global level. Indeed, given the various existing papers in literature showing cross-border investment spillovers within MNE groups in response to taxation and other external factors, there is strong evidence that the comparison between MNEs and non-MNEs on the global level may be more complex than on the entity level. The following analyses explore the possibility that cross-border effects within MNE groups play a role in shaping entity and global level investment responses to taxation.

6. Cross-border tax effects within MNE groups

46. The evidence presented above has shown that MNE group-level characteristics can affect tax sensitivities at the entity level, with certain types of MNE groups displaying lower investment responsiveness to taxation. This section focuses explicitly on cross-border tax effects within MNE groups by first asking a natural follow-up question: does MNE investment at group level respond to tax changes in jurisdictions where the MNE is active? If MNE group-level investment does not respond, the relocation of investment across entities within the same MNE group could be a possible explanation. To explore this possibility, this section presents additional analysis attempting to detect evidence of investment relocation within the MNE group.

6.1 Empirical strategy

47. The observed variation in investment responses across MNE entities raises the possibility that tax increases in a given jurisdiction induce a relocation of economic activities to other jurisdictions, either where the MNE group has existing subsidiaries or to new locations. The following analysis investigates whether the negative within-jurisdictional effect of taxes on investment could be mitigated at MNE group level through cross-border relocation of investment within the MNE group.

48. If that mitigation were indeed occurring, two specific effects would be expected in the data.

- Hypothesis 1: First, some insignificant (or at least very small) effects of tax changes at jurisdiction level on investment at the MNE group level.
- Hypothesis 2: Second, tax increases in one jurisdiction where the MNE group is active induce a positive investment response by other entities within the same MNE group located in different jurisdictions (provided that these different jurisdictions do not change their tax rate or increase it by less than in the one jurisdiction).

Such a positive cross-border tax effect would point in the opposite direction of the negative within-jurisdictional effect. If present, positive cross-border tax effects would imply that investment impacts at MNE group level could be smaller than the more easily observed within-jurisdictional effects.

49. The central challenge in estimating the effect of subsidiary-level tax rates on MNE group-level investment is that MNE groups with operations in more than one jurisdiction are exposed to multiple different jurisdiction level tax rates. An MNE group as a whole may be exposed to tax changes at different times in different host jurisdictions, multiple times in some jurisdictions, and never in others. Specifically, an MNE group may have subsidiaries that are simultaneously subject to tax increases and decreases in their respective jurisdictions. This possibility raises the question of how to correctly incorporate the full set of simultaneous tax changes into the analysis.

50. A further consideration is that not all jurisdictions may be equally important to an MNE group's operations. That is to say, a tax change in a jurisdiction where an MNE group conducts most of its

substantial operations would likely impact group-level investment more than a tax change in a jurisdiction where the MNE group has very little economic substance.

Box 1. Construction of the MNE group-level sample

For the purposes of analyses at MNE group level, a specific MNE sample must be created using consolidated investment rates at that level. The time covered in this sample remains 2007-2016, and the jurisdictional composition also remains the same (i.e., 16 European jurisdictions and Japan), except that these jurisdictions are now treated as ultimate parent jurisdictions rather than the location of subsidiaries. For each MNE group in the sample, the analyses require information on the distribution of the group's economic substance across all jurisdictions where it has a presence and that are available in the data. In order to acquire this information, unconsolidated data on the amount of fixed assets in each jurisdiction and for each year is linked to the respective MNE group in the sample.

Furthermore, the analyses require a combination of information from MNE group level with information from the entity level as contained in the baseline sample. To accomplish this, records from the two samples are paired on the group-year level. For these two samples, the investment rate is calculated in the same way as the baseline sample (see Box 1). Annex C contains additional descriptive statistics for the MNE group-level data used in the following analyses.

51. To address these challenges, the tax changes in all locations where an MNE group is active and present in the data are weighted according to a measure of their economic substance. This approach allows all relevant jurisdiction level tax rates to be condensed into a single weighted tax rate variable. Computed by MNE group and year, this variable represents a weighted average of all tax rates in host jurisdictions according to the percentage of a given MNE group's economic substance present in the respective host jurisdiction. This approach allows for the capture of the simultaneous exposure of MNE groups to opposing tax rate changes, as well as relative differences in the economic substance across jurisdictions.

52. The economic substance weights are computed based on unconsolidated data on firms' fixed assets as observed in ORBIS. The decision to use fixed assets rather than tangible fixed assets to measure economic substance is driven by the lower data quality and higher percentage of missing values for tangible fixed assets compared to fixed assets[11]. To ensure adequate coverage of an MNE group's economic activities, a more restrictive cleaning procedure is applied, linking unconsolidated with consolidated data and benchmarking across multiple levels of aggregation (see Box 2).

53. Another important aspect of the economic substance weight calculation is determining whether to keep the substance weights within each MNE constant across time by averaging each jurisdiction's share in global substance across years, or rather to allow a jurisdiction's substance weight to vary across time as observed in the data. This decision hinges on the degree of confidence in the ORBIS database and its ability to capture changes in substance across time. In particular, prior research has flagged that ownership links are a poor gauge of firm entry and exit (see Bajgar et al. (2020[40])), suggesting that changes in substance across time would be tainted by data quality issues. While the main regression in the body of the paper uses time-variant domestic substance weights, the results are robust to the use of time-invariant weights as well (see Annex E).

[11] As mentioned previously, a notable difficulty in this exercise is that prior evidence comparing ORBIS to CbCR has found that ORBIS MNE groups frequently lack financial information on some of their subsidiaries (Bratta, Santomartino and Acciari, 2021[28]).

6.2 Results

54. As Becker and Riedel (2012[24]) have argued, there could be certain activities taking place in the ultimate parent jurisdiction that relate to the production of a common input, which is important for the operations of the entire MNE group. As a consequence, investments in the ultimate parent (or headquarters) jurisdiction may be stickier, in the sense of being more difficult to reverse, compared to investments in foreign subsidiaries (Egger and Stimmelmayr, 2017[41]). In addition, for a variety of non-financial reasons, it is likely to be more difficult for MNE groups to change the location of their headquarters in response to tax changes (OECD, 2020[39]). To account for the special function of the ultimate parent entity, the following analysis accounts for the possibility that cross-border tax effects relating to the jurisdiction of an MNE's headquarters could differ from those relating to other jurisdictions where the MNE has a presence.

55. As a first step in the analysis of MNE group-level investment, the focus is on the interaction between time-variant domestic substance weights and an indicator variable for the MNE group's ultimate parent jurisdiction. In the following specification, MNE group-level investment is the dependent variable that is regressed on the lagged statutory tax rate[12] in the ultimate parent jurisdiction, interacted with a binary variable indicating whether or not more than 80% of the MNE group's economic substance is located in the parent jurisdiction.

$$\begin{aligned} Groupwide\ investment_{g,t} & \\ &= STR^{UPJ}{}_{g,t-1}\ X\ [domestic\ substance\ weight > 80\%\ ]_{g,t} \\ &+ STR^{UPJ}{}_{g,t-1}\ X\ [domestic\ substance\ weight < 80\%\ ]_{g,t} \\ &+ group\ fixed\ effects_g + year\ fixed\ effects_t \end{aligned} \tag{3}$$

56. In this equation, *g* denotes MNE groups and *t* is time. STR^{UPJ} refers to the STR of the MNE's ultimate parent jurisdiction. Investment is calculated identically as above, as a change in fixed assets corrected for depreciation and adjusted for inflation, price, and currency differences (see Box 1).

57. The results in Table 2 are as expected, indicating on the one hand that MNE groups with a high percentage of economic substance located in the parent jurisdiction have a higher sensitivity of MNE group-level investment to tax rates in the parent jurisdiction (i.e., more negative parameter estimates). On the other hand, MNE groups with less economic substance located in the parent jurisdiction do not exhibit significant group-level investment responses to tax rates in the parent jurisdiction. As these findings suggest, economic substance weights, computed as jurisdictional shares in fixed assets at MNE group level, capture information about MNE group structures that is relevant for understanding how host jurisdiction tax changes affect MNE group-level investment.

58. In addition to using the 80% domestic substance threshold, additional specifications in the annex interact the STR in the UPJ with various other cross-sections of time-invariant domestic substance weights including terciles, 25% intervals, and the median threshold. The results in Table 2 are fundamentally conserved across these additional specifications (see Annex E).

[12] For calculating a weighted-average tax rate that accurately captures group-wide tax effects, STRs are chosen over EMTRs. This is because EMTR data going back to 2007 is only available for a small selection of countries. In order to calculate an accurate weighted average tax rate at the MNE group level, it would be necessary to compute a weighted average of the tax rates in all countries where it is present. If EMTRs were used to calculate the weighted average tax rate, not all countries where the MNE is present could be included, causing the rate to be biased. Given that STR data is available for all countries and years, this measure is the preferred choice for calculating a substance-weighted CIT rate. However, given that EMTRs take into account changes to the tax base as well as the tax rate, EMTRs would have been used in place of STRs had they been universally available stretching back to 2007.

Table 2. STRs in the parent jurisdiction affect MNE group-level investment only when levels of economic substance located in the parent jurisdiction are relatively high

Dependent variable: group-level consolidated investment

	(1)
UPJ STR X domestic substance 0-80%	-0.064 (0.128)
UPJ STR X domestic substance 80-100%	-0.148** (0.068)
Observations	14,539
R2	0.392
Adjusted R2	0.259

Note: MNE group and year fixed effects are included. ORBIS consolidated data is from the following well-covered parent jurisdictions from 2007-2016, as per Millot (2020): Austria, Denmark, Estonia, Finland, France, Germany, United Kingdom, Greece, Hungary, Ireland, Japan, Luxembourg, Netherlands, Portugal, Slovenia, Spain, Sweden. (*) indicates significance at the p<0.1 level, (**) at the p<.05 level, and (***) at the p<.01 level.

59. The next step in the analysis is to address the central question of the relationship between host jurisdiction (entity-level) tax changes and MNE group-level investment. For the purposes of these regressions, statutory tax rates are used instead of EMTRs because MNE activities are spread out across a much larger set of jurisdictions, most of which are not covered in existing EMTR data series.[13] To account for the special function of ultimate parent entities, the tax impacts on MNE group-level investment by parent and subsidiary locations are analysed separately (specifications (1) to (3) in Table 3) before combining them in specification (4) (see Table 3). The general setup is similar to the specification used in the previous regression.[14]

$$Groupwide\ investment\ rate_{g,t} = STR^{ESW}{}_{g,t-1} + group\ fixed\ effects_g + year\ fixed\ effects_t \qquad (4)$$

60. In this equation, *g* denotes MNE groups and *t* is time (measured in years). STR^{ESW} indicates the economic substance-weighted STR. In different specifications, the STR^{ESW} will be limited to host jurisdictions only (weighting excludes ultimate parent jurisdiction) or exchanged for an STR^{UPJ} (ultimate parent jurisdiction STR).

61. As shown in Table 3, the economic substance-weighted average statutory rate (STR^{ESW}) of the MNE group does have a significant negative impact on MNE group-level investment (i.e., in specification (2)), implying that tax increases in economically relevant jurisdictions reduce MNE group-level investment. However, excluding the parent jurisdiction from the substance-weighted average STR, such that it

[13] Dropping observations pertaining to jurisdictions without available EMTRs would result in biased weighted tax rate variables due to missing observations. However, because of known issues with ORBIS coverage and missing data, it is probable that there is therefore some bias present even when using STRs.

