OECD Taxation Working Papers No. 51

# Corporate taxation and investment of multinational firms: Evidence from firm-level data

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https://dx.doi.org/10.1787/9c6f9f2e-en

OECD

OECD Taxation Working Papers

# Corporate Taxation and Investment of Multinational Firms: Evidence from Firm-Level Data

# Abstract

This paper explores the effect of corporate taxes on the investment of multinational enterprises (MNEs), and whether this effect differs across MNE groups depending on their profitability rate. Firm-level analysis conducted on a cross-country panel of MNE entities confirms the earlier finding that MNE investment in a jurisdiction is negatively affected by effective corporate tax rate increases in that jurisdiction. The analysis also suggests that the tax sensitivity of MNE investment differs across entities belonging to different MNE groups, with a U-shape relationship between tax sensitivity and MNE group profitability. Entities belonging to groups with negative profitability or relatively high profitability rates are found to be relatively less sensitive than those belonging to groups with lower but positive profitability rates. For example, the estimated tax sensitivity of firms in MNE groups with a profitability rate above 10% is found to be nearly half the sensitivity of a firm in an MNE group with a profitability rate between 0% and 10%. This has implications with regard to the tax reform proposals currently under discussion by the OECD/G20 Inclusive Framework on BEPS, as this suggests that highly profitable MNE groups, which are more likely to be impacted by the proposals, may be less sensitive to taxes in their investment behaviour than the typical MNE.

# Acknowledgements

All four authors are from the OECD Economics Department. The authors would like to thank David Bradbury, Ana Cinta González Cabral, Tibor Hanappi and Pierce O'Reilly (all from the OECD Centre for Tax Policy and Administration), Martin Wermelinger (OECD Directorate for Financial and Enterprise Affairs), and delegates from the OECD Working Party No. 2 on Tax Policy Analysis and Tax Statistics for their valuable comments. The authors would also like to thank Matej Bajgar, Chiara Criscuolo and Jonathan Timmis (OECD Science, Technology and Innovation Directorate) for their contribution enabling the use of significantly improved ORBIS ownership links data. Finally, the authors would like to thank Violet Sochay and Karena Garnier (both from the OECD Centre for Tax Policy and Administration) for excellent editorial support.

# Table of contents



## Tables

## Figures



## Boxes

# Corporate taxation and investment of multinational firms: evidence from firm-level data

## 1. Introduction and main findings

1. Multinational corporate taxation in the age of digitalisation is currently the subject of important discussions at the international level. In May 2019, the OECD/G20 Inclusive Framework on BEPS adopted a Programme of Work to Develop a Consensus Solution to the Tax Challenges arising from the Digitalisation of the Economy (OECD, 2019[1]), which has led to the development of international tax reform proposals organised under two pillars and described in two Blueprint reports released in October 2020 (OECD, 2020[2]; OECD, 2020[3]). Pillar One involves significant changes to the rules applicable to the taxation of business profits to ensure that the allocation of taxing rights is no longer exclusively determined by reference to physical presence (OECD, 2020[2]). Pillar Two addresses remaining BEPS challenges and is designed to ensure that large internationally operating businesses pay a minimum level of tax regardless of where they are headquartered or the jurisdictions they operate in (OECD, 2020[3]).

2. One likely outcome of these proposals is a slight increase in effective tax rates faced by firms belonging to multinational enterprise (MNE) groups, especially those located in low tax jurisdictions, as analysed by the OECD Secretariat (Hanappi and González Cabral, 2020[4]). This could in turn affect firm behaviour, with a potential impact on global investment and the location of investment across countries.

3. Existing literature shows that corporate income taxes tend to have a negative effect on MNE investment, although there are also many other determinants of investment decisions.[1] Higher corporate income tax, by reducing the after-tax returns on investment, can indeed lead firms to forgo, downscale or relocate some investment projects. A corporate tax increase in one country, all else being equal, tends to result in lower MNE investment in that country (Sorbe and Johansson, 2017[5]; Feld and Heckemeyer, 2011[6]). However, the sensitivity of firm investment to corporate tax rates is likely to depend on the type of firm considered. Evidence from previous literature suggests that this sensitivity depends for example on characteristics such as investment financing structure and liquidity constraints (Zwick and Mahon, 2017[7]); market structure, in particular firm market power (Kopp et al., 2019[8]); and, more specifically for MNEs, tax planning possibilities (Sorbe and Johansson, 2017[5]).

4. Recent literature has documented the rise of 'superstar firms', i.e. highly productive and innovative firms, which often rely intensively on intangible assets. These firms typically operate globally and increasingly dominate certain product markets, especially in digitalised industries and industries characterised by winner-takes-all or winner-takes-most dynamics (Calligaris, Criscuolo and Marcolin,

[1] Hajkova et al. (2006[47]) for example find that taxation is "a relatively minor factor affecting the location choices of MNEs as compared to policies affecting the ease of entry for foreign firms, their labour costs and the functioning of product markets in the host country".

2018[9]; Bajgar et al., 2019[10]; Gutiérrez and Philippon, 2019[11]; Autor et al., 2017[12]). The difference in firm sensitivity to corporate tax is particularly interesting to study in this context. 'Superstar firms', which are generally characterised by very high mark-ups and profitability rates, are indeed likely to react differently from other firms to changes in corporate taxation, as suggested by recent evidence on US firms' reactions to the Tax Cuts and Jobs Act (Kopp et al., 2019[8]).[2] Since these firms are also more likely to be impacted by the international tax reforms currently under discussion, this would have relevant impacts on the overall investment effects of any reforms eventually agreed by the Inclusive Framework.[3] These potential implications are further discussed in the OECD Secretariat's report on the economic impact assessment of the reform proposals (OECD, 2020[13]).

5. This paper explores whether the effect of corporate taxes on MNE investment differs across MNE groups, in particular depending on the profitability rate of the group. Firms in more profitable MNE groups could react differently to taxation from firms in less profitable groups for several reasons. First, more profitable groups are likely to have greater financial resources (e.g. available liquidities) than less profitable groups, which makes them less credit constrained and thus less sensitive to a potential increase in taxation. Secondly, their high profitability rates may be related to monopolistic or oligopolistic positions, in which case corporate tax incidence tends to fall on monopoly rents rather than on normal returns to capital, which may induce smaller behavioural responses to corporate taxation in respect of MNE investment decisions (Kopp et al., 2019[8]). Moreover, these monopolistic positions may have been acquired thanks to significant past investments (e.g. through the grant of patents, or in situations of winner-takes-most dynamics), in which case groups might be reluctant to reduce future investment as this would threaten their dominant position in the market. Finally, more profitable MNE groups may have more tax planning incentives than other groups, and the ability to shift profits could make them less sensitive to local taxation (Johansson et al., 2017[14]; Desai, Foley and Hines, 2006[15]; Grubert, 2003[16]). For example, these MNE groups may rely more on intangible assets, allowing them greater scope to strategically locate these assets in low tax jurisdictions as part of their tax planning strategies, as suggested by de Mooij and Liu (2020[17]). It may also be the case that the fixed costs associated with tax planning may dissuade less profitable groups from engaging in profit shifting in the first place.[4]

6. Relying on a firm-level econometric framework estimated on a panel of 26,078 MNE entities located in 17 countries over the period 2007-2016, this paper confirms the earlier findings that MNE investment in a jurisdiction is negatively affected by effective corporate tax rate increases in that jurisdiction. This may result in the MNE group relocating investment to other jurisdictions, or reducing its overall group-wide investment. These two effects are difficult to disentangle with the available data. While earlier literature has not been able to shed much light on this point, a recent analysis on the effect of the introduction of transfer pricing rules suggests that changes in country-level tax rules result mainly in a relocation of MNEs investment rather than a global adjustment (de Mooij and Liu, 2020[17]).[5]

7. Going one step further, the main contribution of this paper is to investigate whether the sensitivity of MNE investment to corporate taxes depends on the profitability rate of MNE groups. The analysis suggests

[2] See further details in Section 2.2.

[3] This is especially the case for Pillar One, which would only apply to highly profitable firms, above a certain profitability threshold (OECD, 2020[2]). More profitable firms are also more likely to be affected by Pillar Two as they may have greater opportunities and incentives to engage in tax planning.

[4] Fully disentangling the effect of these different channels (liquidity constraints, market dominance and profit shifting behaviours) on the tax sensitivity of investment would constitute an interesting research question but is challenging with the available data and is beyond the scope of this paper.

