

# How aggressive are foreign multinational companies in avoiding corporation tax?\*

Evidence from UK confidential corporate tax returns.

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## Abstract

In this paper, I use confidential UK corporate tax returns dataset from Her Majesty Revenue and Customs (HMRC) to explore whether there are systematic differences in the amount of taxable profits that multinational and domestic companies report. Multinationals are important global corporate players and, particularly in the UK, they have contributed almost 50 percent of total UK revenues between 2000 and 2011. However, multinationals often have more opportunities to avoid tax than domestic standalones, hence they may pay less than their 'fair share' of corporation tax. I estimate, using propensity score matching, that taxable profits relative to total assets reported by foreign multinational subsidiaries are 12.8 percentage points lower than those of comparable domestic standalones, which report their taxable profits to total assets ratio to be 25.2 percent. If we assume that all of the difference can be attributed to tax avoidance, foreign multinational subsidiaries avoid over half of their taxable profits in the UK. The difference is almost entirely attributable to the fact that higher proportion of foreign multinational subsidiaries report zero taxable profits (61.1 percent) than domestic standalones (28.6 percent), suggesting a very aggressive form of tax avoidance.

JEL: H25, H26, H32 Key words: tax avoidance, corporation tax payments, confidential tax returns, administrative data

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# 1 Introduction

Following the financial crisis, issues of aggressive tax avoidance and profit shifting by corporations became more prominent in policy debates as authorities around the world saw combatting tax avoidance as one of the important means of recovering from the fiscal consequences of the crisis. For example, the UK has introduced the Diverted Profits Tax in April 2015 aimed at taxing profits shifted abroad by companies.<sup>1</sup> It has also announced limits to interest deductibility—one of many ways in which corporations minimize their tax payments—from April 2017.<sup>2</sup> More generally, in 2015 the OECD countries have agreed to jointly fight tax avoidance via the Base Erosion and Profit Shifting (BEPS) project.<sup>3</sup> The media has also shown increased appetite for ‘naming and shaming’ many familiar multinational companies, such as Starbucks and Amazon, for paying too little tax.

The question still remains as to whether it is only the very large multinationals that avoid paying corporation tax or do all multinational do so. In this paper, I analyze a universe of confidential corporate tax returns to look at taxable profits companies reported to Her Majesty’s Revenue & Customs (HMRC) during 2000 to 2011. In particular, I focus on whether there are systematic differences in the amount of taxable profits that multinational and domestic companies report.

This is the first study to use actual taxable profits rather than accounting profits to compare tax-paying behaviour of companies in the UK. The use of this new administrative data allows me to estimate the overall size of the difference in taxable profits between UK subsidiaries of foreign multinational companies (foreign multinational subsidiaries) and standalone UK companies (domestic standalones). Further, the availability of tax returns data allows me to explore a new phenomenon - companies reporting zero taxable profits. I find an enormous bunching at zero taxable profits for foreign multinational companies relative to domestic companies, which is not observed to the same extent in the accounting data.<sup>4</sup> Reporting zero taxable profits explains almost all of the difference in taxable profits between foreign multinationals and domestic standalones. Once a foreign multinational company decides to report positive taxable profits, the amount it reports is no different from that of a domestic standalone. This suggests a very aggressive form of tax avoidance for some foreign multinationals. Moreover, a puzzle emerges as I cannot identify any major differences in observable firm level characteristics between tax-payers and non tax-payers. This may suggest that firms could instead differ in their unobservable characteristics such as their ability to avoid tax or reputational costs of aggressive tax

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<sup>1</sup>HMRC description of the diverted profits tax can be found here.

<sup>2</sup>The UK 2016 Budget, p.56.

<sup>3</sup>For the OECD report, see here.

<sup>4</sup>Johannesen *et al.* (2016) find that companies are more likely to report near-zero accounting profits in their home country, the higher the average foreign tax rate of their subsidiaries is.

planning<sup>5</sup>.