[14] In general, it would be preferable to control for the existence of accumulated loss carryforwards at MNE group and entity levels, as well as the tax rules pertaining in the respective jurisdictions with regard to the treatment of accumulated losses within the MNE group. While accumulated losses can have impacts on tax responsiveness, for example, if they are easily transferable across entities within the MNE group, their effects cannot be investigated in this study due to the lack of adequate data.

becomes the substance-weighted average STR of subsidiary jurisdictions only, shows that the significant negative effect on the MNE group-level investment disappears (i.e., in specification (1)). In addition, the direction, size, and significance of these effects remains almost exactly the same in specification (4), where both variables are included, i.e., the STR in the parent jurisdiction and the substance-weighted average STR across subsidiary jurisdictions. Specification (3), where only the STR in parent jurisdictions is included, further corroborates this interpretation.

62. These findings suggest that the significance of the substance-weighted average STR in specification (2) is driven mostly by the special function of the MNE headquarters,[15] while STRs in subsidiary jurisdictions do not significantly reduce MNE group-level investment based on these estimates. This result aligns with the notion that investment in subsidiary locations can more easily be relocated across jurisdictions in response to tax changes, and is also consistent with the hypothesis that MNE groups relocate economic activity across subsidiaries in response to tax changes in the respective jurisdictions of their subsidiaries. In short, the findings lend support to Hypothesis 1 discussed above.

63. The results in Table 2 also give reason, however, to believe that the importance of tax changes in parent jurisdictions is driven mostly by those MNE groups that have the most economic substance in their ultimate parent jurisdiction (i.e., more than 80%). Indeed, MNE groups with less than 80% of their economic substance located in the jurisdiction of their parent entity appear to experience no statistically significant negative effect of taxation on MNE group-level investment. This finding suggests that the negative ultimate parent jurisdiction tax effect on MNE group-level investment could be driven by those MNE groups that have relatively little multinational presence in terms of fixed assets located abroad. For other MNE groups, tax rates in the parent jurisdiction appear to be less relevant for MNE group-level investment.

Table 3. Host jurisdiction STRs do not significantly affect global investment levels

Dependent variable: group-level consolidated investment

	(1)	(2)	(3)	(4)
Economic substance-weighted STR, host jurisdictions only	0.027 (0.026)			0.026 (0.026)
Economic substance-weighted STR		-0.146** (0.068)		
UPJ STR			-0.132** (0.064)	-0.131** (0.064)
Observations	14,539	14,539	14,539	14,539
R^2	0.392	0.392	0.392	0.392
Adjusted R^2	0.259	0.259	0.259	0.259

Note: MNE group and year fixed effects are included. ORBIS consolidated data is from the following well-covered parent jurisdictions from the years 2007-2016, as per Millot et al. (2020[2]): Austria, Denmark, Estonia, Finland, France, Germany, United Kingdom, Greece, Hungary, Ireland, Japan, Luxembourg, Netherlands, Portugal, Slovenia, Spain, Sweden. (*) indicates significance at the p<0.1 level, (**) at the p<.05 level, and (***) at the p<.01 level.

64. Given these new empirical insights, the next step in the analysis focuses on the Hypothesis 2, i.e., the question of whether tax changes in one jurisdiction produce positive cross-border effects on investment

[15] As highlighted by Becker and Riedel (2012), investment in the parent jurisdiction seems to fulfil a special function, implying that tax changes in the parent jurisdiction can propagate throughout the MNE group. This finding is consistent with the results in this paper showing that tax changes in parent jurisdictions have significant effects, while those in host jurisdictions appear to be insignificant.

by other entities within the same MNE group located elsewhere. It should be noted that cross-border tax effects would likely be more difficult to identify than within-jurisdictional tax effects. This is to be expected principally because a cross-border tax effect would be diffused across a large number of jurisdictions.[16] While the cross-border tax effect is divided among all other jurisdictions in which the MNE group has a presence, within-jurisdictional tax effects are, by definition, concentrated in a single jurisdiction.

65. Given these methodological challenges, an empirical strategy is adopted that attempts to measure the effect in the place where it would be strongest. In the present context, this will be the case for tax changes in jurisdictions where there is relatively more economic substance. The greater the proportion of economic substance that an MNE has located in a jurisdiction that experiences a tax rate change, the stronger the cross-border tax effect ought to be. Therefore, the following analysis focuses, for each MNE group, on the jurisdiction where it has located the most economic substance.

66. More specifically, the same "baseline" dataset is used as for previous entity-level heterogeneity analyses and it is restricted such that for each MNE group, all subsidiaries located in the highest-substance jurisdiction are eliminated. In addition, the EMTR[17] of the highest-substance jurisdiction is added as an explanatory variable on the right hand side of the equation (see Equation 5). This specification thus evaluates the cross-border effect of tax changes in the MNE group's highest-substance jurisdiction on investment by MNE subsidiaries that are part of the same group but located outside of the highest-substance jurisdiction.[18] The regression setup is as follows.

$$Firm\ investment\ rate_{f,t} = industry\ growth_{c,s,t-1} + EMTR^{Host}{}_{c,t-1} + EMTR^{TSJ}{}_{g,t-1} X\ (TSJ = UPJ) \quad (5)$$

67. In this equation, *f* denotes the firm (or subsidiary), *g* is the MNE group, *c* is subsidiary host jurisdiction, *s* is 2-digit NACE (rev 2) sector, and *t* is time (year). $EMTR^{Host}$ indicates host jurisdiction EMTR, and $EMTR^{TSJ}$ indicates top-substance jurisdiction EMTR. The coefficient for $EMTR^{TSJ}$ reflects the cross-border tax effect within an MNE group. TSJ=UPJ is a binary variable for whether the top-substance jurisdiction is also the group's ultimate parent jurisdiction. This variable is interacted with the $EMTR^{TSJ}$ in order to allow for the possibility that special properties of investment at headquarters may lead to a different cross-border investment response from tax changes there as opposed to tax changes in host jurisdictions. The quantiles for the share of global substance located in UPJs and TSJs is displayed in Table D.7.

68. Table 4 summarises the regression results. First, as expected, the analysis results in a negative within-jurisdictional tax effect on investment, implying (as before) that higher taxes reduce investment by MNE entities in a given jurisdiction. Second, the analysis finds a positive cross-border tax effect running

[16] For instance, consider an MNE group with equal amounts of fixed assets across 26 jurisdictions labelled A-Z. Consider a scenario in which the statutory tax rate decreases in jurisdiction A and the MNE group decreases investment by 1% in jurisdictions B-Z in order to increase investment in jurisdiction A by 25%. In this scenario, the change in investment in jurisdiction A (i.e., the negative within-jurisdictional tax effect) is relatively large and therefore easier to detect, while the changes in investment in jurisdictions B-Z (i.e., the positive cross-border tax effect) are much smaller, to the point where they could be swallowed up by statistical noise. As a result, the ceiling for the standard errors necessary to achieve statistical significance would be quite low.

[17] Unlike the MNE group-level regression discussed above, the unit of observation is now again on the subsidiary level. Furthermore, the analysis of cross border tax effects does not require the capture of as many subsidiaries as possible within an MNE group.

[18] Note that inaccuracies in the economic substance shares would not undermine this analysis, but actually strengthen it. To the extent that the economic substance bins are incorrect, the true tax effect would actually be stronger than the estimated tax effect. This is because no weighted combined tax rate is used in this analysis. The economic substance shares only come into play in selecting the highest-substance jurisdiction. If the economic substance shares are wrong and lower-substance countries are actually being used, this only means that the analysis underestimates the magnitude of the cross-border tax effect from the highest-substance jurisdiction.

from the highest-substance jurisdiction to others where the MNE group has affiliates; however, in line with Becker and Riedel (2012[24]), the positive cross-border tax effect is only statistically significant if the highest-substance jurisdiction is not also the ultimate parent jurisdiction. This effect is quantitatively substantial. For every 10 percentage point increase in the EMTR in the highest-substance jurisdiction, investment in other jurisdictions is estimated to increase by 1.1 percentage points. This finding is conserved in direction and statistical significance in almost all cases across 96 unique samples created by 96 different modulations of cleaning steps (see Figure F.1). This finding suggests that there is no significant relocation from MNE subsidiaries in the jurisdiction where the MNE headquarters is located, aligning well with previous results highlighting the special function of the headquarters within the MNE group. At the same time, it supports the view that MNE groups relocate economic substance across some of their subsidiaries in response to tax increases, as suggested by Hypothesis 2 defined above.

Table 4. Cross-border tax effect: Influence of EMTR in a group's top-substance jurisdiction on investment in group's subsidiaries outside of the top-substance jurisdiction

Dependent variable: firm-level investment

	(1)
Industry growth	0.044**
	(0.018)
Host jurisdiction EMTR	-0.167***
	(0.058)
Top-substance jurisdiction EMTR X TSJ≠UPJ	0.106**
	(0.047)
Top-substance jurisdiction EMTR X TSJ=UPJ	0.021
	(0.078)
Observations	42,006
R^2	0.414
Adjusted R^2	0.267

Note: Firm, year, and industry-year fixed effects are included. ORBIS unconsolidated data is from the following well-covered jurisdictions from the years 2007-2016, as per Millot et al. (2020[2]): Austria, Denmark, Estonia, Finland, France, Germany, United Kingdom, Greece, Hungary, Ireland, Japan, Luxembourg, Netherlands, Portugal, Slovenia, Spain, Sweden. (*) indicates significance at the p<0.1 level, (**) at the p<.05 level, and (***) at the p<.01 level.

Box 2. Caveats

General Issues

- Ability to observe firm entry and exit in Orbis is notably poor (Bajgar et al., 2020[40]). To the extent that that MNEs are reacting to the changes in taxation by creating or terminating subsidiaries rather than changing investment decisions on the intensive margin, this paper's analysis does not capture the full range of MNE investment responses. Furthermore, note that the focus on the intensive margin informs the choice of EMTR as the measure of taxation in the various analyses of the paper.
- Given the large share of raw observations dropped through the cleaning processes, it is possible that the final samples analysed in this paper is no longer reflective of the full distribution of MNE entities along various dimensions. The validity of the results of this paper with respect to the full MNE sector assumes that all cleaning steps (including dropping subsidiaries that appear to enter or exit) are orthogonal to the relationship between the EMTR and the investment rate; to the extent that this is false, the results are biased.

- Interpretation of results assumes that the cleaning steps successfully discard Orbis observations with erroneous investment rate values throughout the analyses in the paper; imperfections in Orbis financial data could jeopardize the results. Furthermore, in filtering to particular well-covered jurisdictions, the analysis assumes that jurisdiction identifiers in Orbis as well as the variable identifying which GUOs correspond to particular subsidiaries are without error. Errors in GUO identifiers would cause measurement error in the key explanatory variables (such as interaction between group characteristics and EMTRs) throughout the paper, biasing the coefficients of focus.

Relevance of Orbis Coverage Issues to Results

- Unlike in other parts of the paper, the analysis of economic substance-weighted average (ESW) tax rate is uniquely vulnerable to coverage issues in Orbis. While the within-jurisdiction heterogeneity analysis and cross-border tax effect analysis do not require observing the entire global operations of the MNE group in order to be valid, the ESW tax rate does. To the extent that an MNE's jurisdictional distribution of economic substance across the globe cannot be observed due to coverage and missing values in Orbis, the weights that generate the ESW tax rate are biased, generating an incorrect tax rate. This measurement error would bias the coefficient of the ESW tax rate as an explanatory variable, biasing the results.
- For the heterogeneity analysis, it is not important that Orbis coverage includes all (or even more than one) subsidiaries in a particular group. This is because the left-hand side variable is the individual subsidiary's investment rate, and the explanatory variable is an interaction of the known EMTR in a jurisdiction and an MNE's characteristic from its consolidated financials. Because the fixed-effects regressions evaluate within-unit change over time, the presence or non-presence of other subsidiaries in Orbis would not affect the relationship between the individual subsidiary's investment rate, its host jurisdictions' EMTR, and the MNE's global characteristic from its consolidated accounts. Of course, the sample would need to be representative of the global MNE sector and the financial information itself would have to be correct, as addressed in earlier caveats. The only additional assumption is that the subsidiaries selected out of analysis due to Orbis coverage issues are not systematically different in their investment tax sensitivity dynamics.
- For similar reasons as in the case of the heterogeneity analysis, the cross-border tax effect analysis would not be affected by orbis coverage issues. Additional explanation of this robustness can be found in footnote 17.