[5] Relocation effects might be less pronounced in the context of the current reform, as jurisdictions act in a coordinated manner. However as long as the corporate tax reform affects the effective tax rate of certain jurisdictions more than others, relocation effects are still likely to occur.

that the tax sensitivity of MNE investment differs across entities belonging to different groups, with a U-shape relationship between tax sensitivity and MNE group average profitability (i.e. the average profitability of the group over the sample period 2007-2016). Entities belonging to groups with negative profitability or relatively high profitability rates (profit before tax to turnover above 10%) are found to be relatively less sensitive than those belonging to groups with medium profitability rates (zero to 10%). The tax sensitivity of firms in MNE groups with a profitability rate above 10% is found to be nearly half the sensitivity of a firm in an MNE group with profitability rate between 0% and 10%. For MNE groups above 15% profitability, the tax sensitivity is even lower, about one third of the sensitivity of MNE groups between zero and 10% profitability. This tends to suggest that highly profitable MNE groups, which are more likely to be impacted by the proposals currently under discussion by the Inclusive Framework, may be less sensitive to taxes in their investment behaviour than the typical MNE.

8. The next section provides an overview of the literature on corporate taxation and firm-level investment. Section 3. presents the empirical framework used to estimate the tax sensitivity of firm-level investment and Section 4. describes the firm-level data and tax indicators used in the empirical analysis. Section 5. presents the empirical results and the final section offers some concluding thoughts, including implications of the results.

## 2. Corporate taxation and firm-level investment

### *2.1. Corporate taxes can affect business investment*

9. Macro-level evidence from the literature on the effect of corporate taxes on aggregate business investment is mixed (Ramey, 2019[18]). This may reflect that macro-level estimates suffer from unavoidable limitations, as corporate tax changes are relatively rare and often part of broader reforms that may affect economic activity through other channels, making identification difficult. Another reason why macro-level evidence is mixed could also be that different firms react differently to changes in taxation, or that certain corporate tax provisions affect firms differently (e.g., depreciation schedules or loss carryover provisions). Analyses at a more granular level are therefore crucial to understand how business investment reacts to corporate taxation.[6]

10. Existing studies at the industry level or at the firm level both tend to point to a negative effect of statutory corporate tax rates on investment. For example, earlier OECD work at the firm level suggests that a reduction in the statutory corporate tax rate from 35% to 30% would increase the investment-to-capital ratio by approximately 2% in the long run (Arnold et al., 2011[19]), in line with previous OECD estimates at the industry level (Vartia, 2008[20]). However, it is worth highlighting that these studies evaluate the effects of changes in statutory CIT rates that would be of relevance to the entire universe of firms liable to tax in a given country. In contrast, the tax liabilities arising under the new corporate tax proposals would be targeted towards a subset of generally large and profitable MNEs.

11. Corporate taxation is also found to have a negative impact on foreign direct investment (FDI), although the estimated elasticity varies across studies – see Feld and Heckemeyer (2011[6]) for a survey of the empirical literature.[7] An increase in a jurisdiction's corporate taxation tends to reduce investment by corporate groups both at the extensive margin, i.e. the number of establishments located in this jurisdiction,

[6] Ideally, these analyses should cover not only the effects of statutory CIT rates but also effects of other provisions related to corporate tax bases. To account for the latter some studies have used corporate effective average or marginal tax rates (see section 3. for a discussion of these measures).

[7] One difference between these studies and the present analysis is that FDI data include both real investment and 'paper profits', which are both sensitive to the corporate tax rate, whereas the present analysis only focuses on real investment by companies.

and at the intensive margin, i.e. the level of investment in each entity located in this jurisdiction (Giroud and Rauh, 2019[21]).[8] These effects could reflect a relocation of investment by multinational groups and/or changes in the group global investment.

12. The negative relationship between corporate tax and multinational investment is corroborated by indirect evidence from papers analysing the impact on investment decisions of rules against profit shifting, which can result in increases in effective taxation. De Mooij and Liu (2020[17]) for example find that the introduction of transfer pricing regulations in a country leads to a reduction by more than 11% of MNE affiliates' investment in this country. Other papers have found a negative effect of anti-avoidance rules on multinational investment, either across countries (Klemm and Liu, 2019[22]; Buettner, Overesch and Wamser, 2018[23]), or focusing on specific countries, for example Germany (Egger and Wamser, 2015[24]). As discussed by De Mooij and Liu (2020[17]), these effects could again reflect a relocation of investment rather than a reduction in group-level investment.

### *2.2. The sensitivity of investment to corporate taxation depends on the type of firm*

13. Empirical evidence at the firm level shows that the sensitivity to corporate taxation depends on the type of firm. At the national level, one study suggests that tax sensitivity can vary across sectors, manufacturing firms being on average more sensitive to corporate tax than service firms, and depending on firm size, small firms being on average more sensitive than bigger firms (Fuest, Peichl and Siegloch, 2018[25]).[9]

14. According to a recent analysis by Kopp et al. (2019[8]), the sensitivity of firm investment to corporate effective tax rates also depends on the market power of the firm. Based on firm-level data for 17 advanced economies, they show that the impact of fiscal shocks on investment and employment is significantly smaller in firms with higher mark-ups. They find the same effect on a sample of US firms observed in 2018, following the Tax Cuts and Job Act. The interpretation put forward by the authors is that when market power is high, the incidence of the tax falls on monopoly rents rather than on normal return to capital, so that reductions in corporate effective tax rates increase post-tax monopoly profits, and only induce a small behavioral response in production and investment decisions.

15. The finding of a lower sensitivity to taxes of firms with higher mark-ups as compared to other firms could also be explained by other factors related to market power that have been found to shape the tax sensitivity of firm investment. One of these factors is the nature of assets, which according to recent research may be a significant determinant of tax sensitivity. For example, de Mooij and Liu (2020[17]) find that the negative effect of the introduction of transfer pricing rules on investment is less pronounced among firms with a relatively high share of intangible assets than among those with a lower share of intangible assets. Investment reactions might also depend on the redeployability of assets, i.e. the extent to which assets are saleable in secondary market, in light of recent evidence of stronger investment reactions from firms with less redeployable assets to the Brexit referendum (Campello et al., 2020[26]). Another potential factor are liquidity constraints, as evidence shows that firms with a greater share of liquid assets tend to react less to effective taxation than other firms (Zwick and Mahon, 2017[7]). Finally, tax planning strategies may also play a role. Existing evidence shows that firm investment is less sensitive to domestic taxation when the firm is part of a MNE group with more tax planning possibilities (Sorbe and Johansson, 2017[5]).

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[8] The present paper focuses on continuing firms, i.e. on the intensive margin, since the ORBIS data used for the analysis is generally not considered to be a reliable indicator of firm entry and exit.

[9] The latter result however tends to depend on the precise analytical framework considered: according to an earlier firm-level analysis, the effect of corporate tax rate on investment is similar for small and large firms, but tends to be more negative for older firms (Arnold et al., 2011[19]).

## 3. Empirical framework

16. The link between corporate effective tax rates and MNE investment is estimated at the firm level using the same approach as in Sorbe and Johansson (2017[5]). The investment rate (i.e. the ratio of investment to the stock of capital) at the firm level is regressed on a lagged measure of the corporate effective tax rate (ETR) at the country level. Following Sorbe and Johansson (2017[5]), the estimated equation is derived from a neo-classical investment model where investment depends on the user cost of capital (Hall and Jorgenson, 1967[27]), isolating the effect of corporate taxes, which is one key component of the user cost.[10]

17. ETRs tend to provide a more accurate picture of the effects of corporate tax systems on the actual tax liabilities faced by firms than statutory tax rates, as they capture the effect of fiscal depreciation rules and other tax deductions. The analysis uses a forward-looking ETR measure, i.e. a synthetic tax policy indicator calculated on the basis of a hypothetical investment project, as opposed to backward-looking measures that capture the taxes actually paid by companies in the past. Forward-looking measures are indeed likely to better reflect the present investment incentives delivered by corporate tax systems at a given point in time (OECD, 2019[28]). Forward-looking ETRs are also more exogenous to investment than backward-looking ones, as they are computed based on hypothetical investment projects rather than based on taxes actually paid.