This paper comprises two pieces of analysis. The first part presents new stylized facts using the HMRC data. Specifically, I discuss what types of firms pay what shares of overall corporation tax receipts in the UK. In this part, I focus on the differences between all multinational and all domestic companies. Since both foreign multinationals and multinationals headquartered in the UK (domestic multinationals) are generally larger in scale and more profitable than domestic companies, one would expect multinationals to pay the majority of UK corporation tax. The data confirms this—despite the fact that all types of multinationals constitute only 3 percent of companies operating in the UK, they have consistently contributed over 50 percent of total annual corporate tax revenue to the UK government from 2000 to 2011. However, question remains as to whether multinationals ‘should’ be paying even more. I investigate this by comparing subsidiaries of foreign multinationals to comparable domestic companies and find that, on average, these multinationals report lower taxable profits relative to their size than comparable domestic companies.<sup>6</sup>

In the second part of the paper, I estimate the size of the difference in the taxable profits between multinationals and domestic companies, using propensity score matching approach. Specifically, I focus on the difference in reported taxable profits between foreign multinational subsidiaries and domestic standalones.

In order to appropriately account for the difference in size between foreign multinational subsidiaries and domestic standalones, as well as the endogeneity problem arising from self-selection into being a multinational, I adopt the propensity score matching approach (Paul R. Rosenbaum (1983), Rosenbaum and Rubin (1985)). I ‘match’ companies based on the size of their assets and industry and find that the unweighted mean ratio of taxable profits to total assets for foreign multinational subsidiaries is 12.4 percent, whereas for domestic standalones it is 25.2 percent, i.e. foreign multinational subsidiaries report 12.8 percentage points lower taxable profits relative to total assets than domestic standalones. If we attribute all of the difference between these matched samples of foreign multinational subsidiaries and domestic standalones to tax avoidance, then foreign multinationals avoid over half of their taxable profits.

However, this is likely to be an underestimate of the true size of tax avoidance of all foreign multinational subsidiaries. This is because the propensity score matching leads to exclusion of the very large foreign multinational subsidiaries (since no comparable domestic standalones exist) that report much lower taxable profits relative to their size than the smaller foreign multinational subsidiaries in the matched sample. Specifically, the unweighted ratio of taxable profits to total assets is 5.6 percent for the very large,

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<sup>5</sup>The accounting literature identifies a relationship between firm’s CEO who may be aggressive tax planner and the amount of accounting profits that a firm reports (Armstrong *et al.* (2012), Armstrong *et al.* (2015)).

<sup>6</sup>The choice of the scaling variable is discussed at length in Section 3.

unmatched foreign multinational subsidiaries, less than half of what this ratio is for foreign multinational subsidiaries in the propensity score matched sample.

The difference between the matched samples of foreign multinational subsidiaries and domestic standalones is mainly attributable to the fact that a higher proportion of foreign multinational subsidiaries report zero taxable profits (61.1 percent) than domestic standalones (28.6 percent).<sup>7</sup> Reporting zero taxable profits explains more than 85 percent of the average difference in taxable profits relative to total assets between foreign multinational subsidiaries and domestic standalones. Therefore when restricting the sample to companies which report positive taxable profits, the difference in taxable profits relative to total assets between the ownership types is small and insignificant. Once foreign multinationals decide to report positive taxable profits, their reporting behaviour does not differ from that of domestic standalones.

I find that companies reporting zero taxable profits do not differ from companies reporting positive taxable profits in terms of their observable firm-level characteristics. Zero taxable profit reporting companies are very similar in terms of size, age and industry composition to those reporting positive taxable profits. Further, they are almost evenly split between companies headquartered in countries with higher corporate tax rate than the UK and countries with lower corporate tax rate than the UK. The only significantly important determinant of reporting zero taxable profits is propensity to report zero taxable profits in previous years. I find persistence in the duration of the zero taxable profit reporting spell. Foreign multinational subsidiaries report zero taxable profits for 6 years on average while domestic standalones report zero taxable profits for 3 years on average.<sup>8</sup> This suggests that there may be important heterogeneity within the sample of multinationals, for example, between aggressive tax avoiders (who report zero taxable profits most of the time) and unsophisticated tax planners (who report zero taxable profits no more frequently than domestic standalones).