7. Conclusion

69. The empirical findings presented in this paper can be summarised in two main insights. First, the results in Section 4 suggest that the tax sensitivity of investment, estimated at entity level, seem to vary substantially across several dimensions, notably being lower on average for MNE entities than domestic ones. Section 5 demonstrated that amongst MNE entities, tax sensitivities have been estimated to be lower for entities that are part of MNE groups that are not liquidity constrained, wield significant market power, have profit shifting opportunities within the MNE group or are part of a group with related entities in zero-CIT jurisdictions.

70. Second, Section 6 has further examined the specificity of MNE investment behaviour by examining further group and entity-level responses to investment. This section asks the question whether MNE groups respond to tax changes at the jurisdiction level by relocating economic substance across their subsidiaries. Specifically, two hypotheses have been tested, both of which would be consistent with the view that there is at least some relocation of economic substance in response to tax changes. The empirical results are supportive of both hypotheses, suggesting that: (i) tax changes at host jurisdiction level do not seem to lead to significant changes in overall investment levels across the MNE group; (ii) while tax increases in a given host jurisdiction are associated with investment increases in other jurisdictions where the MNE group has a presence. Taken together, these last two findings are consistent with the interpretation that MNE groups relocate economic activity within the group in response to tax increases at the jurisdiction level. Ultimately, MNEs' different investment responses compared to non-MNEs stem from MNE's simultaneous exposure to a multiplicity of national tax rates, and the need to balance its investments across different tax environments.

Annex A. Heterogeneity of MNE investment response to taxation

71. The regressions presented in this annex assess heterogeneity within MNE groups as described in Section 5. All regressions rely on the baseline sample consisting of MNE subsidiaries from 17 jurisdictions with financial records from 2007-2016. Additional restrictions placed on the baseline sample for certain regressions below, as well as descriptions of the MNE characteristics employed, are described in Section 3 of this paper. Descriptive statistics of the baseline sample are available in Annex B. Firm, year, and industry-year fixed effects are included in all regressions below. All EMTRs used as explanatory variables throughout this annex are host jurisdiction EMTRs lagged by one year.

72. In order to avoid misinterpreting the results, it is important to note that explanatory indicator variables describing locations of subsidiaries such as “subsidiary in a zero-CIT jurisdiction” or “subsidiary in an investment hub” do not refer to whether the specific in-sample subsidiary meets these criteria. Rather, they refer to whether the in-sample subsidiary is part of an MNE group that contains another subsidiary that meets the criteria. For instance, none of the subsidiaries in the baseline sample are in zero-CIT jurisdictions, but the “subsidiary in zero-CIT jurisdiction” indicator is “true” if the subsidiaries are part of the same MNE group as at least one *other* subsidiary located in zero-CIT jurisdictions.

73. Each MNE characteristic used below is intended to capture a broader underlying factor that cannot be directly observed in the data. Presence of subsidiaries or intermediaries in zero-CIT jurisdictions or in investment hubs (Tables A.6-A.8) could give indications of profit shifting opportunities within the MNE group. Book-tax differences calculated on the firm level (Table A.5) might indicate that a subsidiary is relevant to tax planning behaviour, as greater book-tax differences could be related to lower backward-looking ETRs.

74. Both MNE group-level mark-ups and firm-level industry concentration (Tables A.3 and A.4) speak to issues of market power but do so in different ways. MNE group-level mark-ups (Table A.3) are calculated using consolidated accounts, referring explicitly to group EBITDA over turnover. Subsidiaries in high deciles of the distribution of MNE group-level mark-ups are subsidiaries that are part of groups that could potentially have high levels of market power within their industries. Moreover, the market concentration indicator (Table A.4) captures the percentage of turnover within the subsidiary’s jurisdiction and industry controlled by the several largest firms. Therefore, a firm in the highest tercile of the market concentration distribution does not necessarily itself (nor its group) have significant market or pricing power; rather, it implies that the subsidiary is operating in a jurisdiction and industry with other firms that do.

75. In order to conduct a robustness check on various results, most regressions are re-run using a dynamic specification. These specifications are identical to the ones listed above in all respects except that they include a lagged dependent variable (i.e., the investment rate) as an explanatory variable in order to account for the possibility that there is some persistence in investment behaviour. In other words, the

dynamic specification encodes the assumption that firms' investment decisions in the past may affect firms' investment decisions in the future.[19]

76. These dynamic specifications include an additional restriction on the sample. First, years where the lagged investment rate is unavailable due to the nature of unbalanced data are dropped. Second, years where the change in the investment rate exceeds the range of [-80%, 500%] are dropped. This step, also employed in Millot et al (2020[2]), is necessary to ensure that variations in the investment rate remain within a reasonable range.

77. Also note that the word "dynamic" above a particular column in that table indicates that the results in that column are from the dynamic specification (i.e., those where lagged investment rate is included as an explanatory variable). All other columns of results are from the baseline sample. The magnitude of the estimate for the lagged investment rate tends to be similar in order of magnitude to that of Millot et al (2020[2]) in all specifications.

[19] Unfortunately, it was impossible to use General Method of Moments concepts to create an even more rigorous specification using past lags of investment as instruments for more recent lags. When GMM was attempted, instruments failed the relevancy tests. This means the analysis is unable to alleviate Nickel Bias stemming from endogeneity in which the lagged investment rate is correlated with the error term. However, the magnitude of the estimate for the lagged investment rate tends to be similar in order of magnitude to that of Millot (2020[2]) in all specifications.

Table A.1. Reproduction of Millot 2020 U-shaped relationship between profitability and investment response to EMTR changes

Dependent variable: Firm-level investment

	Baseline	Dynamic	Baseline	Dynamic	Baseline	Dynamic
	(1)	(2)	(3)	(4)	(5)	(6)
EMTR	-0.078***	-0.115***				
	(0.023)	(0.028)				
Industry growth	0.021***	0.025***	0.021***	0.025***	0.021***	0.025***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Lagged investment rate		0.240***		0.240***		0.240***
		(0.00)		(0.00)		(0.00)
EMTR X profitability <0%			-0.017	-0.073		
			(0.07)	(0.09)		
EMTR X profitability 0-10%			-0.104***	-0.128***		
			(0.03)	(0.03)		
EMTR x profitability >10%			-0.013	-0.089		
			(0.05)	(0.06)		
EMTR X profitability <0%					-0.017	-0.073
					(0.07)	(0.09)
EMTR X profitability 0-5%					-0.092***	-0.092**
					(0.03)	(0.04)
EMTR X profitability 5-10%					-0.124***	-0.187***
					(0.04)	(0.05)
EMTR X profitability 10-15%					-0.004	-0.093
					(0.06)	(0.08)
EMTR X profitability >15%					-0.024	-0.085
					(0.07)	(0.09)
Observations	231,866	144,257	231,866	144,257	231,866	144,257
R2	0.484	0.627	0.484	0.627	0.484	0.627
Adjusted R2	0.334	0.464	0.334	0.464	0.334	0.464

Note: profitability is computed as profit/loss before tax divided by turnover at the group level (Millot et al., 2020[2]). Firm, year, and industry-year fixed effects are included in all regressions.

Table A.2. Subsidiaries of highly liquid groups are less sensitive to EMTRs

Dependent variable: Firm-level investment

	Baseline	Dynamic	Baseline	Dynamic	Baseline	Dynamic
	(1)	(2)	(3)	(4)	(5)	(6)
Industry growth	0.015	0.017	0.015	0.016	0.016	0.018*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Lagged investment rate		0.214***		0.215***		0.214***
		(0.004)		(0.004)		(0.004)
EMTR X liquidity 1 below median	-0.114***	-0.203***				
	(0.04)	(0.05)				
EMTR X liquidity 1 above median	-0.021	-0.082				
	(0.04)	(0.05)				
EMTR X liquidity 2 below median			-0.098**	-0.182***		
			(0.04)	(0.05)		
EMTR X liquidity 2 above median			-0.039	-0.101**		
			(0.04)	(0.05)		
EMTR X liquidity 3 below median					-0.086**	-0.180***
					(0.04)	(0.05)
EMTR X liquidity 3 above median					-0.057	-0.111**
					(0.04)	(0.05)
Observations	148,801	96,110	146,114	94,319	148,594	95,951
R^2	0.537	0.656	0.536	0.656	0.538	0.657
Adjusted R^2	0.351	0.466	0.351	0.467	0.351	0.467

Note: liquidity 1 = current assets/fixed assets. Liquidity 2 = Cash flow/fixed assets. Liquidity 3 = cash and cash equivalents/fixed assets. Each liquidity measure calculated at the group level. For each liquidity measure, subsidiary-year observations are binned into below median [liquidity] or above median [liquidity] and interacted with EMTR. This reproduces a result of Millot et al. (2020[2]). Firm, year, and industry-year fixed effects are included in all regressions.

Table A.3. Subsidiaries of groups with higher markups are less sensitive to EMTRs

Dependent variable: Firm-level investment rate

	Baseline	Dynamic
	(1)	(2)
Lagged investment rate		0.203***
		(0.005)
Industry growth	0.01	0.018
	(0.011)	(0.012)
EMTR X group-level markup decile 1 [-32.8,0.0357]	-0.089**	-0.176***
	(0.036)	(0.044)
EMTR X group-level markup decile 2 (0.0357,0.0561]	-0.092**	-0.187***
	(0.036)	(0.043)
EMTR X group-level markup decile 3 (0.0561,0.0739]	-0.075**	-0.164***
	(0.035)	(0.043)
EMTR X group-level markup decile 4 (0.0739,0.091]	-0.069*	-0.149***
	(0.035)	(0.043)
EMTR X group-level markup decile 5 (0.091,0.109]	-0.066*	-0.159***
	(0.035)	(0.042)
EMTR X group-level markup decile 6 (0.109,0.127]	-0.049	-0.143***
	(0.035)	(0.042)
EMTR X group-level markup decile 7 (0.127,0.148]	-0.053	-0.156***
	(0.035)	(0.043)
EMTR X group-level markup decile 8 (0.148,0.18]	-0.056	-0.165***
	(0.035)	(0.043)
EMTR X group-level markup decile 9 (0.18,0.24]	-0.037	-0.142***
	(0.036)	(0.043)
EMTR X group-level markup decile 10 (0.24,3.4]	-0.034	-0.115**
	(0.037)	(0.045)
Observations	119,161	78,094
R^2	0.565	0.669
Adjusted R^2	0.359	0.462

Note: Group-level markup calculated as EBITDA/turnover in ORBIS consolidated data. Subsidiary-years are binned into deciles based on group-level markup and interacted with EMTR. Profitable firms only. Firm, year, and industry-year fixed effects are included in all regressions.