18. More precisely, the analysis relies on forward-looking effective marginal tax rates (EMTRs), which are used to analyse how taxes affect the incentive to expand existing investments (i.e. at the intensive margin), as opposed to effective average tax rates (EATRs) which are more appropriate to analyse discrete investment decisions (i.e. at the extensive margin) (OECD, 2019[28]; Devereux and Griffith, 2003[29]).[11]

19. After looking at the average effect of EMTRs on investment, the empirical framework tests whether this effect differs across MNE groups with different characteristics. This study focuses primarily on one source of heterogeneity in tax elasticities, namely, profitability. To this end, the EMTR variable is interacted with dummy variables indicating different levels of profitability rates at the MNE-group level. The reason for using group-level profitability (while the investment equation is otherwise estimated at the entity level) is that it is the profitability position at the group level that may matter for the investment decisions of the group, and also that observed entity-level profitability may be distorted by profit-shifting behaviour.[12]

[10] Other components of the user cost, such as the net financing cost of investment, are not included in the baseline specification.

[11] The variability of the EMTR indicator used as an explanatory variable in the model is limited by the fact that the indicator is observed only at the country-time level. However, all countries in our sample have seen some variation, often significant, in the EMTR indicator over the time period considered in this analysis (see Annex E), due to more or less important changes occurring in tax legislation from one year to another.

[12] The reason why the investment equation is estimated at the entity level is that it is easier, both methodologically and for data reasons, to relate the investment of an MNE group in a country to the tax rate in the country, than to relate the global investment of an MNE group to the “global tax rate” that it faces. This is because computing this global tax rate would require having a full picture of the location of this MNE group’s investment and of EMTRs in all these locations, while these variables are only available for a limited subset of countries covered, both in firm-level databases and country-level ETR databases.

20. Specifically, the following equation is estimated on a panel of MNE entities across countries:

$$\frac{I_{f,g,c,i,t}}{K_{f,g,c,i,t-1}} = \beta_1 EMTR_{c,t-1} \times 1_{\pi_g \leq 0\%} + \beta_2 EMTR_{c,t-1} \times 1_{0\% < \pi_g \leq 10\%} + \beta_3 EMTR_{c,t-1} \times 1_{\pi_g > 10\%} + \theta VAgrowth_{c,i,t-1} + \delta_f + \delta_t + \delta_{it} \quad (1)$$

where: $I_{f,g,c,i,t}$ is the investment of firm *f*, belonging to MNE group *g*, and operating in country *c*, industry *i* and year *t*, measured as the change in fixed assets (including both tangible and intangible assets) between *t* and *t-1* corrected for depreciation (both at book value); $K_{f,g,c,i,t-1}$ is the capital stock at the end of the previous year, proxied by fixed assets;[13] $EMTR_{c,t-1}$ is the forward-looking effective marginal corporate tax rate in country *c* and year *t-1*; $\pi_g$ is the average profitability of the group over the period, measured as the ratio of *Profit before tax* on *Operating turnover* consolidated at the group-level. $VAgrowth_{c,i,t-1}$ is a control variable corresponding to value-added growth at the country-industry level, in volume terms, to account for the fact that firms in fast-growing industries are likely to have higher investment rates. Finally, $\delta_f$, $\delta_t$ and $\delta_{it}$ are firm, time and industry-time fixed effects, controlling for all firm-specific (as well as industry- and country-specific[14]) and time-specific (both across industries and within each industry) characteristics influencing investment rates. Following the results of the literature, the average effect of EMTRs on investment is expected to be negative. However, if differences are observed across the various $\beta$ coefficients, this would mean that entities belonging to groups with different profitability levels are more or less sensitive to changes in effective taxation.

21. Although the above specification includes a demanding fixed effect structure, controlling for all sources of unobserved heterogeneity at the firm and industry-time level, it does not take into account all sources of time variation within each country, including the effect of the business cycle. To further examine the differences in tax sensitivity across MNE groups with different profitability levels, a further specification is therefore estimated including country-year fixed effects in order to control for all sources of time variation in each country. This second specification provides more precise information on the relative tax sensitivity of firms in different group profitability intervals, however, it does not provide information about the average level of the tax sensitivity. For this reason, the first set of estimations are favoured in the interpretation of the results.[15]

22. One limitation of the model is that the investment effect of taxation is estimated at the level of MNE entities, without considering the potential reaction of other entities in the MNE group. Therefore, it is not possible to distinguish whether the investment effect corresponds to a global investment change at the group-level or to a relocation of investment to another entity located in a different country (where the ETR may not have changed).

23. Another limitation is that the model focuses on short term rather than long term investment reactions. An alternative option would be to estimate an autoregressive distributed lag model or an error correction

[13] As noted in Sorbe and Johansson (2017[5]), one caveat of this measure is that book value depreciation is generally more rapid than economic depreciation, which means that the denominator of the investment rate (lagged *fixed assets)* is generally lower than the economic value of the capital stock, resulting in an upward distortion in the investment rate. However, this is unlikely to bias the results as this distortion is not related to the variables of interest in the model (i.e. tax rate, group profitability).

[14] Firms do not change country nor industry in the firm-level sample, which implies that firm fixed effects implicitly also control for country and industry fixed effects.

[15] The specification with country-year fixed effects does not provide information on the average level of the tax sensitivity because the EMTR is measured at the country-year level, so controlling for country-year fixed effects implies dropping one interaction variable from the regressions (due to collinearity) and estimating the EMTR effect for the other group profitability intervals in comparison to the omitted one.

model to investigate both short term and long term effects on investment (Bond and Xing, 2015[30]; Bond et al., 2003[31]). However, given that the model used in the present analysis includes firm fixed effects, including explanatory variables based on lagged values of the dependent variable would potentially bias the estimation (Nickell bias), especially as the sample has a short period and a large number of entities (Nickell, 1981[32]).

24. One possible way to try to mitigate this problem is to use a first-differenced generalised method of moments (GMM) estimator, following the approach initially proposed by Arellano and Bond (1991[33]). This approach consists in estimating a dynamic panel data model, taking first differences to remove unobserved time-invariant firm-specific effects, and instrumenting the lagged dependent variable in the differenced equation by additional lags of the variable to circumvent the issue that in first difference estimations the lagged dependent variable is correlated with the error term.[16] One disadvantage of GMM estimations is that they can induce biases in the case of weak instruments, leading to weak identification (Ziliak, 1997[34]). Another disadvantage compared to the baseline OLS regression is that this approach significantly reduces the number of observations, due to the multiple years of firm-level observations needed to run the estimation. Finally, implementing GMM estimators is complex, and runs the risk of overlooking some limitations which might lead to misuse them (Roodman, 2009[35]). Notwithstanding this, the Arellano-Bond GMM estimator can be useful to be able to take into account longer-term dynamics in the reactions of firms to corporate tax in the above framework, and is therefore implemented as a robustness check in this paper (see Annex D).

## 4. Data and descriptive statistics

### *4.1. Firm-level data*

25. The econometric analysis relies on a harmonised cross-country firm-level dataset, where underlying data are sourced from ORBIS, a commercial database commercialised by Bureau Van Dijk (see Box 1). ORBIS contains financial information from firms' balance sheets and income statements, as well as information on ownership links between firms. ORBIS data were used to identify MNE corporate group structures, to build the investment rate at the entity (unconsolidated account) level and to calculate the profitability ratio at the group (consolidated account) level. The analysis is restricted to firms affiliated to MNE groups.

26. While ORBIS covers a large number of countries, the final sample of countries is driven by the availability of data on fixed assets at the entity-level.[17] The final sample covers MNE entities in 17 countries, mostly in Europe (Austria, Germany, Denmark, Estonia, Spain, Finland, France, United Kingdom, Greece, Hungary, Ireland, Japan, Luxembourg, Netherlands, Portugal, Sweden, Slovenia).[18] These entities may, however, have their ultimate parent headquartered in any country worldwide, and given that the coverage of ORBIS for consolidated account data is good worldwide, it is possible to observe the profitability of MNE groups even if the ultimate parent is not located in a country included in the entity-level sample.

27. Although the sample at the entity-level is restricted to 17 – mostly European – countries, the results are likely to be applicable to other countries given that the model estimates firm-level effects of corporate

[16] In order to maximise the number of observations, the difference GMM results presented in this paper rely on forward orthogonal deviations transform instead of first differencing, as proposed by Arellano and Bover (1995[46]).

[17] The number of countries covered in the final sample is also driven by the availability of country-level effective tax rate data (see section 4.2. ).

[18] The coverage of ORBIS is uneven across countries included in the sample (see Annex Table A A.1 ), resulting in some countries having a low number of observations. The results of the analysis are robust to dropping these countries (countries with less than 1000 firm-year observations) from the sample (see Annex F).

tax everything else being equal, and that the list of countries covered (including for example Nordics, Eastern and Southern European countries, and big European Union countries) is relatively varied both in terms of taxation and economic structure.