One likely explanation for the large number of zero taxable profit reporting multinationals is that foreign multinational subsidiaries are more aggressive in avoiding tax in the UK than their domestic counterparts.<sup>9</sup> This may be because foreign multinational subsidiaries, unlike domestic standalones, are able to use various methods of profit shifting, such as debt shifting, abusive patent licensing strategies or abusive transfer pricing to minimize their taxable profits in the UK (Dharmapala (2014)). An example of debt shift-

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<sup>7</sup>The tax return form shows taxable profits as either zero or positive figures; negative profits are reported as zeros. Therefore the data is censored at zero. We can find taxable losses at the back of the tax returns form, but only the portion of the losses which refers to trading activities. This is discussed in the empirical section.

<sup>8</sup>The numbers are for continuously observed firms only.

<sup>9</sup>This supports the evidence from Johannesen *et al.* (2016) who use bunching of the ratio of accounting profits to total assets around zero to estimate the extent of profit shifting of multinationals in Europe. They find that reporting near-zero accounting profits may be linked with aggressive tax avoidance by multinational companies and is related to the tax rate of foreign parent.

ing is when a UK subsidiary of a foreign multinational borrows from its parent company in a low tax country so as to reduce its taxable profits (tax base) in the UK (since interest payments are tax deductible). This increases the tax base in the lower tax country, so as to reduce the overall tax burden for the company. In a similar way, multinationals can use abusive transfer pricing to reduce its total tax liability; i.e. purchase goods from its foreign subsidiary at higher than a market price (Grubert (2003), Markle (2012)).<sup>10</sup> Finally, multinationals often set up subsidiaries in low tax countries where they hold all their intellectual property, which they then license to their subsidiaries in higher tax countries such as the UK. In this paper, I find that in the UK, 40 percent of the gap in taxable profits relative to total assets between foreign multinational subsidiaries and domestic standalones can be explained by the differences in leverage. This implies that 40 percent of tax avoidance may be attributed to debt shifting.

There are other possible explanations for the high proportion of zero taxable profits reported by foreign multinational subsidiaries relative to domestic standalones. However, they appear not to be the main driver behind this observed effect. I address each in turn.

First, it could be that foreign multinational subsidiaries perform consistently worse than domestic standalones. However, this is unlikely given widely accepted evidence that multinationals are more productive than domestic companies (Yeaple (2013), Harris and Robinson (2003), Griffith (1999), Benfratello and Sembenelli (2006), Girma and Gorg (2007), Wang and Wang (2015)). In any case, calculating the total factor productivity (TFP) for foreign multinational subsidiaries and domestic standalones in my data reveals that the former are far more productive, which is consistent with the previous empirical evidence. Another concern could be that foreign multinational subsidiaries might report more zero taxable profits because they have more losses than domestic standalones. The UK system treats losses asymmetrically and when the company makes losses it reports zero taxable profits on the tax form. The firm can recover a portion of those losses once it becomes profitable again, by carrying them forwards and offsetting them against its future taxable profits. To do so, it has to record those losses on the tax form, which allows me to reconcile the zero taxable profit reporting companies with the ones making losses. However, even after excluding companies which reported losses in the current period and hence are not liable to pay any corporation tax this period, 34 percent of foreign multinational subsidiaries report zero taxable profits relative to only 10 percent of domestic standalones. Finally, given that only an average of 9 percent of all companies that report zero taxable profit brought forward losses from previous years to offset against their taxable profits in the current year, negative trading profits and low productivity do not appear to be the main reason for companies reporting zero taxable profits.<sup>11</sup>

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<sup>10</sup>For a more detailed approach to the profit shifting using transfer pricing by multinationals see Liu and Schmidt- Eisenlohr (2016) paper using tax and trade linked data from the HMRC to look at transfer pricing strategies of companies.

<sup>11</sup>De Simone *et al.* (2015) and Hopland *et al.* (2015) both consider profit shifting with loss making

A second possible explanation is the fact that foreign multinational subsidiaries can benefit from group tax relief, which is not available to domestic standalones.<sup>12</sup> However, the tax returns data shows that only 2 percent of companies reporting zero taxable profits use group tax relief to reduce their taxable profits to zero, suggesting group tax relief is unlikely to be main driver of companies reporting zero taxable profits.<sup>13</sup> Further, group tax relief cannot explain the observation from the data that the proportion of companies reporting zero taxable profits among foreign multinationals with only one establishment (i.e. companies which would not be eligible for group tax relief) in the UK is also high.