Table A.4. Subsidiaries in highly concentrated markets are less sensitive to EMTRs

Dependent variable: Firm-level investment

	Top 10 baseline (1)	Top 10 dynamic (2)	Top 20 baseline (3)	Top 20 dynamic (4)	Top 5 baseline (5)	Top 5 dynamic (6)
Lagged investment rate		0.249***		0.248***		0.248***
		(0.004)		(0.004)		(0.004)
Industry growth	0.035***	0.032***	0.043***	0.039***	0.031***	0.030**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
EMTR X turnover share of top 10 – 1st tercile [0.295,0.419]	-0.139***	-0.174***				
	(0.04)	(0.06)				
EMTR X turnover share of top 10 – 2nd tercile (0.419,0.509]	-0.098**	-0.139**				
	(0.04)	(0.06)				
EMTR X turnover share of top 10 – 3rd tercile (0.509,0.676]	0.02	0.0002				
	(0.05)	(0.07)				
EMTR X turnover share of top 20 – 1st tercile [0.442,0.574]			-0.124***	-0.164***		
			(0.04)	(0.06)		
EMTR X turnover share of top 20 – 2nd tercile (0.574,0.647]			-0.085**	-0.142**		
			(0.04)	(0.06)		
EMTR X turnover share of top 20 – 3rd tercile (0.647,0.78]			-0.077	-0.074		
			(0.05)	(0.07)		
EMTR X turnover share of top 5 – 1st tercile [0.175,0.284]					-0.124***	-0.141**
					(0.04)	(0.06)
EMTR X turnover share of top 5 – 2nd tercile (0.284,0.374]					-0.106***	-0.188***
					(0.04)	(0.06)
EMTR X turnover share of top 5 – 3rd tercile (0.374,0.576]					0.015	0.067
					(0.05)	(0.07)
Observations	182,434	84,410	184,968	85,146	185,404	85,836
R^2	0.376	0.625	0.377	0.628	0.377	0.626
Adjusted R^2	0.253	0.462	0.255	0.464	0.255	0.463

Note: share of top X is a numerical variable ranging from 0 to 1 describing the percentage of turnover controlled by the top X subsidiaries in the given subsidiary's jurisdiction-industry. This measure intends to proxy for market concentration and follows the methodology of Sorbe and Johannsson (2017[33]). Firm, year, and industry-year fixed effects are included in all regressions.

Table A.5. Firm-level book-tax differences are inversely associated with investment sensitivity to EMTRs

Dependent variable: Firm-level investment rate

	baseline (1)	dynamic (2)
Lagged investment rate		0.204*** (0.004)
Industry growth	0.016 (0.01)	0.022** (0.01)
EMTR X Book tax differences quantile 1 [358,5.75e+06]	-0.122*** (0.03)	-0.167*** (0.04)
EMTR X Book tax differences quantile 2 (5.75e+06,1.79e+07]	-0.081** (0.03)	-0.129*** (0.04)
EMTR X Book tax differences quantile 3 (1.79e+07,4.49e+07]	-0.04 (0.03)	-0.091** (0.04)
EMTR X Book tax differences quantile 4 (4.49e+07,1.33e+08]	0.002 (0.03)	-0.053 (0.04)
EMTR X Book tax differences quantile 5 (1.33e+08,3.02e+11]	0.052* (0.03)	-0.019 (0.04)
Observations	142,117	91,393
R^2	0.537	0.648
Adjusted R^2	0.349	0.454

Note: loss-making subsidiary-years and subsidiary-years with negative values for taxes paid or taxes paid in excess of profits are dropped. Book-tax differences are computed at firm-year level as host jurisdiction STR multiplied by before-tax ORBIS profits and then subtracting ORBIS taxes paid. Therefore, higher quantiles of book tax differences indicate a greater difference between backward-looking effective tax rate and host jurisdiction statutory tax rate. Firm, year, and industry-year fixed effects are included in all regressions.

Table A.6. Subsidiaries of groups with intermediaries in zero-CIT jurisdictions are less sensitive to EMTRs

Dependent variable: Firm-level investment

	baseline (1)	dynamic (2)
Lagged investment rate		0.239*** (0.003)
Industry growth	0.020*** (0.01)	0.024*** (0.01)
EMTR X NO intermediaries in zero-CIT jurisdictions	-0.078*** (0.02)	-0.113*** (0.03)
EMTR at least one intermediary in zero-CIT jurisdictions	0.572 (0.449)	-0.591 (0.559)
Observations	234,300	145,619
R^2	0.484	0.627
Adjusted R^2	0.334	0.463

Note: Intermediaries are calculated according to Phillips et al. (2020[38]). A group has an intermediary in a zero-CIT jurisdiction if it has at least one subsidiary in a jurisdiction that has no CIT in at least 10 of the sample years, such that the subsidiary neither immediately owns nor is immediately owned by any subsidiaries within that jurisdiction. Firm, year, and industry-year fixed effects are included in all regressions.

Table A.7. Subsidiaries of groups with subsidiaries in investment hubs are less sensitive to EMTRs

Dependent variable: Firm-level investment

	baseline (1)	dynamic (2)
Lagged investment rate		0.239*** (0.003)
Industry growth	0.020*** (0.008)	0.025*** (0.009)
EMTR X NO subsidiaries in investment hubs	-0.093** (0.042)	-0.112** (0.052)
EMTR X at least one subsidiary in investment hubs	-0.052** (0.026)	-0.105*** (0.033)
Observations	227,209	141,105
R^2	0.485	0.628
Adjusted R^2	0.335	0.464

Note: Investment hubs are defined according to the 2020 Impact Assessment on Pillars One and Two (OECD, 2020[39]). Firm, year, and industry-year fixed effects are included in all regressions.

Table A.8. Subsidiaries of groups with presence in zero-CIT jurisdictions are less sensitive to EMTR changes

Dependent variable: Firm-level investment

	baseline (1)	dynamic (2)
Lagged investment rate		0.239***
		(0.003)
Industry growth	0.020***	0.024***
	(0.008)	(0.009)
EMTR X all subsidiaries in medium or high -CIT jurisdictions only	-0.091***	-0.139***
	(0.027)	(0.063)
EMTR X at least one subsidiary in low-CIT jurisdictions (but none in zero-CIT jurisdictions)	-0.140***	-0.114*
	(0.026)	(0.033)
EMTR X at least one subsidiary in zero-CIT jurisdiction	0.024	-0.035
	(0.047)	(0.058)
Observations	234,300	145,619
R^2	0.484	0.627
Adjusted R^2	0.334	0.463

Note: zero-CIT jurisdictions are those that have a zero CIT rate for at least 10 of the sample years. Low-CIT jurisdictions are those that have a CIT rate between 0 and 10% for at least 10 of the sample years. Medium or high CIT jurisdictions are all other jurisdictions. Firm, year, and industry-year fixed effects are included in all regressions.

Annex B. Descriptive statistics of baseline sample

Table B.1. Distribution of key variables in baseline sample

Key variable	Minimum	1st quartile	Median	Mean	3rd quartile	Maximum	Standard deviation
Investment rate	-0.05	0.01	0.09	0.16	0.24	0.94	0.21
Fixed assets (EUR)	3	463,016	2,938,133	106,116,631	15,785,958	181,463,128,515	1,510,161,601
Depreciation (EUR)	0	53,896	262,969	3,691,906	1,192,848	4,891,543,153	39,263,365
Host EMTRs	0.03	0.17	0.25	0.25	0.32	0.43	0.07

Note: These descriptive statistics describe the baseline sample for analysis of heterogeneity. Due to missing values in other variables, descriptive statistics of actual samples regressed may vary.

Table B.2. Count of observations by host jurisdiction

Year	AT	DE	DK	EE	ES	FI	FR	GB	GR	HU	IE	JP	LU	NL	PT	SE	SI
2008	704	3349	1197	254	4733	1374	6972	3181	558	662	201	94	99	577	1802	3454	231
2009	531	2986	917	169	4112	1011	5258	2350	374	495	258	93	103	492	1358	2657	177
2010	578	3089	1022	172	3891	1120	5360	2048	193	551	248	69	124	511	1293	2452	199
2011	666	3155	1140	174	4124	1084	5636	2334	403	636	288	31	127	533	1210	2962	253
2012	679	3528	1137	217	4365	1251	6010	2528	433	582	216	140	131	578	1388	3402	250
2013	692	3630	1074	206	4492	1303	6141	3389	415	699	324	118	116	576	1390	3402	236
2014	706	3106	1121	230	4580	1267	6222	3222	428	666	223	99	110	561	1170	3125	264
2015	732	2998	1108	221	4069	1310	6051	3069	459	703	212	92	90	459	1306	3153	246
2016	772	2957	1116	205	4150	1216	5767	2891	443	669	178	111	92	429	1306	2884	239

Table B.3. Count of distinct corporate groups and subsidiaries by year

Year	Distinct corporate groups	Count of subsidiaries
2008	8,420	29,442
2009	7,605	23,341
2010	7,506	22,920
2011	7,855	24,756
2012	8,342	26,835
2013	8,645	28,203
2014	8,456	27,100
2015	8,322	26,278
2016	8,107	25,425
Total	**11,543**	**234,300**

Figure B.1. Host jurisdiction distribution of observations, by cleaning step

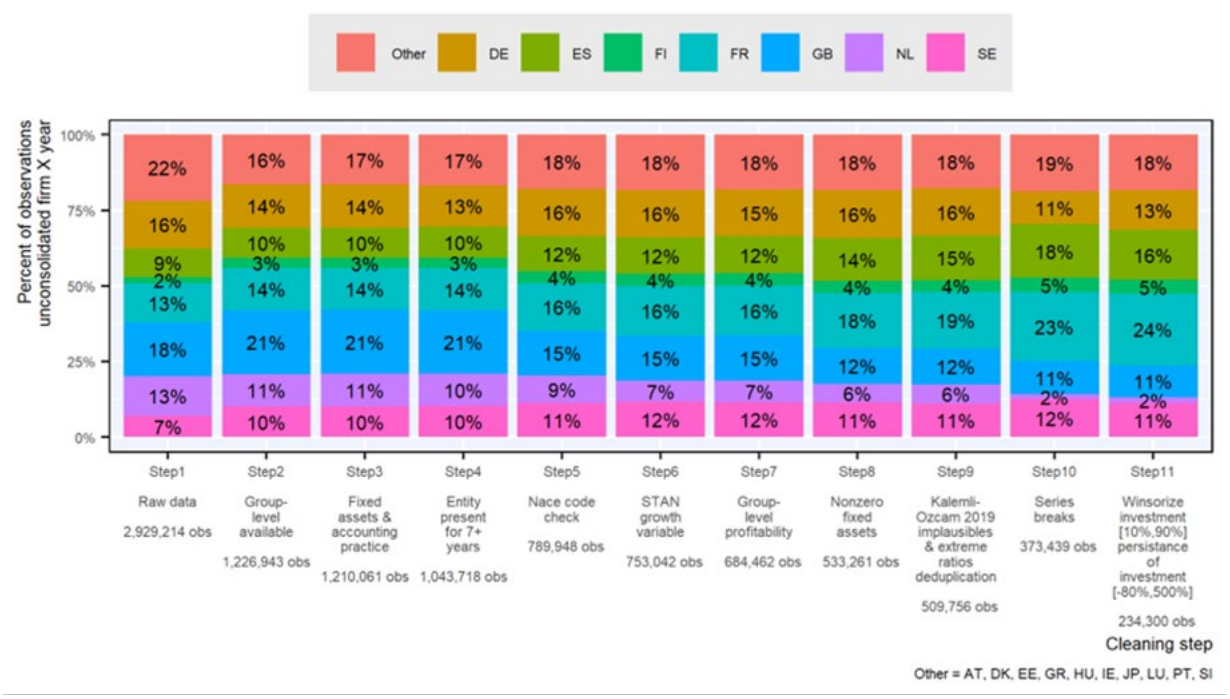
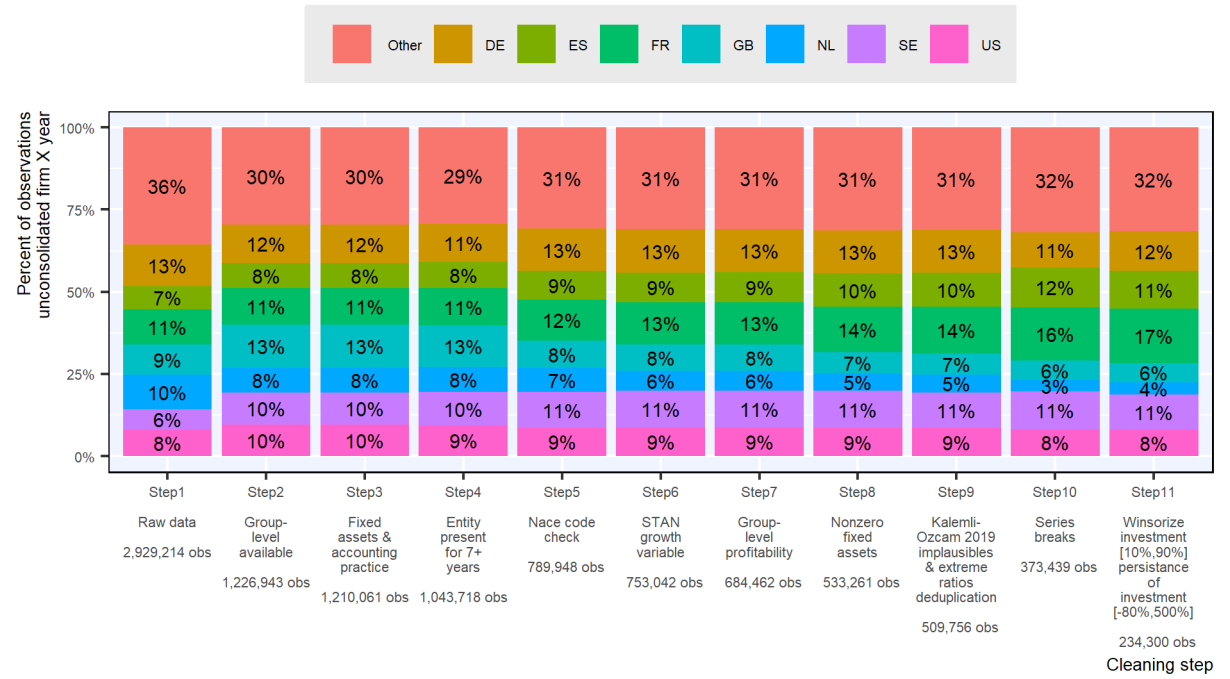