28. The sample covers all non-agriculture, non-financial business industries (i.e. all industries excluding NACE Revision 2 codes below 5, above 82 or between 64 and 66). The time coverage of the ORBIS vintage used in this study varies across firms and countries, with a maximum 27-year history (1990-2016). Since entities are matched to corporate groups based on ownership links observed in 2016, the sample is restricted to ten years (2007-2016), in order to minimise discrepancies with corporate group structure data, which focus primarily on year 2016.

### Box 1. Main steps of ORBIS data cleaning

ORBIS is the largest cross-country firm-level database that is available and accessible for economic and financial research. However, since the information is primarily collected for use in the private sector, typically with the aim of financial benchmarking, a number of steps need to be undertaken before the data can be used for economic analysis. The steps applied follow suggestions by Kalemli-Ozcan et al. (2015[36]) and previous OECD experience (Gal, 2013[37]). As discussed in Andrews, Criscuolo and Gal (2016[38]), Bailin Rivares et al. (2019[39]), or Gal et al. (2019[40]) these data are cleaned and benchmarked using a number of common procedures such as keeping accounts that refer to entire calendar year, using harmonized consolidation level of accounts, dropping observations with missing information on key variables as well as outliers identified as implausible changes or ratios.

Additional cleaning steps are then applied specifically for the purpose of the present analysis. Investment rates at the entity-level are built using nominal values originally in euros converted back to local currency to avoid exchange rate movements affecting the measure. Extreme values of investment rates are then excluded (below the 10th or above the 90th percentile level). A further possible cleaning step is to clean jumps in investment rates over time (investment rates more than five times higher from one year to another), which is particularly important for the analysis of the dynamics of investment. As this cleaning step tends to drop a large number of observations, it is only applied for the GMM estimation - which looks more specifically at the dynamics of investment - and not for the baseline model estimation (the baseline model results are nevertheless broadly robust to applying this cleaning step). Outliers in terms of profitability at the consolidated group-level are also removed (dropping in a first step observations with a ratio of pre-tax profit to turnover either below -100% or above 100%, and in a second step pre-tax on turnover ratios below 1$^{st}$ or above 99$^{th}$ percentile level). The sample is restricted to firms with at least eight years of observations in the sample.

Finally, for the purposes of this analysis, MNE groups were identified relying on ORBIS ownership links data for the year 2016. These data were extensively cleaned and complemented by the OECD Science, Technology and Innovation Directorate, following the methodology detailed in Bajgar et al. (2019[10]) and were updated for the year 2016. Entities in ORBIS are assigned to corporate groups based on their Global Ultimate Owner (GUO), using a 50% ownership threshold, and considering GUOs of corporate nature (i.e. Industrial companies, Banks, Financial companies, Insurance companies, or Financial companies) to avoid, for example, assigning to the same group two independent firms owned by the same individual or government entity. In turn, MNE groups are defined as corporate groups having entities in at least two jurisdictions. For each MNE group, only the consolidated accounts of this GUO are kept in the sample, to avoid potential double counting.

### 4.2. Forward-looking effective tax rates

29. The source of forward-looking EMTR is the data prepared by the Leibniz Centre for European Economic Research (ZEW) for the European Union (EU) Commission project TAXUD/2018/DE/307, computing forward-looking ETRs on investment in EU member states as well as a few non-EU countries[19] (Spengel et al., 2019[41]). The methodology builds on the theoretical model developed by Devereux and Griffith (1998[42]; 2003[29]) and is also in line with the methodology underlying OECD indicators of forward-looking ETRs described in detail in Hanappi (2018[43]). The advantage of ZEW data compared to OECD indicators is that they contain 21 years of history (1998 to 2018), whereas OECD forward looking ETRs are currently only available for 2017. An alternative data source would have been the ETR time series published by the Oxford Centre for Business Taxation (CBT), however, this data source covers a smaller set of tax provisions as well as fewer country-year observations in the most recent years.

30. EMTR data are sensitive to the tax provisions included in the calculations. For example, specific tax provisions to address the debt-equity bias, in particular the Allowance for Corporate Equity (ACE), have a significant effect on the EMTRs (Spengel et al., 2016[44]). Some countries have introduced an ACE in the last two decades, leading to significant discrepancies in the EMTR trends across sources, i.e., the ZEW and CBT data series. For that reason, countries having an ACE system during the sample period (2007-2016) are excluded from the econometric analysis, namely Belgium, Italy and Latvia.[20]

### 4.3. Other controls

31. Value-added growth at the country-industry-level, which is used as a control variable, is sourced from the OECD STAN database. The data on value-added growth cover 28 industries in the non-agriculture, non-financial business sector, grouped according to the World Input-Output Database categories. In the empirical analysis, extreme values of value added growth (below -30% and above 30%) are excluded, in line with Sorbe and Johansson (2017[5]).

### 4.4. Final sample and descriptive statistics

32. The final sample is an unbalanced panel spanning ten years (2007-2016) and 17 countries, which contains almost 163,000 entity-year observations. This represents more than 26,000 distinct entities, which belong to more than 9,000 distinct MNE groups.[21]. The number of observations is relatively stable over time, although it decreases in the last year of the sample due to significantly weaker industry-level value added data coverage in this final year (Table 1). Most of the firms do not stay in the sample for all of the ten years, due mainly to variation in ORBIS coverage. The sample is restricted to firms that have at least

[19] ZEW EMTR data cover 35 countries (28 EU member states and North Macedonia, Turkey, Norway, Switzerland, Canada, Japan and the United States), of which 20 are well-covered in ORBIS data at the unconsolidated accounts level (Austria, Belgium, Germany, Denmark, Estonia, Spain, Finland, France, United Kingdom, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, Latvia, Netherlands, Portugal, Sweden, Slovenia). The EMTR data for the countries and years included in the sample are presented in Annex E.

[20] The list of countries having introduced an ACE system relies on a paper by Hebous and Klemm (2018[50]). Portugal also has an ACE system since 2008, but its application is limited (only available to SMEs until 2017, and with a ceiling of EUR 2,000,000 of corporate equity) and it apparently has minimal effects on the EMTR indicator.

[21] The relatively low number of entities per MNE group represented in the sample can be explained by the incomplete coverage of ORBIS data at the unconsolidated account-level (the sample covers only a selection of countries, and the coverage is uneven across the countries covered), as well as by the relatively strict data cleaning applied to the data. However it is not necessary to have in the sample all the entities belonging to each MNE group to identify the effect of corporate tax on firm-level investment in the model used in this paper.

eight observations over the sample period.[22] Basic statistics on the main variables of interest for the final sample are presented in Table 2.

### Table 1. Number of observations in the final sample

| | Number of firms | Number of groups |
|---|---|---|
| 2007 | 16,951 | 6,624 |
| 2008 | 18,180 | 7,002 |
| 2009 | 18,351 | 7,011 |
| 2010 | 17,891 | 6,892 |
| 2011 | 17,660 | 6,687 |
| 2012 | 16,716 | 6,445 |
| 2013 | 16,115 | 6,206 |
| 2014 | 15,738 | 5,932 |
| 2015 | 14,684 | 5,548 |
| 2016 | 10,704 | 4,549 |
| **2007-2016** | **26,078** | **9,381** |

Note: The detail of the number of observations by country is available in Annex Table A A.1 and Table A A.2
Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.

### Table 2. Basic statistics on the final sample

| Variable | Number of observations | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Investment rate | 162,990 | 0.18 | 0.22 | -0.11 | 2.22 |
| Effective Marginal Tax Rate (lagged) | 162,990 | 0.25 | 0.07 | 0.03 | 0.43 |
| Industry value- added growth rate | 162,990 | 0.01 | 0.06 | -0.30 | 0.30 |
| Average group profitability | 162,990 | 0.06 | 0.07 | -0.31 | 0.42 |

Note: Investment rate corresponds to the change in firm fixed assets corrected for depreciation (both measured at book value) divided by lagged fixed assets. Average group profitability corresponds to the ratio of Profit before tax to Operating turnover at the group consolidated account level, averaged over the sample period. All variables are expressed as ratios.
Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.

## 5. Results

### *5.1. Baseline results*

33. The results confirm the sensitivity of firm investment to domestic EMTRs (column 1 in Table 3), with a negative coefficient estimated at around -0.13 (significant at the 10% level). This implies that a five percentage point increase in the EMTR is associated with a 0.6 percentage point decrease in the investment rate. This effect of effective tax rates on investment is of the same order of magnitude as the firm-level estimate of Sorbe and Johansson (2017[5]), relying on the same empirical framework for an earlier period (2000-2010) and with generally weaker data coverage.