A third reason could be that foreign multinational subsidiaries undertake more investment or research and development (R&D), which are tax deductible, than comparable domestic standalones. However, the tax returns data reveals that it is domestic standalones who claim more capital allowances as fraction of their size, contradicting this hypothesis.

The advantage of this paper over previous approaches is three-fold. First, unlike most of the literature on this subject, which uses accounting profits as a proxy for taxable profits, I use administrative data on taxable profits directly from the tax returns. Secondly, I have a full population of UK companies. Finally, previous approaches have focused on studying the relationship between tax rates and logarithm of profits to estimate the extent of tax avoidance of multinational companies (see Dharmapala (2014) for review of the literature). By adding a constant to the profits number they do include negative and zero taxable profits, but this yields imprecise estimates and does not enable them to study the zero profits phenomenon directly.

Previous studies, which used accounting profits to proxy for taxable profits, may have underestimated the extent of tax avoidance by multinational companies. Comparison of taxable profits and accounting profits reveals distinct patterns between companies reporting positive profits and non-positive ones. To compare taxable and accounting profits I include in taxable profits, which are otherwise censored at zero, losses that companies report in the tax returns form. I find that companies which report positive profits, report significantly higher accounting profits than taxable profits.<sup>14</sup> However, bunching at zero profits is much stronger in tax returns data than in the accounting data.

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companies and how presence of these affiliates in the group affects the standard profit shifting incentives.

<sup>12</sup>A company with multiple subsidiaries in the UK, whether domestic or multinational, can use group relief offered by HMRC to offset losses made by one of the companies in a group against profits of another company in that group (<https://www.gov.uk/hmrc-internal-manuals/company-taxation-manual/ctm80145>)

<sup>13</sup>The fraction of companies using group loss provisions to reduce their taxable profits to zero does not vary between ownership types.

<sup>14</sup>The difference between what companies report on their accounting statements and the taxable profits they report is to be expected (Desai and Dharmapala (2009)) due to differences in accounting standards and tax reporting standards. This is partly due to the fact that accounting depreciation tends to be less generous than tax depreciation, which means that after taking into account capital allowances, accounting profits can be expected to be higher than taxable profits (Hanlon and Heitzman (2010), Dharmapala (2014)).

Both of those differences are systematically larger for foreign multinational subsidiaries, which would suggest that they may be driven by factors unrelated to reporting standards. Comparison of propensity score matching results using accounting and taxable profits data reveals that the extent of tax avoidance estimated using accounting data is much smaller than that estimated using taxable profits.

Sample size has plagued previous studies as important parts of economy were omitted by excluding small firms. Accounting datasets generally report missing data for a large portion of observations. I am the first to use the HMRC tax returns data with universal coverage to solve this problem. This means that the stylized facts from the first part of the paper which rely on the HMRC data, account for all taxable profits in the UK. This allows me to attribute the whole tax base to various ownership types. When estimating the size of the difference in taxable profits between foreign multinational subsidiaries and domestic standalones I additionally rely on accounting information to obtain total asset figures. In contrast to information on accounting profits, data on total assets has substantially better coverage. Therefore, in my propensity score matching analysis, I have a larger than previously analyzed sample of foreign multinational subsidiaries and domestic standalones. I am able to match not only large foreign multinational subsidiaries with large domestic standalones, but also smaller foreign multinational subsidiaries for which I have a larger number of comparable domestic standalones.

Egger *et al.* (2010) use accounting data to show that multinationals earn significantly higher profits than comparable domestic firms in low tax countries, but earn significantly lower profits in high tax countries. Given that the UK was a relatively high tax country during the sample period, their findings would suggest that multinationals operating in the UK would report lower accounting profits than domestic companies. This is consistent with my finding that foreign multinational subsidiaries report lower taxable profits relative to their size than domestic standalones.