Figure B.2. Parent jurisdiction distribution of observations, by cleaning step



79. The two figures above show a relative lack of sharp changes in sample composition across cleaning steps. All regression results in Annex A are largely robust, removing Swedish or US parents or any individual host jurisdiction (see Annex F).

Table B.4. Count of observations by parent jurisdiction

Number of observations	Parent jurisdiction	Number of observations	Parent jurisdiction
219	United Arab Emirates	663	Republic of Korea
10	Angola	102	Kuwait
5,120	Austria	204	Cayman Islands
212	Australia	3	Kazakhstan
3,783	Belgium	135	Liechtenstein
5	Bulgaria	9	Liberia
304	Bermuda	133	Lithuania
255	Brazil	2,431	Luxembourg
1,562	Canada	64	Latvia
4,389	Switzerland	37	Morocco
67	Chile	56	Marshall Islands
2,682	China	51	Malta
5	Colombia	24	Mauritius
95	Netherlands Antilles	400	Mexico
104	Cyprus	152	Malaysia
78	Czech Republic	8,774	Netherlands
27,002	Germany	4,205	Norway
7,569	Denmark	21	New Zealand
24	Estonia	8	Panama
20	Egypt	19	Philippines
26,326	Spain	5	Pakistan
10,540	Finland	312	Poland
37,813	France	6,738	Portugal
4	Gabon	3	Qatar
14,010	United Kingdom	4	Serbia
2,057	Greece	140	Russia
30	Hong Kong	27	Saudi Arabia
77	Croatia	25,883	Sweden
1,117	Hungary	306	Singapore
2,504	Ireland	139	Slovenia
383	Israel	25	Slovakia
547	India	205	Thailand
3	Iran	4	Tunisia
142	Iceland	110	Turkey
7,333	Italy	599	Taiwan
12	Jamaica	19,236	United States of America
6,413	Japan	137	British Virgin Islands
663	Republic of Korea	120	South Africa

Annex C. Group-level analysis sample descriptive statistics

Table C.1. Distributions of key variables

Key Variable	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum	Standard deviation
Investment rate	-0.09	0.05	0.12	0.16	0.23	0.78	0.16
Fixed assets (EUR)	14,174	13,659,770	49,326,595	1,477,035,606	214,038,664	299,129,548,941	9,651,656,549
Depreciation (EUR)	0	1,315,317	4,182,152	98,929,796	16,536,192	27,553,948,760	739,503,015
Number of jurisdictions	1	1	2	4.29	5	46	5.68
Domestic substance %	0.05	0.87	0.98	0.91	0.99	0.99	0.13
Weighted STR (All jurisdictions)	0.12	0.2	0.25	0.25	0.28	0.38	0.06
Ultimate parent STR	0.12	0.2	0.25	0.25	0.28	0.38	0.06
Weighted STR (Host jurisdictions)	0	0	0.2	0.16	0.26	0.48	0.12

Table C.2. Count of observations by parent jurisdiction by year

Year	AT	DE	DK	EE	ES	FI	FR	GB	GR	HU	IE	JP	LU	NL	PT	SE	SI
2008	17	334	64	3	150	136	125	84	96	14	1	1	3	45	17	219	3
2009	25	386	76	3	201	149	134	97	98	20	5	0	1	52	20	245	2
2010	46	414	73	4	233	144	147	112	63	20	8	1	1	55	21	244	2
2011	44	419	77	4	235	149	150	101	99	21	8	70	1	61	22	246	2
2012	47	403	72	4	228	153	155	109	87	21	4	81	2	58	21	248	1
2013	43	403	78	4	224	156	147	110	95	19	8	74	0	60	19	259	2
2014	39	390	78	3	220	152	153	113	91	21	7	86	1	50	22	238	2
2015	41	375	81	2	219	159	156	113	83	14	8	89	1	56	18	255	2
2016	45	381	77	3	224	152	148	119	85	17	6	95	1	51	23	254	2

Annex D. Cross-border effects sample descriptive statistics

Table D.1. Distributions of key variables

Key Variable	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum	Standard deviation
Investment rate	-0.05	0.02	0.09	0.17	0.25	0.94	0.21
Host jurisdiction EMTRs	0.03	0.17	0.22	0.24	0.31	0.43	0.08
Top-substance host jurisdiction EMTRs	-0.05	0.17	0.18	0.21	0.28	0.35	0.09

Table D.2. Counts of observations by host jurisdiction and year

Year	AT	DE	DK	EE	ES	FI	FR	GB	GR	HU	IE	JP	LU	NL	PT	SE	SI
2008	124	418	211	100	568	183	645	545	66	168	38	5	18	86	278	322	59
2009	151	468	248	94	664	214	700	625	67	202	52	5	23	79	315	336	61
2010	141	507	243	107	719	229	696	600	48	206	44	3	35	98	288	340	63
2011	156	575	269	107	739	219	774	641	66	227	56	2	37	94	311	365	95
2012	175	584	281	112	731	242	762	665	80	207	56	3	37	101	321	391	91
2013	192	622	274	112	734	243	773	759	83	241	55	4	37	106	311	400	85
2014	185	591	283	115	721	231	793	807	66	268	59	2	36	105	307	407	91
2015	181	542	263	117	729	218	764	774	70	259	56	0	34	64	300	415	88
2016	202	572	289	114	731	219	738	794	87	262	43	0	27	56	343	386	94

Table D.3. Count of observations and distinct corporate groups by year

Year	Distinct corporate groups	Count of observations
2008	827	3,834
2009	926	4,304
2010	909	4,367
2011	961	4,733
2012	989	4,839
2013	1,032	5,031
2014	1,005	5,067
2015	991	4,874
2016	989	4,957
total	**1347**	**42,006**

Table D.4. Count of observations by parent jurisdiction by year

Year	AT	DE	DK	EE	ES	FI	FR	GB	GR	HU	IE	JP	LU	NL	PT	SE
2008	128	1012	196	1	200	302	714	297	10	7	104	22	47	178	31	585
2009	150	1152	217	1	251	322	757	349	16	8	101	25	49	218	45	643
2010	167	1133	234	2	244	325	807	349	14	7	124	25	43	188	54	651
2011	165	1170	239	4	262	328	872	387	14	7	123	121	57	245	60	679
2012	151	1198	234	4	269	355	898	378	14	10	134	122	54	201	62	755
2013	168	1327	239	4	280	335	873	413	15	12	129	134	54	206	66	776
2014	174	1332	241	3	297	342	854	392	12	11	119	157	67	233	73	760
2015	172	1253	237	3	279	366	798	361	15	8	111	192	75	182	66	756
2016	178	1289	215	2	270	334	855	320	14	9	127	257	84	170	64	769

Table D.5. Count of distinct corporate groups by parent jurisdiction

Parent jurisdiction	AT	DE	DK	EE	ES	FI	FR	GB	GR	HU	IE	JP	LU	NL	PT	SE
Count of distinct corporate groups	42	349	58	1	131	142	119	107	16	3	20	52	10	74	18	205

Table D.6. Count of observations by top-substance jurisdiction in group

Top-substance jurisdiction	Count of observations	Top-substance jurisdiction	Count of observations
Austria	1,659	India	7
Australia	31	Italy	305
Belgium	176	Japan	933
Bulgaria	1	Republic of Korea	1
China	12	Lithuania	7
Czech Republic	135	Luxembourg	755
Germany	9,507	Malta	32
Denmark	2,025	Netherlands	1,572
Estonia	103	Norway	36
Spain	2,536	Poland	64
Finland	2,769	Portugal	484
France	7,973	Romania	6
United Kingdom	3,776	Russia	11
Greece	111	Sweden	6,202
Croatia	2	Singapore	4
Hungary	138	Slovakia	9
Ireland	503	South Africa	121

Table D.7. Distribution of percentage of global substance in UPJ and TSJ

	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile
TSJ when TSJ is not UPJ	14.2%	40.7%	54.0%	72.6%	85.8%
TSJ when TSJ is UPJ	21.1%	71.5%	85.2%	97.8%	99.9%
UPJ when TSJ is not UPJ	1.0%	6.1%	18.9%	32.4%	49.9%

Note: TSJ indicates top-substance jurisdiction, defined as the jurisdiction with the highest fixed assets for each MNE. UPJ indicates ultimate parent jurisdiction. The percentages are the share of global MNE fixed assets located in the type of jurisdiction indicated.