[22] Restricting to a fully balanced panel would imply a drastic reduction of the sample to only 22,480 entity-year observations.

34. The results also suggest that the sensitivity to effective tax rates tends to differ across groups with different profitability levels. The interaction of EMTRs with dummy variables corresponding to different intervals of average group-wide profitability (ratio of profit before tax to operating turnover) points to a U shape relationship between sensitivity to corporate tax and group profitability (columns 2 and 3 in Table 3). The estimated sensitivity of investment rate to EMTR is the strongest, and is statistically significant, for entities belonging to groups with profitability rates between zero and 10%, while for entities belonging to groups with negative profitability or profitability above 10% the sensitivity is lower and not statistically significantly different from zero. The difference between the coefficients is nevertheless itself not statistically significant in this first set of regressions, but it is significant in the next set of regressions with a more demanding fixed effect structure (column 4-5), as discussed in the following paragraph.

35. In order to examine more closely the difference in tax sensitivity across groups with different profitability rates, a specification with a more demanding fixed-effect structure is used, including country-year fixed effects, to control for all sources of time variation of the investment rate in each country.[23] Due to collinearity, this implies dropping one interaction variable from the right-hand side variables and estimating the EMTR effect for the other group profitability intervals in comparison to the omitted one (i.e. groups with profitability above 10% in column 4, and above 15% in column 5). The results of this specification confirm a U-shape relationship between tax sensitivity and group profitability, and moreover indicate that the estimated differences in tax sensitivity across groups with different profitability rates are statistically significant, MNE groups above 10% or 15% profitability being significantly less sensitive than MNE groups between 0 and 10% profitability (column 4-5 in Table 3).

36. This suggests that MNE groups with very low or very high profitability rates tend to be less affected by changes in corporate taxes. For MNEs with negative profitability, this result could be explained by the fact that these firms generally do not have to pay corporate income tax, and loss carry-forward provisions may shield them from having to pay taxes for some time into the future.[24] For firms with high profitability rates, this result could be due to various factors, for example: (i) more profitable firms tend to have lower liquidity constraints, providing them with a greater capacity to absorb a negative shock of higher taxation; (ii) high profitability levels may be associated with monopolistic positions acquired thanks to significant past investments (e.g. through the grant of patents or in situations of winner-takes-most dynamics), and these highly profitable firms might be reluctant to reduce future investment following a tax increase as this could threaten their dominant position in the market; and (iii) more profitable firms may have stronger tax planning incentives than other firms, which would make them less sensitive to domestic taxation, as shown in Sorbe and Johansson (2017[5]).

37. These factors are difficult to fully disentangle with the available data. Additional regression results tend to confirm the role of the group liquidity position in the entity-level sensitivity to corporate tax. Using a specification similar to Equation (1), MNE entities belonging to groups with a low share of liquid assets (namely cash flow, current assets, or cash and cash equivalent as a share of fixed assets[25]), are found to be significantly more sensitive to EMTR than other MNE entities (see Annex B).

38. Based on the regression results presented in Table 3, Figure 1 presents the estimated firm sensitivity to effective taxation depending on group-level profitability (using results in column 2-3, which provide an

[23] This specification is more precise than in the previous regressions, however, it does not provide information about the average level of the tax sensitivity, which is why the results of the first set of estimations are favoured in the interpretation and the graphical illustrations of the results.

[24] In line with this interpretation, Dreßler and Overesch (2013[48]) find that the tax rate elasticity of investment is lower for MNEs shielded by loss carry-forwards.

[25] Although those ratios are often used in the literature to proxy for liquidity constraints, recent literature has shown that they can be imperfect proxies of genuine liquidity constraints, which depend on other factors at the firm-level, as pointed out by Farre-Mensa and Ljungqvist (2016[53]).

estimate not only of the relative tax sensitivity across groups with different profitability levels, but also of the level of tax sensitivity). While it is estimated that MNE groups with a profitability rate between 0% and 10% would on average reduce their domestic investment rate by around 0.15 percentage points following a one percentage point increase in the country's EMTR, the effect is nearly twice as small for MNE groups with profitability ratios above 10% and more than three times smaller for MNE groups with profitability rates above 15%. This finding may have implications for the overall investment effects of the international tax reforms currently under discussion. This is particularly the case for Pillar One, which would only affect highly profitable MNE groups above a certain profitability threshold (OECD, 2020[2]). It may also be the case for Pillar Two, since highly profitable MNE groups tend to be more likely to engage in profit shifting to low-tax jurisdictions than the average MNE group.

## Table 3. Investment regression results

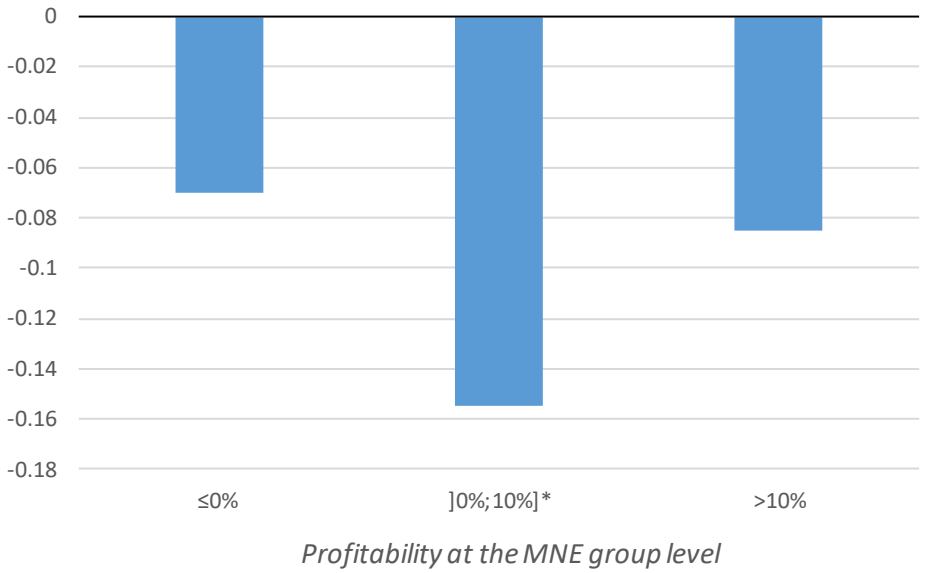
| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $EMTR_{c,t-1}$ | -0.131* | | | | |
| | (0.0716) | | | | |
| Value added $growth_{i,c,t}$ | 0.0536*** | 0.0535*** | 0.0535*** | 4.91e-06 | -6.60e-05 |
| | (0.0168) | (0.0168) | (0.0168) | (0.0119) | (0.0119) |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability \leq 0\%}$ | | -0.0697 | -0.0697 | -0.0160 | -0.0680 |
| | | (0.115) | (0.115) | (0.100) | (0.119) |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability \in ]0\%;10\%]}$ | | -0.155** | | -0.106* | |
| | | (0.0732) | | (0.0604) | |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability > 10\%}$ | | -0.0854 | | | |
| | | (0.0840) | | | |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability \in ]0\%;5\%]}$ | | | -0.145* | | -0.148* |
| | | | (0.0812) | | (0.0884) |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability \in ]5\%;10\%]}$ | | | -0.169* | | -0.172* |
| | | | (0.0941) | | (0.101) |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability \in ]10\%;15\%]}$ | | | -0.116 | | -0.0969 |
| | | | (0.0983) | | (0.0991) |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability > 15\%}$ | | | -0.0498 | | |
| | | | (0.0954) | | |
| Firm fixed effects | YES | YES | YES | YES | YES |
| Year fixed effects | YES | YES | YES | YES | YES |
| Industry*year fixed effects | YES | YES | YES | YES | YES |
| Country*year fixed effects | NO | NO | NO | YES | YES |
| Observations | 162,990 | 162,990 | 162,990 | 162,986 | 162,986 |
| R-squared | 0.376394 | 0.376402 | 0.376404 | 0.379937 | 0.379941 |

Note: The estimated equation in Column 2 corresponds to Equation (1), where the dependent variable is the investment rate at the firm-level, proxied by the change in fixed assets corrected for depreciation (both measured at book value) divided by lagged fixed assets. Column 3 corresponds to a similar equation with more disaggregated brackets for group-level profitability. Column 4 and 5 correspond to the same equations as column 2 and 3, adding country-year fixed effects. Due to collinearity this implies dropping one interaction variable from the right-hand side variables (the interaction between the EMTR variable and the dummy variable for the highest profitability interval, i.e. profitability above 10% in column 4 and above 15% in column 5). Average group profitability is based on the ratio of Profit before tax to Operating turnover at the group consolidated account level, averaged over the sample period. OLS estimates. Robust standard errors clustered at country*year level are presented in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, * at the 10% level.
Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.