In what follows, section 2 describes the data, section 3 presents stylized facts, section 4 outlines the empirical methodology and the challenges associated with it, section 5 discusses the results and section 6 concludes.

## **2 Data**

### **2.1 Data description and sample selection criteria**

The primary data source used in this paper is the confidential universe of unconsolidated corporation tax returns in the UK for the years 2000 - 2011 provided by HMRC. The dataset comprises of all items that are submitted on the corporation tax return form (CT600 form) and the unit of observation is an unconsolidated statement in each of the years (see online Appendix for the form). The information available encompasses various

sources of taxable income, deductions and a final figure of taxable profits together with tax liability and tax payment. Each company is required to fill in at least taxable profits (box 37) and corporation tax liability (box 63) information (for details of box numbers and related variable names see Table 15 in the Appendix). However, firms are not required to fill in every single box on the CT600 form and, in fact, they do not. What is more, the HMRC data does not offer any firm level characteristic variables, apart from trading turnover. Therefore I merge the HMRC data with the accounting data from the FAME dataset.

### 2.1.1 Ownership definition

The FAME dataset also includes information on firm ownership, which I use to identify firms into various ownership categories. The FAME ownership dataset is a cross section from the latest edition of the dataset (2013). I identify multinational companies based on whether they have any affiliates (parents or subsidiaries abroad). I distinguish between multinationals headquartered in the UK (domestic multinationals) and multinationals headquartered abroad (foreign multinationals). I define all other firms as domestic companies, but I distinguish between domestic groups and domestic standalones. I define a domestic standalone as an independent company, which has no subsidiaries. I define a domestic group as a company that is part of a group that has no foreign affiliates.<sup>15</sup>

I supplement the FAME ownership data with other variables from FAME and HMRC dataset to identify companies into two additional ownership categories, which I call ‘unidentified multinational’ and ‘other groups’. Unidentified multinationals are companies that have overseas income or have claimed double tax relief in the UK, while other groups are generally companies which have claimed group relief or have reported they have losses to be surrendered as group relief.<sup>16</sup>

Table 1 shows the breakdown of ownership types using 7 main categories: foreign multinational, domestic multinational, domestic group, domestic standalone, other group, unidentified multinational and missing ownership. Since FAME is most likely to report no ownership information in cases where companies are independent standalones, the missing ownership companies are quite plausibly domestic standalones. The unidentified multinationals are most likely a mix of foreign and domestic ones. I can see the number of observations and companies in each category over the whole analyzed time period 2000 - 2011; 3.1% of companies are identified as multinationals, 36% are identified as domestic.<sup>17</sup>

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<sup>15</sup>This is only to the extent that I see no foreign affiliates 10 levels down for this company OR that its parent company has no foreign affiliates 10 levels down either.

<sup>16</sup>For more details on the criteria I used to identify companies into various ownership groups see Appendix 7.1.

<sup>17</sup>The remaining 61% of companies which I classified as missing ownership are most likely domestic standalones, which would imply that 97% of companies in the UK are domestic.



Table 1: Number of company year observations classified into each ownership category, whole sample. Source: HMRC data.

	no of obs	no of firms	% of total firms
foreign multinational	382,353	45,839	1.4%
domestic multinational	43,249	4,751	0.1%
domestic group	911,670	112,026	3.5%
domestic standalone	3,573,689	608,231	18.9%
other group	3,105,551	435,654	13.6%
unidentified multinational	427,459	50,268	1.6%
missing ownership	8,304,161	1,953,622	60.9%

### 2.1.2 Sample selected for the analysis

Matching the HMRC data with accounting data restricts the sample size. I find a matched unconsolidated accounting statement in FAME for 76 percent of unconsolidated tax returns from the HMRC data, which includes 89 percent of the tax liability and 92 percent of trading turnover. I further ensure that I have non-missing total assets information and full 12 months accounting period for each matched HMRC-FAME observation and call the obtained sample, a selected sample.<sup>18</sup>

This selected sample is representative of the whole population. The chosen selection criteria exclude a similar proportion of observations, tax, taxable profits and trading turnover across the ownership types. Therefore the distribution of taxable profits and tax across ownership types is the same in the full HMRC data and in the selected sample, which allows me to draw inference that will be externally valid (see Table 2). I use this selected sample to show the new stylized facts in section 3.