Annex E. Robustness of domestic substance weights

Table E.1. HQ STRs reduce investment in MNEs with most substance in headquarter

Dependent variable: group-level investment

	(1)	(2)	(3)
HQ STR X domestic substance 1st tercile	-0.052		
	(0.138)		
HQ STR X domestic substance 2nd tercile	-0.272*		
	(0.139)		
HQ STR X domestic substance 3rd tercile	-0.276*		
	(0.154)		
HQ STR X domestic substance below median		-0.163	
		(0.119)	
HQ STR X domestic substance above median		-0.226*	
		(0.123)	
HQ STR X domestic substance <25%			-0.478
			(0.472)
HQ STR X domestic substance 25%-50%			-0.305
			(0.273)
HQ STR X domestic substance 50%-75%			-0.021
			(0.146)
HQ STR X domestic substance 75%-100%			-0.259**
			(0.114)
Observations	6,693	6,693	6,693
R^2	0.392	0.392	0.392
Adjusted R^2	0.244	0.244	0.244

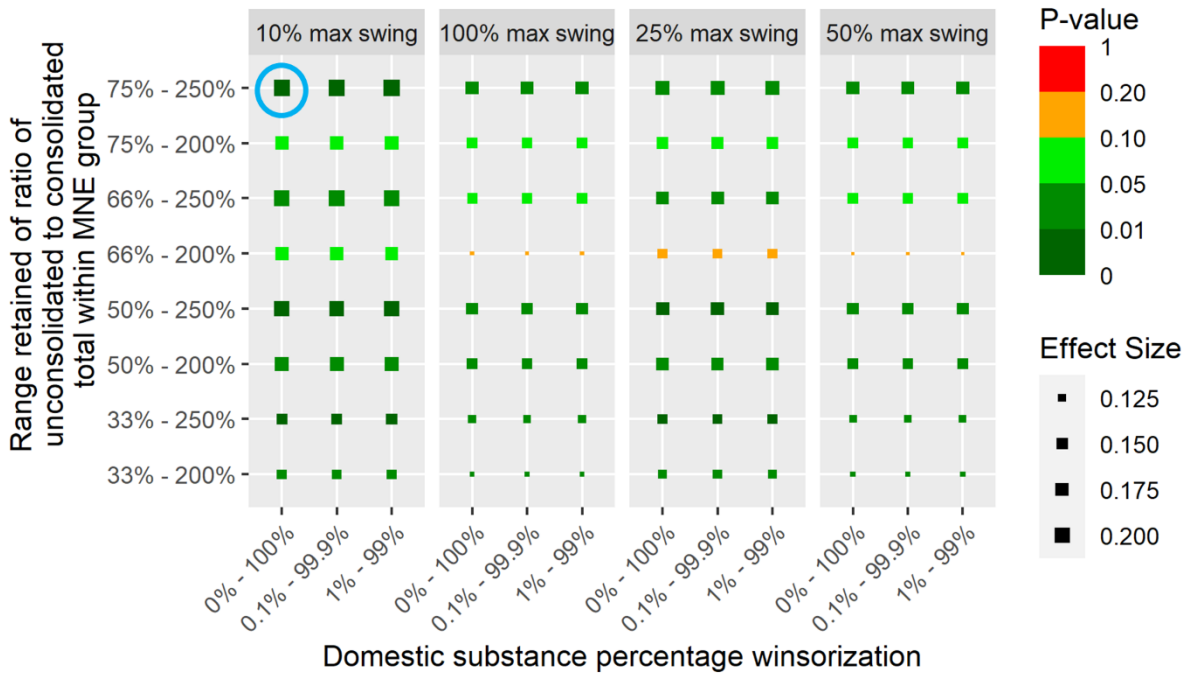
Note: In this sample, stricter cleaning includes only the consideration of groups with domestic substance percentages between 5% and 95%. The domestic substance percentages in this sample are time-invariant, averaged across years for each MNE X host jurisdiction. Firm, year, and industry-year fixed effects are included in all regressions.

Annex F. Sensitivity Analyses

80. This annex presents additional sensitivity analyses incorporating 180 regressions to validate the results of the regressions based on the economic-substance-weighted average (ESW) STR (Table 3 and Figures F.2, F.3, and F.4) and those analysing the positive cross-border tax effect (Table 4 and Figure F.1). Figure F.1 demonstrates that the effect of the EMTR in an MNE's top-substance jurisdiction on its investments in other jurisdictions remains positive and statistically significant even when the cleaning parameters of the sample are varied along 3 different dimensions. The figures further demonstrate that – even when cleaning parameters of the sample are varied along three different dimensions – the ESW STR is statistically significant and negative in its effect on global MNE investment (Figure F.3), and that this effect is exclusively due to the UPJ STR (Figure F.2); it disappears entirely when the UPJ STR is removed from the ESW STR (Figure F.4).

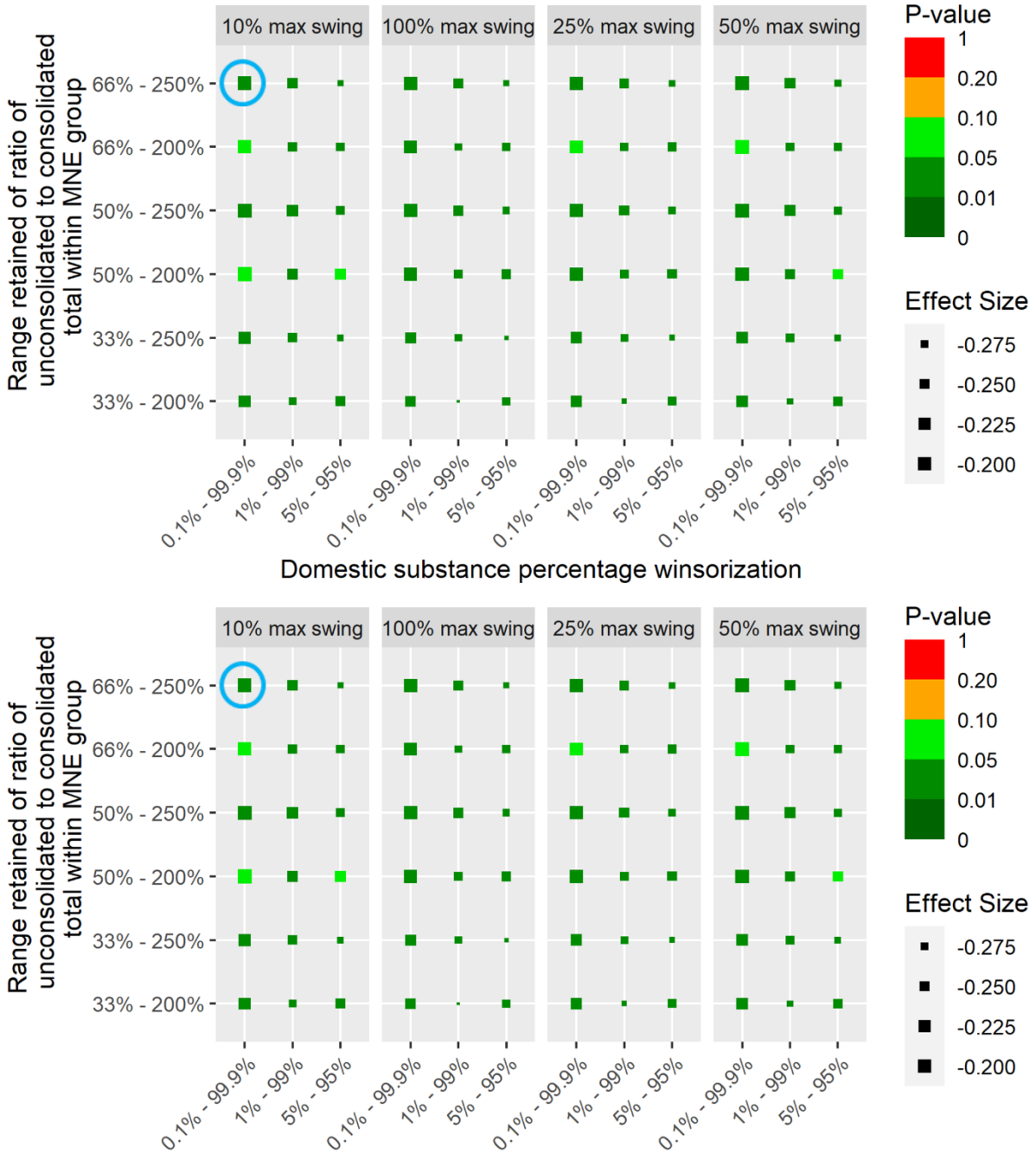
In most cases, further sensitivity analyses also validate the results of the regressions of EMTR interacted with MNE characteristics (Annex A and Figures F.5-F.13), demonstrating that the results in Annex A are mostly insensitive to change in jurisdiction sample selection. In order to assuage concerns about coverage in ORBIS unconsolidated data in particular jurisdictions, each host jurisdiction in the sample is removed, and each regression in Annex A rerun with the other 15 originally included jurisdictions. This means each specification in Annex A is run 16 additional times on 16 different samples of jurisdictions, producing a total of 448 regressions. Effect size boxplots are used to summarize the results. As a result of Bureau Van Dijk's data collection methods and the nature of local filings, coverage patterns typically occur at the host jurisdiction level rather than parent jurisdiction level. Chi square test results for each regression in Annex A are also provided (Table F.1).

Figure F.1. Robustness check: Cross-border tax effect size and statistical significance across 96 Samples with varied cleaning parameters



Note: Each coloured square represents the coefficient for the effect of EMTR of non-HQ top-substance jurisdiction in the regression in Table 4 for a different sample determined by the modulation of 3 cleaning steps. For instance, the green square in the bright blue circle at the top left corner of Figure F.1 represents the positive size and significance at the .01 level (size of the square and colour, respectively) of the non-HQ top-substance jurisdiction coefficient in a regression as specified in Table 4 and cleaned as follows: Only MNE groups where the ratio of unconsolidated to consolidated fixed assets was between 75% and 250% were retained in this regression (Y axis); no winsorization of the percentage of global group substance in the headquarter jurisdiction was executed (X axis); all MNEs with greater than a 10% change over time in the percentage of global group substance located in the headquarter jurisdiction are dropped (Dark gray bar at top, i.e. "facet"). "X% max swing" refers to the maximum allowed variation over time in the percentage of an MNE's substance located in the headquarter. The ratio of totals on the Y axis refers to fixed assets.

Figure F.2. Robustness check: Effect size and statistical significance of UPJ STR on group-level investment across 84 samples with varied cleaning parameters

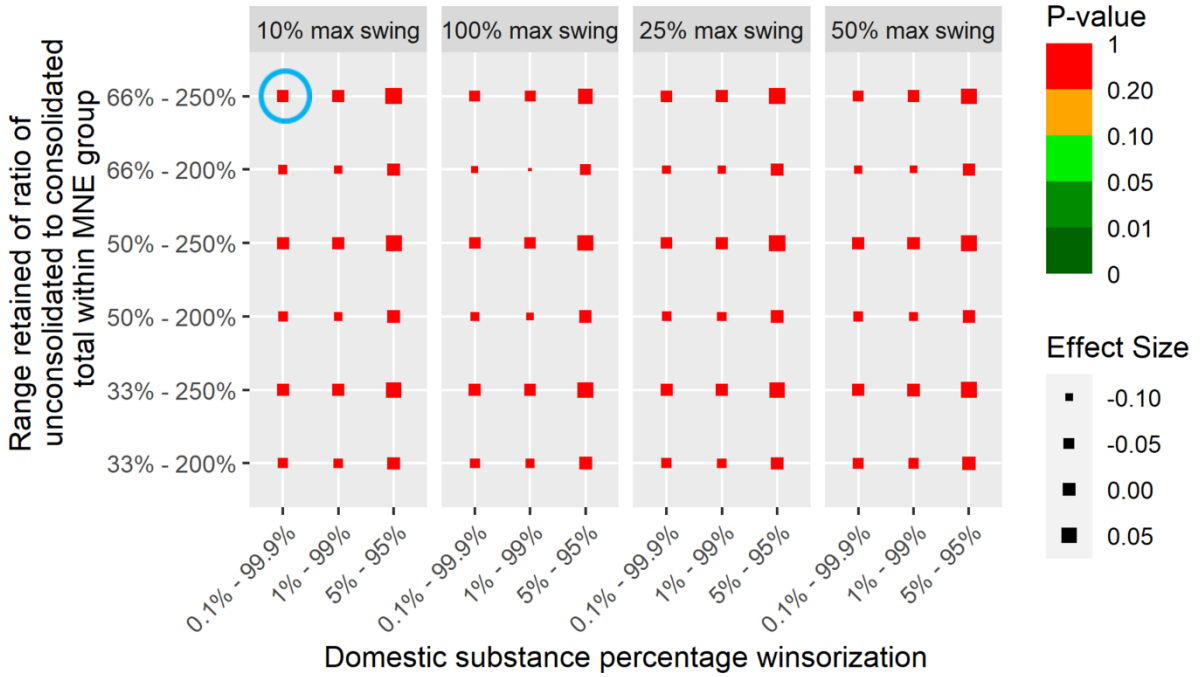


Note: Each coloured square represents the coefficient for the effect of UPJ STR on MNE group-level global investment for the identical specification Table 3 Column 3, but for a different sample determined by the modulation of 3 cleaning steps. For instance, the green square in the bright blue circle at the top left corner of Figure F.2 represents the negative size and statistical significance at the .05 level (size of the square and colour, respectively) of the UPJ STR coefficient in a regression as specified in column 3 of Table 3 and cleaned as follows: Only MNE groups where the ratio of unconsolidated to consolidated fixed assets was between 66% and 250% were retained in this regression (Y axis); winsorization of the percentage of global group substance in the headquarter jurisdiction was executed at [.1%-99.9%] (X axis); all MNEs with greater than a 10% change over time in the percentage of global group substance located in the headquarter jurisdiction are dropped (Dark gray bar at top, i.e. "facet"). "X% max swing" refers to the maximum allowed variation over time in the percentage of an MNE's substance located in the headquarter. The ratio of totals on the Y axis refers to fixed assets.