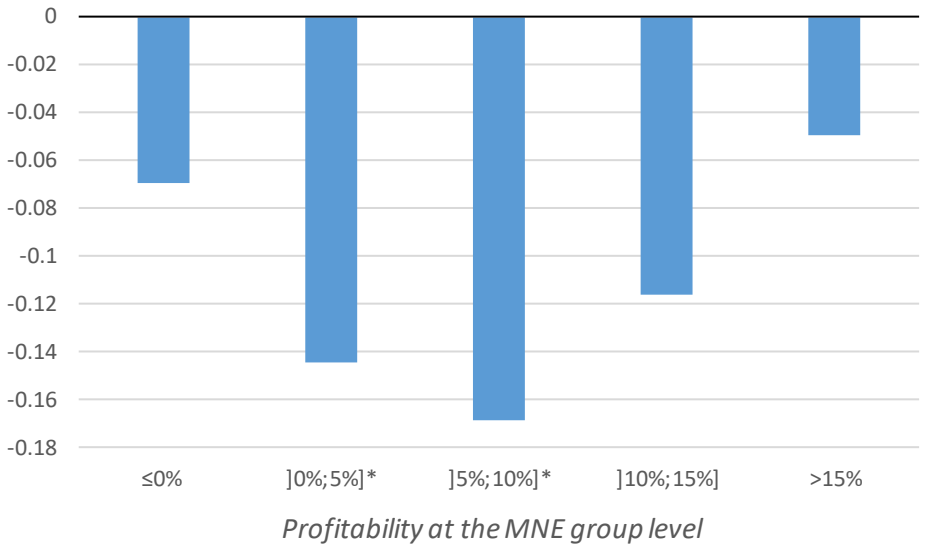
## Figure 1. Firm sensitivity to corporate tax depends on group profitability

Estimated change in investment rate associated to a 1 percentage point increase in EMTR, percentage point

Panel A




Panel B




Note: Figures in Panel A (respectively Panel B) rely on regression results shown in Table 3, Column 2 (respectively Column 3). The only difference between the two panels is the number of brackets considered for group-level profitability rates. The estimated effects for profitability groups marked with a star (*) are statistically significantly different from zero at the 5% level (in Panel A) or 10% level (in Panel B), whereas the effects for other profitability groups are not. The difference between the coefficients is itself not statistically significant, but it is significant in a second set of regressions with a more demanding fixed effect structure (column 4-5 of Table 3). This second set of regressions only provides information about the difference between the coefficients and not about the average level of the tax sensitivity, which is why it is not used in this graphical illustration.

Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.

### *5.2. Robustness checks*

39. Results are robust to:

- Excluding one country at a time from the sample;
- Excluding all countries with low coverage in ORBIS, i.e. with less than 1,000 observations per year (see results in Annex F);
- Using a two-year moving average of EMTR values at the country level (to take into account possible uncertainty around the exact timing of tax reforms implementation, as well as a potentially longer lag in response times to tax changes);[26]
- Restricting the sample to entities belonging to MNE groups with a turnover above 750 million euros, representing around 70% of the baseline sample (see results in Annex F);
- Using profitability intervals based on quartiles of the group profitability sample distribution (rather than round thresholds, such as 0% and 10%), in order to have an equal number of observations across profitability groups (see results in Annex C).

40. Results also hold when estimating a dynamic panel data model, using a difference GMM estimator following the approach proposed by Arellano and Bond (1991[33]).[27] This estimation confirms the negative short-term effect of domestic EMTR on firm investment, with a coefficient estimated at around -0.14 and statistically significant at the 5% level (see Annex D). The advantage of this model is that it also allows for the consideration of the dynamics of investment, taking into account adjustment costs. [28] The coefficient on the lagged investment rate is statistically significant and estimated at around 0.33, which is in line with previous estimates of investment rate persistence using the same estimation method (Baum, Caglayan and Talavera, 2008[45]). Moreover, the results suggest the same U-shape relationship between tax sensitivity of MNE entities' investment and the profitability rate of the groups they belong to. In particular, the estimated effect of EMTR on the investment of firms belonging to groups with profitability rates between 0% and 10% is negative and statistically significant, whereas it is close to zero and not statistically significant for groups with profitability rates above 10%.[29]

## 6. Conclusion

41. This firm-level study confirms the earlier finding that corporate taxes tend to have a negative effect on the average MNE investment (Sorbe and Johansson, 2017[5]; Vartia, 2008[20]). Going one step further,

[26] Lags beyond two years have not been found to be significant, possibly because of the relatively short time dimension of the sample considered.

[27] Difference GMM is used rather than system GMM as the estimation shows no sign of weak instrument problem due to highly persistent data (Bond, Hoeffler and Temple, 2001[52]).

[28] There are reasons, including the presence of adjustment costs, why the current level of investment may depend on previous investment. Adjustment costs are, however, not modelled per se in this estimation, which would require a more sophisticated estimation strategy, such as an error correction model, which would require longer time series than what is available in the data.

[29] Compared to the baseline OLS estimation sample, one additional cleaning step has been applied to the data used for the GMM estimation, which consists in cleaning jumps in investment rates over time (investment rate more than five times higher from one year to another are replaced to missing). Without this cleaning step the estimates of the persistence of investment rate seemed implausibly low compared to firm-level estimates found in the previous literature (Baum, Caglayan and Talavera, 2008[45]) (Kandilov and Leblebicioğlu, 2012[51]) (Ratti, Lee and Seol, 2008[49]). The other coefficients are broadly unaffected by this cleaning step. The baseline OLS estimation results are also broadly robust to including this cleaning step.

the results of the analysis suggest that the tax sensitivity of MNE entities' investment varies depending on the profitability rate of the groups to which they belong, following a U-shape relationship. Entities belonging to groups with negative profitability or relatively high profitability rates are found to be relatively less sensitive than those belonging to groups with medium profitability rates. For example, the tax sensitivity of firms in MNE groups with a profitability rate (computed as profit-before-tax to turnover) above 10% is found to be nearly twice as small as the sensitivity of a firm in an MNE group with profitability rate between 0% and 10%. For MNE groups above 15% profitability, the tax sensitivity is even lower, about three times smaller than for MNE groups between zero and 10% profitability.

42. This tends to suggests that highly profitable MNE groups may be less sensitive to taxes in their investment behaviour than the typical MNE group. This has implications with regard to the tax reform proposals currently under discussion by the Inclusive Framework. Large, profitable MNE groups are more likely to be impacted by the proposals than other MNE groups. If these firms are less tax sensitive on the margin than the average MNE group, increases in group-level investment costs potentially induced by the reforms may result in only a limited reduction in global investment levels. These implications are further discussed in the report summarising the economic impact assessment of the Pillar One and Pillar Two proposals, recently released by the OECD Secretariat (OECD, 2020[13]).

43. As is the case with most of the existing literature, the results in this paper do not answer the question of whether an increase in taxation would lead MNE groups to reallocate investment to other jurisdictions or to reduce their global investment. This could be investigated in future research, for example by looking at investment reactions to changes in taxation at the group-level, as done in a recent paper by de Mooij and Liu (2020[17]).