I further limit the selected sample for the purpose of the regression analysis to include foreign multinational subsidiaries and domestic standalones only. These companies constitute about 30 percent of total taxable profits in the UK and their observable characteristics are similar to other types of multinationals and domestic companies, which makes them representative of the ownership classes they were chosen from.

To make the comparison between the ownership types as close as possible I only include foreign multinational subsidiaries which report to have no subsidiaries themselves (70% of foreign multinational subsidiaries sample). This solves two possible issues: appropriate asset size and presence of overseas income. The total assets number multinationals report would be unaffected by the equity value of their subsidiaries. Also, the effect of overseas income on their taxable profits should be negligible.<sup>19</sup>

<sup>18</sup>Section 7.1 in the Appendix describes each selection criteria in detail and discusses what each of them does to the analyzed sample.

<sup>19</sup>The concern here could be that the treatment of overseas income has changed following the 2009 dividend tax reform, hence, firms were no longer required to report overseas income on their tax returns. This could create a discord between the taxable profits of multinationals with overseas income before and after 2009. What is more, part of the overseas income is sheltered by double tax relief in the

In my empirical analysis I do not consider domestic multinationals for two distinct reasons. First, one may think that they would be a good comparison group for foreign multinational subsidiaries. However, since domestic multinationals have similar opportunities to avoid tax as foreign multinationals, the size of the difference between the two groups would not give me any information on the size of tax avoidance. On the other hand, they may present an interesting comparison with domestic standalones. However, the size of the total assets of domestic multinationals in my dataset is not a good approximation of the size of their total assets in the UK. This is because 99 percent of the domestic multinational observations in the selected sample report having at least one subsidiary, either foreign or domestic.<sup>20</sup> This means that the total assets figures in unconsolidated accounts of those companies include the equity value of those subsidiaries, while their taxable profits do not include taxable profits of the subsidiaries. Thus, the ratio of their taxable profits to total assets will be biased downwards relative to companies with no subsidiaries which report the same taxable profits. Therefore those companies might not be as comparable to domestic standalones in terms of the main variable of interest as foreign multinational subsidiaries without any subsidiaries are. Further, half of the domestic multinationals report only consolidated accounts in the FAME dataset. An alternative would be to use trading turnover reported in the tax return form as a measure of size. However, this is not possible as trading turnover for domestic multinationals is almost always missing (likely because companies are not required to report turnovers). It means that I have no data source to approximate their size in the UK.

I also do not focus the empirical analysis on the differences between foreign multinational subsidiaries and domestic groups. The exclusion of domestic groups from the empirical analysis comes from the fact that I cannot identify those types of companies with certainty. I can say with confidence that they are not domestic standalones, but it is entirely plausible that a company that I have classified as a domestic group based on the lack of foreign income and the presence of domestic parent and no foreign subsidiaries up to level 10 has for example a very complicated structure that involves a foreign subsidiary 11 levels down from it or has never received any dividend income from its subsidiaries during the sample period.

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UK. This means that multinational companies only pay tax on part of the reported overseas income. The exclusion of the sheltered portion of overseas income from the taxable profits would decrease the numerator of the taxable profits to total assets ratio for multinational companies which receive overseas income. To alleviate this concern the main empirical analysis is performed using foreign multinational subsidiaries with zero subsidiaries themselves and in any case only 2.6% of the analysed sample has reported to bring any overseas income to the UK. Therefore the issue of including overseas income which is sheltered by double tax relief in the taxable profit measure is not a major one. However, for robustness purposes I exclude the portion of overseas income sheltered by double tax relief from the analysis in the empirical section.

<sup>20</sup>This is the case for both parent companies and their subsidiaries alike. This is not the case for foreign multinational subsidiaries as only 30 percent of them report to have subsidiaries themselves and those I exclude from the sample.