Figure F.3. Robustness check: Effect size and statistical significance of economic substance weighted STR on group-level investment across 84 samples with varied cleaning parameters

Note: Each coloured represents the coefficient for the effect of the Economic Substance Weighted STR on MNE group-level global investment for the identical specification Table 3 Column 2, but for a different sample determined by the modulation of 3 cleaning steps. For instance, the green square in the bright blue circle at the top left corner of Figure F.3 represents the negative size and statistical significance at the 0.1 level (size of the square and colour, respectively) of the UPJ STR coefficient in a regression as specified in column 2 of Table 3 and cleaned as follows: Only MNE groups where the ratio of unconsolidated to consolidated fixed assets was between 66% and 250% were retained in this regression (Y axis); winsorization of the percentage of global group substance in the headquarter jurisdiction was executed at [.1%-99.9%] (X axis); all MNEs with greater than a 10% change over time in the percentage of global group substance located in the headquarter jurisdiction are dropped (Dark gray bar at top, i.e. "facet"). "X% max swing" refers to the maximum allowed variation over time in the percentage of an MNE's substance located in the headquarter. The ratio of totals on the Y axis refers to fixed assets.

Figure F.4. Robustness check: Effect size and statistical significance of economic substance weighted STR when UPJ STR is removed on group-level investment, across 84 samples with varied cleaning parameters



Note: Each coloured square represents the coefficient for the effect of the non-UPJ Economic Substance Weighted on MNE group-level global investment for the identical specification Table 3 Column 1, but for a different sample determined by the modulation of 3 cleaning steps. For instance, the red square in the bright blue circle at the top left corner of Figure F.4 represents the negative size and statistical insignificance at the 0.1 level (size of the square and colour, respectively) of the non-UPJ ESW STR coefficient in a regression as specified in column 1 of Table 3 and cleaned as follows: Only MNE groups where the ratio of unconsolidated to consolidated fixed assets was between 66% and 250% were retained in this regression (Y axis); winsorization of the percentage of global group substance in the headquarter jurisdiction was executed at [.1%-99.9%] (X axis); all MNEs with greater than a 10% change over time in the percentage of global group substance located in the headquarter jurisdiction are dropped (Dark gray bar at top, i.e. "facet"). "X% max swing" refers to the maximum allowed variation over time in the percentage of an MNE's substance located in the headquarter. The ratio of totals on the Y axis refers to fixed assets.

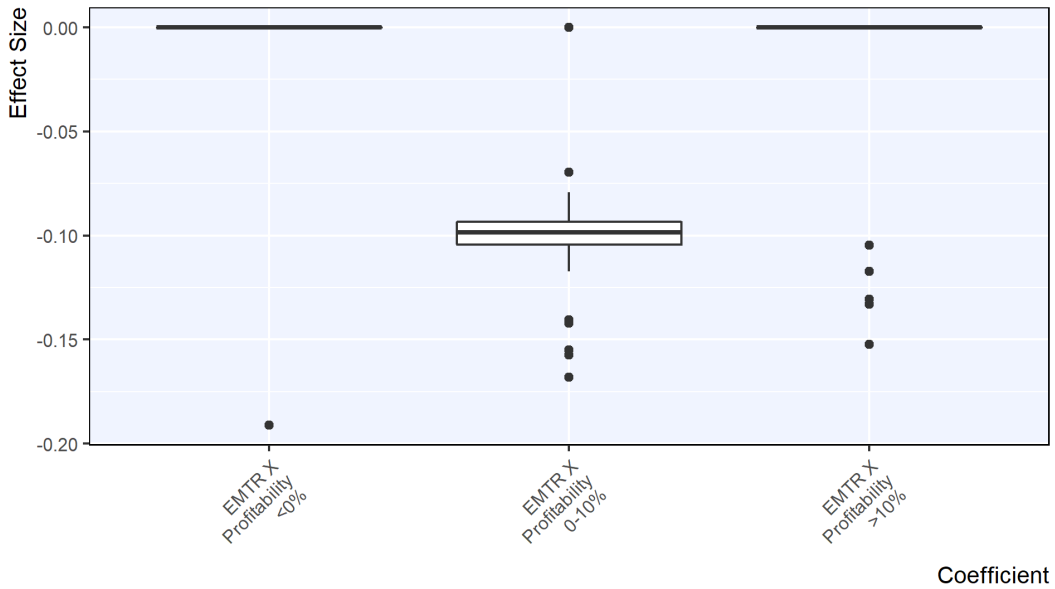
Table F.1. Statistical significance of differences between highest-bin and lowest-bin coefficient within each regression in Annex A (Chi Squared Test)

MNE Characteristic Interacted with EMTR	Baseline	Dynamic
Profitability (3 bins)	0.06	0.28
Profitability (5 bins)	0.11	0.16
Liquidity 1	0.05	0.04
Liquidity 2	0.15	0.13
Liquidity 3	0.30	0.16
Markup	0.14	0.17
Industry concentration (top 10)	0.01	0.03
Book tax differences	0.00	0.00
Intermediaries	0.07	0.20
Investment hubs	0.20	0.45
Zero-CIT jurisdictions	0.02	0.11

Note: Each number in the table represents the P-value of a Chi squared test of the hypothesis that there is no difference between the coefficient for the EMTR interacted with the highest bin of the MNE characteristic and the coefficient for the EMTR interacted with the lowest bin of the MNE characteristic. Therefore, a low number indicates a statistically significant difference between the coefficients. For the profitability regressions, the 5-10% bin is compared with the highest bin.

Figure F.5. Host jurisdiction selection sensitivity check: Reproduction of Millot 2020 U-shaped relationship between profitability and investment response, part 1

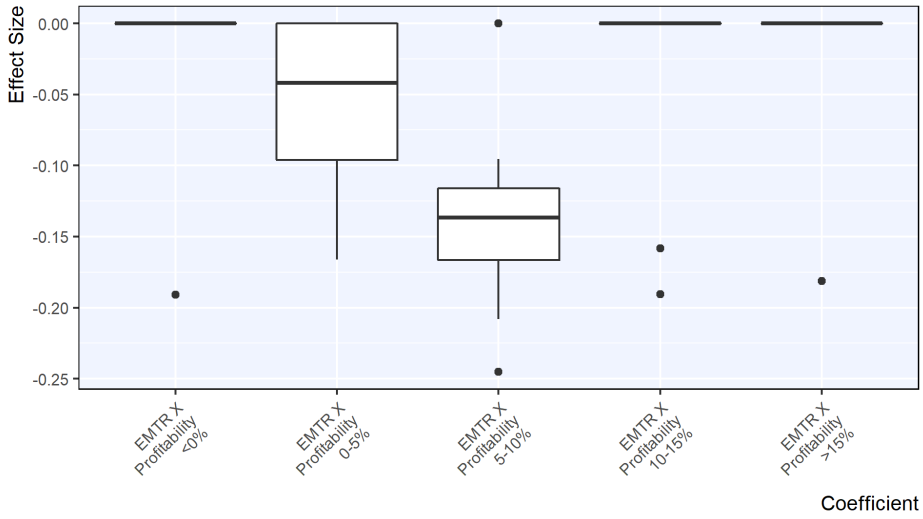
Original specification in Table A.1, columns 3 and 4



Note: Estimates that are statistically insignificant in their difference from zero at the 0.1 level are set to zero in their effect size (Y axis). The boxplot shows the distribution of effect sizes from the 16 jurisdiction-specific robustness samples.

Figure F.6. Host jurisdiction selection sensitivity check: Reproduction of Millot 2020 U-shaped relationship between profitability and investment response, part 2

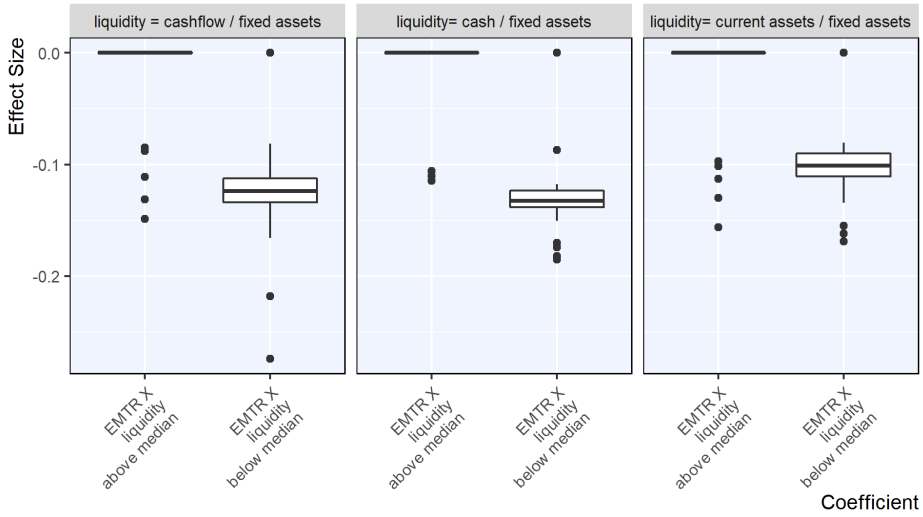
Original specification in Table A.1, columns 5 and 6



Note: Estimates that are statistically insignificant in their difference from zero at the 0.1 level are set to zero in their effect size (Y axis). The boxplot shows the distribution of effect sizes from the 16 jurisdiction-specific robustness samples.