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# Annex A. Detailed information on number of observations

## Table A A.1. Number of observations by year and country of subsidiary

| | AUT | DEU | DNK | EST | ESP | FIN | FRA | GBR | GRC | HUN | IRL | JPN | LUX | NLD | PRT | SWE | SVN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2007 | 2 | 1,484 | 491 | 70 | 3,495 | 716 | 1,971 | 3,267 | 332 | 194 | 132 | 303 | 1 | 54 | 1,375 | 2,861 | 203 |
| 2008 | 3 | 1,746 | 527 | 86 | 3,539 | 718 | 2,014 | 3,459 | 358 | 385 | 185 | 338 | 12 | 60 | 1,466 | 3,071 | 213 |
| 2009 | 5 | 1,774 | 539 | 84 | 3,739 | 764 | 1,920 | 3,588 | 358 | 357 | 167 | 332 | 22 | 51 | 1,361 | 3,086 | 204 |
| 2010 | 1 | 1,706 | 537 | 96 | 3,684 | 785 | 1,882 | 3,531 | 320 | 426 | 182 | 303 | 27 | 53 | 1,116 | 3,058 | 184 |
| 2011 | 11 | 1,712 | 515 | 94 | 3,611 | 737 | 1,683 | 3,461 | 375 | 414 | 183 | 303 | 25 | 57 | 1,274 | 3,009 | 196 |
| 2012 | 40 | 1,649 | 505 | 88 | 3,437 | 699 | 1,298 | 3,349 | 303 | 406 | 178 | 272 | 23 | 52 | 1,298 | 2,933 | 186 |
| 2013 | 57 | 1,593 | 492 | 88 | 3,221 | 656 | 1,254 | 3,238 | 315 | 399 | 171 | 252 | 23 | 51 | 1,302 | 2,824 | 179 |
| 2014 | 67 | 1,557 | 488 | 91 | 3,101 | 632 | 1,498 | 3,104 | 304 | 407 | 159 | 254 | 20 | 40 | 1,153 | 2,682 | 181 |
| 2015 | 46 | 1,468 | 432 | 79 | 2,921 | 583 | 1,490 | 2,952 | 318 | 392 | 160 | 194 | 20 | 30 | 1,026 | 2,399 | 174 |
| 2016 | 46 | 665 | 247 | 77 | 1,741 | 566 | 1,324 | 2,499 | 276 | 384 | 139 | 142 | 23 | 26 | 756 | 1,617 | 176 |

Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.

## Table A A.2. Number of observations by jurisdiction of ultimate parent

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Angola | 20 | Finland | 6,969 | Malta | 119 | Switzerland | 2,846 |
| Australia | 464 | France | 18,775 | Marshall Islands | 23 | Thailand | 47 |
| Austria | 1,491 | Germany | 16,592 | Mauritius | 17 | Tunisia | 2 |
| Belgium | 1,825 | Greece | 1,486 | Mexico | 230 | Turkey | 82 |
| Bermuda | 394 | Hong Kong (China) | 37 | Morocco | 10 | United Arab Emirates | 16 |
| Brazil | 123 | Hungary | 497 | Netherlands | 4,459 | United Kingdom | 16,914 |
| British Virgin Islands | 2 | Iceland | 65 | New Zealand | 23 | United States | 14,819 |
| Bulgaria | 8 | India | 674 | Norway | 2,428 | | |
| Canada | 584 | Indonesia | 8 | Pakistan | 2 | | |
| Cayman Islands | 211 | Ireland | 1,908 | Panama | 3 | | |
| Chile | 52 | Israel | 136 | Poland | 150 | | |
| China | 1,547 | Italy | 4,150 | Portugal | 5,630 | | |
| Chinese Taipei | 176 | Japan | 7,959 | Russia | 77 | | |
| Croatia | 58 | Korea | 331 | Saudi Arabia | 35 | | |
| Curaçao | 95 | Kuwait | 96 | Singapore | 401 | | |
| Cyprus | 106 | Latvia | 62 | Slovak Republic | 16 | | |
| Czech Republic | 45 | Liechtenstein | 139 | Slovenia | 234 | | |
| Denmark | 5,131 | Lithuania | 43 | South Africa | 152 | | |
| Egypt | 20 | Luxembourg | 1,679 | Spain | 19,970 | | |
| Estonia | 18 | Malaysia | 173 | Sweden | 20,136 | | |

Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.

### Table A A.3. Number of observations in each profitability group

| | |
|---|---|
| π<=0% | 17574 |
| 0%<π<=5% | 65522 |
| 5%<π<=10% | 44570 |
| 10%<π<=15% | 18965 |
| π>15% | 16359 |

Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.

# Annex B. Regression results on group liquidity ratios

## Table A B.1. Firm sensitivity to corporate tax depends on group liquidity position

Investment regression results

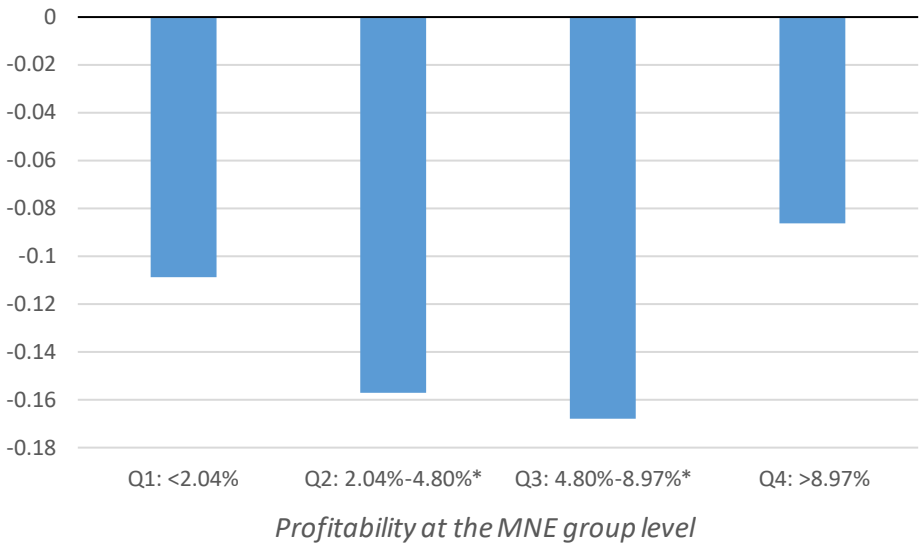
| | (1) | (2) | (3) |
|---|---|---|---|
| *Liquidity ratio:* | *Cash Flow on Fixed Assets* | *Current Assets on Fixed Assets* | *Cash and cash equivalent on Fixed Assets* |
| Value added growth$_{i,c,t}$ | 0.0522*** | 0.0514*** | 0.0508*** |
| | (0.0186) | (0.0174) | (0.0174) |
| EMTR$_{c,t-1}$ X 1$_{\text{Low average liquidity ratio}}$ | -0.205*** | -0.150** | -0.147* |
| | (0.0763) | (0.0697) | (0.0773) |
| EMTR$_{c,t-1}$ X 1$_{\text{High average liquidity ratio}}$ | -0.0204 | -0.0833 | -0.0755 |
| | (0.0891) | (0.0856) | (0.0826) |
| Firm fixed effects | YES | YES | YES |
| Year fixed effects | YES | YES | YES |
| Industry*year fixed effects | YES | YES | YES |
| Observations | 135,796 | 144,977 | 144,959 |
| R-squared | 0.367 | 0.369 | 0.369 |

Note: The estimated equation is similar to Equation (1), except that the dummy variables interacted with the EMTR variable refer here to average liquidity ratios at the group level. The dependent variable is the investment rate at the firm-level, proxied by the change in fixed assets corrected for depreciation (both measured at book value) divided by lagged fixed assets. Liquidity ratios correspond to firm Cash Flow (in Column 1), Current Assets (in Column 2), or Cash and Cash equivalent (in Column 3) divided by firm fixed assets, all measured at the group consolidated account level, and averaged over the sample period. High and low average liquidity ratios correspond to average liquidity ratios above or below the sample median. OLS estimates. Robust standard errors clustered at country*year level are presented in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, * at the 10% level.
Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.

# Annex C. Results estimated on group profitability quartiles

### Figure A C.1. Firm sensitivity to corporate tax across group profitability quartiles

Estimated change in investment rate associated to a 1 percentage point increase in EMTR, percentage point




Note: Figures rely on the results of a regression using a specification similar to the one shown Equation (1), except that dummy variables representing different group profitability intervals are based on quartiles of the sample distribution of group profitability. Q1 (respectively Q4) corresponds to the lowest (respectively highest) profitability quartile. Profitability levels corresponding to the different quartiles are indicated on the x-axis. The estimated effects for profitability quartiles marked with a star (*) are statistically significantly different from zero at the 10% level, whereas the effects for other profitability quartiles are not.
Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.