## 2.2 The choice of variables for the analysis

In this section I discuss the choice of the main variables for the comparison of profit reporting behaviour between companies. The choice of using the ratio of taxable profits to total assets is driven both by conceptual discussion and data availability. I further describe the merits of the alternative options for both numerator and denominator of the ratio. Some of those are then explored in more detail in the empirical analysis.

Most of the work in the public economics and finance literature, which focuses on corporation taxes, uses a measure of an effective tax rate to compare the tax paying behaviour of companies. The effective tax rate is defined as a measure of tax divided by a measure of accounting profits before tax. This rate would be equivalent to the statutory tax rate, if accounting profits were equivalent to taxable profits and accounting measure of tax was equal to actual tax liability. However, due to numerous deductions, capital allowances, group loss offset provisions and tax avoidance it is usually lower. In previous literature the extent to which this effective tax rate is related to the firms' profits, leverage or firm structure, such as presence of tax havens has been used as an indicator of profit shifting.

Using effective tax rates to compare companies' tax-paying behaviour has two main difficulties. The first one is that accounting profits appear to be systematically different than taxable profits for foreign multinationals but not for domestic standalones. One reason for this may be that accounting profits measures might be affected by tax avoidance to a larger degree for foreign multinationals.<sup>21</sup> This might generate a bias that could affect the comparison of effective tax rates based on accounting profit measures between ownership types. The second reason is that accounting profits are missing for a large proportion of the observations in my sample.

Scaling tax liability from the tax returns by taxable profits by construction would yield the statutory tax rate. In turn, scaling tax liability by a measure of accounting profits and comparing it to the statutory tax rates would measure the difference between taxable and accounting profits. Since the main objective of this paper is to establish whether there are systematic differences in the taxable profits reported by foreign multinational subsidiaries and domestic standalones, the discussion of the differences between accounting and taxable profits is of secondary importance. However, to the extent that the previous literature has been relying on accounting profits to discuss tax avoidance, it is important to establish whether the two measures of profits yield different results. This is considered in the empirical analysis section.

An alternative approach to compare the tax paying behaviour of companies is to use tax from the tax returns but consider other scaling factors that are related to the size of the company, but might not be affected by companies' tax avoidance to the same extent

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<sup>21</sup> Accounting profits include retained profits, royalties and interest and could be manipulated.

as accounting profits might be. The alternatives here are trading turnover from HMRC data, total or fixed assets from FAME data or shareholder funds from FAME data. I discuss each of those options in turn.

HMRC data has information on trading turnover of companies, which is a total value of sales of a company which arise from its trading activities. Since trading turnover only covers information on trading activities of companies, for consistency purposes the taxable profit measure used when scaling by trading turnover should only include profits from trading activities, i.e. trading profits. However, a substantial fraction of taxable profits of multinational companies (over 30 percent) comes from outside trading activities, such as overseas income, interest on loans, capital gains (Fig 9, Appendix). This is not the case for domestic standalones which derive almost all of their profits from trading activities. Therefore using this measure would disproportionately bias downwards the ratio of taxable profits to size for multinational companies.

What is more, since the trading turnover information comes from the HMRC data, we would expect it to have a universal coverage. However, companies are not required to report trading turnover to the HMRC and as a result many do not. It is generally the case that the fractions of missing observations are larger for trading turnover than for total assets in case of multinationals, but not in case of domestic standalones. This would imply that using trading turnover as a size measure would bias the sample composition towards domestic standalones. What is more, trading turnover data is quite volatile and responds more heavily to the business cycle fluctuations than the taxable profits. This is because the tax base includes profits not only from trading turnover, which varies a lot over time, but also other profit sources such as interest from bank deposits, overseas income, net gains etc.<sup>22</sup> Therefore using trading turnover as a scaling measure could introduce additional fluctuations unrelated to tax avoidance into the analysis.<sup>23</sup>

The size measures available in the accounts, especially the items from the balance sheet such as total assets, fixed assets and shareholder funds offer an alternative. Table 17 in the Appendix outlines what each measure includes and how they are related to each other. Total assets are less volatile than trading turnover, hence they should be a better approximation of firms overall size over time. There are several concerns that may be raised against using total assets as a scaling measure for firms profits. Firstly, total assets include investments, part of which is the equity value of all subsidiaries that a company has, which might inflate the size of the company. However, the main empirical analysis is done using foreign multinational subsidiaries with zero subsidiaries themselves, which means that investments would not affect the size of the estimated difference.