Figure F.7. Host jurisdiction selection sensitivity check: Effect of group-level liquidity on subsidiary-level investment sensitivity to taxation

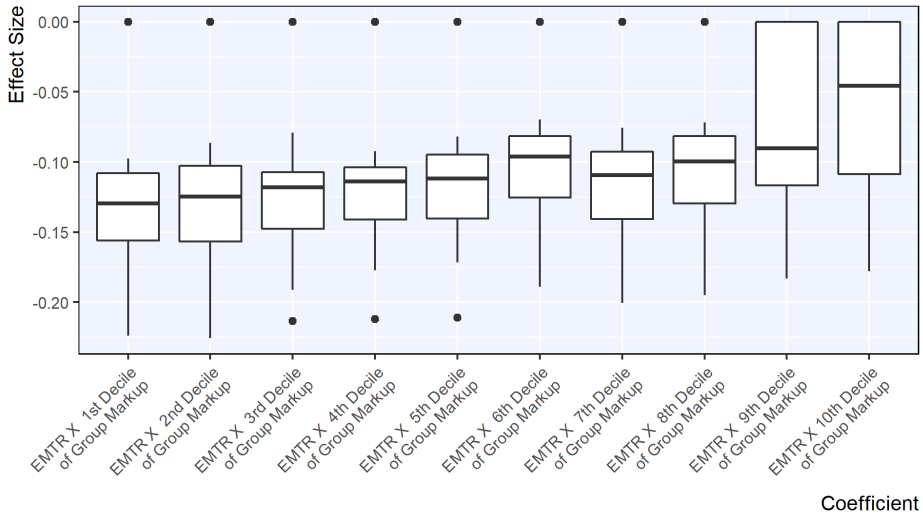
Original specification in Table A.2



Note: Estimates that are statistically insignificant in their difference from zero at the 0.1 level are set to zero in their effect size (Y axis). The boxplot shows the distribution of effect sizes from the 16 jurisdiction-specific robustness samples.

Figure F.8. Host jurisdiction selection sensitivity check: Effect of group-level markups on subsidiary-level investment sensitivity to taxation

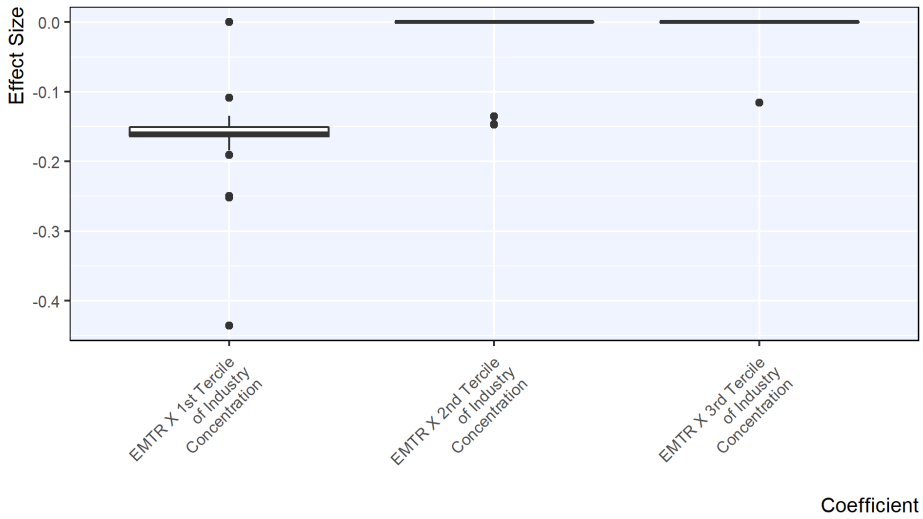
Original specification in Table A.3



Note: Estimates that are statistically insignificant in their difference from zero at the 0.1 level are set to zero in their effect size (Y axis). The boxplot shows the distribution of effect sizes from the 16 jurisdiction-specific robustness samples.

Figure F.9. Host jurisdiction selection sensitivity check: Effect of subsidiary-level industry concentration on subsidiary-level investment sensitivity to taxation

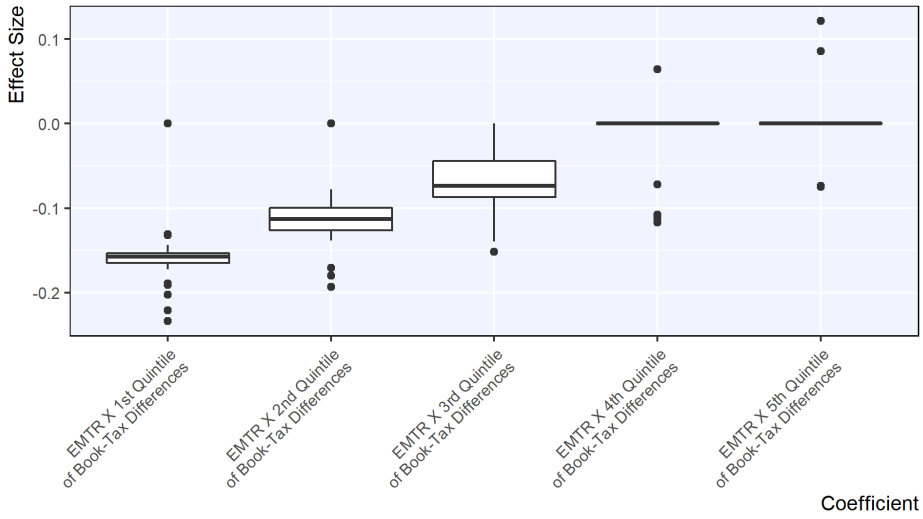
Original specification in Table A.4



Note: Estimates that are statistically insignificant in their difference from zero at the 0.1 level are set to zero in their effect size (Y axis). The boxplot shows the distribution of effect sizes from the 16 jurisdiction-specific robustness samples.

Figure F.10. Host jurisdiction selection sensitivity check: Effect of group-level book-tax differences on tax sensitivity of subsidiary-level investment

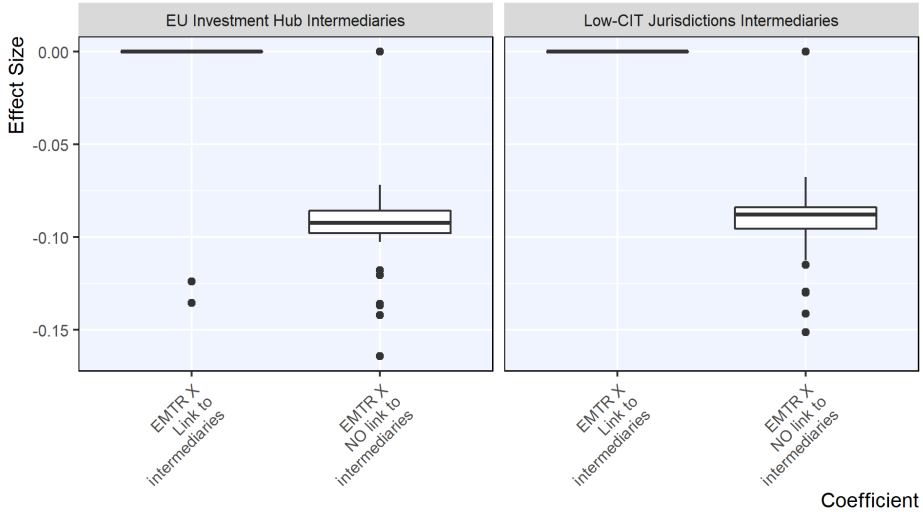
Original specification in Table A.5



Note: Estimates that are statistically insignificant in their difference from zero at the 0.1 level are set to zero in their effect size (Y axis). The boxplot shows the distribution of effect sizes from the 16 jurisdiction-specific robustness samples.

Figure F.11. Host jurisdiction selection sensitivity check: Effect of subsidiary ownership link to intermediaries on subsidiary-level investment sensitivity to taxation

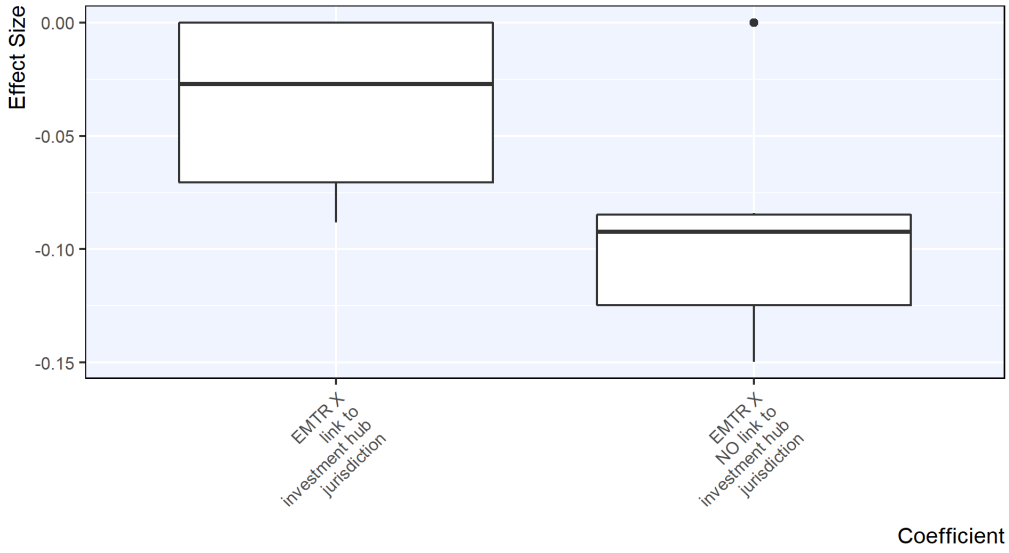
Original specification in Table A.6



Note: Estimates that are statistically insignificant in their difference from zero at the 0.1 level are set to zero in their effect size (Y axis). The boxplot shows the distribution of effect sizes from the 16 jurisdiction-specific robustness samples.

Figure F.12. Host jurisdiction selection sensitivity check: Effect of ownership links to another subsidiary located in an investment hub jurisdiction on subsidiary-level investment sensitivity to taxation

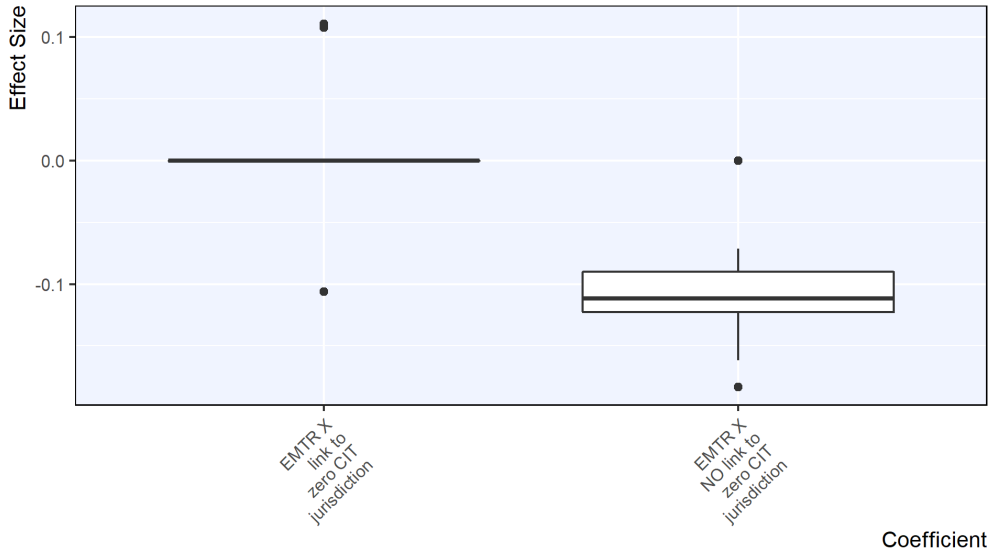
Original specification in Table A.7



Note: Estimates that are statistically insignificant in their difference from zero at the 0.1 level are set to zero in their effect size (Y axis). The boxplot shows the distribution of effect sizes from the 16 jurisdiction-specific robustness samples.

Figure F.13. Host jurisdiction selection sensitivity check: Effect of ownership links to another subsidiary located in a zero-CIT jurisdiction on subsidiary-level investment sensitivity to taxation

Original specification in Table A.8



Note: Estimates that are statistically insignificant in their difference from zero at the 0.1 level are set to zero in their effect size (Y axis). The boxplot shows the distribution of effect sizes from the 16 jurisdiction-specific robustness samples.

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