# Annex D. Results using a dynamic panel model estimation (GMM estimation)

## Table A D.1. Firm sensitivity to corporate tax depends on group profitability

Investment regression - Estimation with difference GMM

| | (1) | (2) | (3) |
|---|---|---|---|
| *Dependent variable:* | | Investment rate$_{f,t}$ | |
| Investment rate$_{f,t-1}$ | 0.333*** | 0.332*** | 0.332*** |
| | (0.0615) | (0.0616) | (0.0617) |
| EMTR$_{c,t-1}$ | -0.144** | | |
| | (0.0655) | | |
| Value added growth$_{i,c,t}$ | 0.0125 | 0.0123 | 0.0125 |
| | (0.0113) | (0.0113) | (0.0113) |
| EMTR$_{c,t-1}$ X 1$_{Average\ group\ profitability \leq 0\%}$ | | -0.183 | -0.183 |
| | | (0.132) | (0.132) |
| EMTR$_{c,t-1}$ X 1$_{Average\ group\ profitability \in ]0\%;10\%]}$ | | -0.198*** | |
| | | (0.0743) | |
| EMTR$_{c,t-1}$ X 1$_{Average\ group\ profitability > 10\%}$ | | 0.0240 | |
| | | (0.0811) | |
| EMTR$_{c,t-1}$ X 1$_{Average\ group\ profitability \in ]0\%;5\%]}$ | | | -0.246** |
| | | | (0.104) |
| EMTR$_{c,t-1}$ X 1$_{Average\ group\ profitability \in ]5\%;10\%]}$ | | | -0.141* |
| | | | (0.0725) |
| EMTR$_{c,t-1}$ X 1$_{Average\ group\ profitability \in ]10\%;15\%]}$ | | | 0.0204 |
| | | | (0.119) |
| EMTR$_{c,t-1}$ X 1$_{Average\ group\ profitability > 15\%}$ | | | 0.0282 |
| | | | (0.0889) |
| Year fixed effects | YES | YES | YES |
| Industry*year fixed effects | NO | NO | NO |
| Country*year fixed effects | NO | NO | NO |
| Observations | 32,975 | 32,975 | 32,975 |
| Number of firms | 8,163 | 8,163 | 8,163 |
| Arrelano-Bond test for AR(1) - p-value | 0.000 | 0.000 | 0.000 |
| Arrelano-Bond test for AR(2) - p-value | 0.876 | 0.879 | 0.879 |
| Hansen test - p-value | 0.247 | 0.254 | 0.254 |

Note: The estimated equation is similar to Equation (1), except that the explanatory variables include the lagged value of investment rate at the firm-level. Investment rate is proxied by the change in fixed assets corrected for depreciation (both measured at book value) divided by lagged fixed assets. The sample consists of an unbalanced panel of 8163 firms in 17 countries over 2009-2016. The model is estimated in Stata using the "xtabond2" command (Roodman, 2009[35]), with the noleveleq (specifying the GMM estimator in difference) and orthogonal (using forward orthogonal deviations instead of differences, to maximise sample size, as proposed by Arellano and Bover (1995[46])) options. The lagged investment rate variable is instrumented with a 2-year and 3-year lag. Robust standard errors clustered at country*year level are presented in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, * at the 10% level. The Hansen test of over-identifying restrictions and the Arellano-Bond tests for autocorrelation do not reject the chosen instrument set.
Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.

# Annex E. Effective Marginal Tax Rates across countries

## Table A E.1. Effective Marginal Tax Rate over time across countries in the sample

| | AUT | DEU | DNK | EST | ESP | FIN | FRA | GBR | GRC | HUN | IRL | JPN | LUX | NLD | PRT | SWE | SVN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2007 | 18.4% | 28.3% | 16.7% | 3.8% | 33.6% | 21.2% | 34.8% | 27.9% | 13.7% | 15.5% | 13.1% | 41.9% | 17.2% | 17.4% | 17.1% | 18.5% | 16.1% |
| 2008 | 18.4% | 22.5% | 17.1% | 3.6% | 33.4% | 21.2% | 34.9% | 28.0% | 14.1% | 15.5% | 13.1% | 41.9% | 17.2% | 17.4% | 17.1% | 18.5% | 15.3% |
| 2009 | 17.4% | 21.7% | 17.2% | 3.6% | 33.4% | 18.3% | 35.0% | 28.9% | 20.8% | 15.5% | 13.3% | 42.8% | 16.5% | 14.1% | 17.1% | 17.4% | 14.5% |
| 2010 | 17.4% | 21.7% | 17.2% | 3.6% | 33.4% | 19.1% | 28.3% | 29.0% | 13.5% | 15.9% | 13.2% | 42.8% | 16.5% | 14.2% | 19.9% | 17.4% | 13.8% |
| 2011 | 18.4% | 22.5% | 17.2% | 3.6% | 31.4% | 21.8% | 28.4% | 28.4% | 11.1% | 16.6% | 13.2% | 42.8% | 15.8% | 13.9% | 19.9% | 17.4% | 13.8% |
| 2012 | 18.4% | 22.5% | 14.7% | 3.6% | 33.2% | 20.7% | 29.4% | 27.4% | 11.1% | 16.6% | 13.2% | 42.1% | 15.8% | 16.9% | 21.9% | 17.4% | 12.3% |
| 2013 | 18.4% | 22.5% | 14.7% | 3.6% | 34.8% | 18.5% | 30.8% | 26.7% | 19.8% | 16.6% | 13.2% | 42.1% | 16.9% | 13.4% | 21.9% | 14.5% | 11.6% |
| 2014 | 18.4% | 22.5% | 16.9% | 3.6% | 34.1% | 15.4% | 32.5% | 25.3% | 21.2% | 16.6% | 13.2% | 40.4% | 16.9% | 16.9% | 21.9% | 14.5% | 11.6% |
| 2015 | 18.4% | 22.5% | 16.3% | 3.4% | 38.1% | 16.4% | 32.5% | 24.6% | 24.5% | 16.6% | 12.3% | 39.1% | 16.9% | 16.8% | 20.4% | 14.5% | 11.6% |
| 2016 | 18.8% | 22.5% | 15.4% | 3.4% | 36.0% | 16.9% | 32.7% | 24.7% | 24.7% | 16.6% | 12.3% | 38.2% | 16.9% | 16.8% | 20.3% | 14.5% | 11.6% |

Source: ZEW ETR data prepared for the European Union Commission project TAXUD/2018/DE/307 (Spengel et al., 2019[41])

# Annex F. Robustness checks on different firm-level samples

## Table A F.1. Investment regression results: robustness checks on restricted samples

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *Sample restricted to:* | *Countries well covered in ORBIS* | | | *MNE groups above EUR 750 million turnover* | | |
| $EMTR_{c,t-1}$ | -0.155* | | | -0.160** | | |
| | (0.0862) | | | (0.0748) | | |
| Value added $growth_{i,c,t}$ | 0.0536** | 0.0535** | 0.0534** | 0.0434** | 0.0437** | 0.0436** |
| | (0.0237) | (0.0237) | (0.0237) | (0.0182) | (0.0182) | (0.0182) |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability \leq 0\%}$ | | -0.0586 | -0.0587 | 0.0243 | 0.0243 | |
| | | (0.152) | (0.152) | (0.133) | (0.133) | |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability \in ]0\%;10\%]}$ | | -0.183** | | | -0.203*** | |
| | | (0.0875) | | | (0.0770) | |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability > 10\%}$ | | -0.103 | | | -0.111 | |
| | | (0.0974) | | | (0.0881) | |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability \in ]0\%;5\%]}$ | | | -0.180* | | | -0.184** |
| | | | (0.0948) | | | (0.0805) |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability \in ]5\%;10\%]}$ | | | -0.187 | | | -0.228** |
| | | | (0.114) | | | (0.0960) |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability \in ]10\%;15\%]}$ | | | -0.155 | | | -0.167 |
| | | | (0.111) | | | (0.107) |
| $EMTR_{c,t-1}$ X $1_{Average\ group\ profitability > 15\%}$ | | | -0.0387 | | | -0.0449 |
| | | | (0.102) | | | (0.110) |
| Firm fixed effects | YES | YES | YES | YES | YES | YES |
| Year fixed effects | YES | YES | YES | YES | YES | YES |
| Industry*year fixed effects | YES | YES | YES | YES | YES | YES |
| Observations | 136,292 | 136,292 | 136,292 | 115,482 | 115,482 | 115,482 |
| R-squared | 0.369507 | 0.369518 | 0.369522 | 0.399562 | 0.399598 | 0.399591 |

Note: The table presents the results of the same set of regression as the one presented in Column 1, 2 and 3 of Table 3, run on a different (more restricted) firm-level sample. In columns 1, 2, 3 of the above table, the sample is restricted to countries with relatively good ORBIS coverage (countries with more than 1000 observations per year on average in the sample, i.e. France, Germany, Portugal, Spain, Sweden and the United Kingdom). In columns 4, 5 6, the sample is restricted to MNE groups with turnover above EUR 750 million. OLS estimates. Robust standard errors clustered at country*year level are presented in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, * at the 10% level.

Source: Calculations based on ORBIS, ZEW ETR data and OECD STAN database.