A second issue is that total assets measure is equivalent to the sum of shareholder funds and liabilities. The interest payments (on debt) are deductible so that the corporate

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<sup>22</sup>For a breakdown of taxable profits into various categories see Appendix, Fig 9.

<sup>23</sup>For more details see Appendix 7.1.

income tax base approximates the profits accruing to shareholders, not the profits accruing to shareholders and debtholders. This means that for companies with higher leverage (debt to asset ratio) total assets will be higher for a given level of shareholder funds. This in turn implies that the more leveraged the company is, the lower its taxable profits to total assets ratio would be. This would be a serious concern, especially in the light of foreign multinational subsidiaries shifting debt so as to minimize the size of their corporate tax base. However, since I have detailed data on leverage, in the empirical section I explore the differences in debt to assets ratios between foreign multinational subsidiaries and domestic standalones to account for a portion of tax avoidance attributable to it. This offers interesting insight into tax avoidance practices of the foreign multinational subsidiaries located in the UK.

Another possible scaling measure for taxable profits could be shareholders funds. Shareholder funds is a sum of issued capital and total reserves, which is the book value of equity of a given company. By definition shareholder funds are equivalent to total assets less liabilities, hence using this measure will exclude the discussion of leverage differences from the analysis.

The choice of the scaling factor cannot be discussed without considering the numerator. Since most of the tax literature uses corporation tax variable from the profit and loss account, a most natural candidate from the tax returns would be tax liability or net tax payable. However, the interpretation of any tax measure scaled by total assets is not a very obvious one. On the other hand, taxable profits scaled by total assets is a tax return based measure of returns on assets. This measure is an indicator on how profitable a company is relative to its total assets. What is more, since the UK taxes small and medium companies differently than the large ones, using taxable profits will eliminate the variation in the tax rates from the analysis.<sup>24</sup> In the empirical section, for comparison purposes, I also show results based on tax liability scaled by total assets.

### 3 Stylized facts

In this section I present novel stylized facts on the companies contributions to tax and taxable profits in the UK. Specifically, I show the proportion of net tax payable and the differences in the mean ratios of taxable profits to total assets between various ownership types. I further discuss possible explanations for the observed differences, focusing in particular on companies reporting zero taxable profits.

Firstly, Table 2 shows the fractions of net tax payable by ownership types. Columns 4 and 5 show the breakdown of net tax payable contributed by each ownership type for the selected sample, while columns 2 and 3 show the same breakdown for the whole

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<sup>24</sup>In the UK foreign multinational subsidiaries often qualify for small and medium tax rates.

sample.<sup>25</sup> Foreign multinationals have contributed about 23% of total tax in the UK over the years 2000 - 2011. This, together with domestic multinationals and unidentified multinationals means that multinational companies paid 55% of total UK corporation tax over the period. This fraction is the same for taxable profits. These proportions have varied over time and fluctuated between 60% and 50% (Figure 10, Appendix).<sup>26</sup>

Table 2: Total and proportion of net tax payable contributed by various types of companies by ownership type, selected vs whole sample, 2000 - 2011. Whole sample refers to the universe of corporate tax returns from the HMRC data, selected sample refers to the selection criteria described in section 2.2. Source: HMRC data.

	whole sample (bln)	%	selected sample (bln)	%
foreign multinational	104.0	23%	69.9	22%
domestic multinational	48.0	11%	29.1	9%
domestic group	49.5	11%	34.9	11%
domestic standalone	27.5	6%	24.7	8%
other group	83.2	18%	58.2	19%
unidentified multinational	97.7	21%	58.7	19%
missing ownership	47.4	10%	35.6	11%

However, the comparison of the levels of tax paid or profits reported does not answer the question whether multinationals report more or less profits than comparable domestic companies as multinationals tend to be larger and make more profits. Therefore I take into consideration the discussion of the scaling factors and profit measures from section 2 and look at taxable profits scaled by total assets to understand the difference between companies by ownership type.

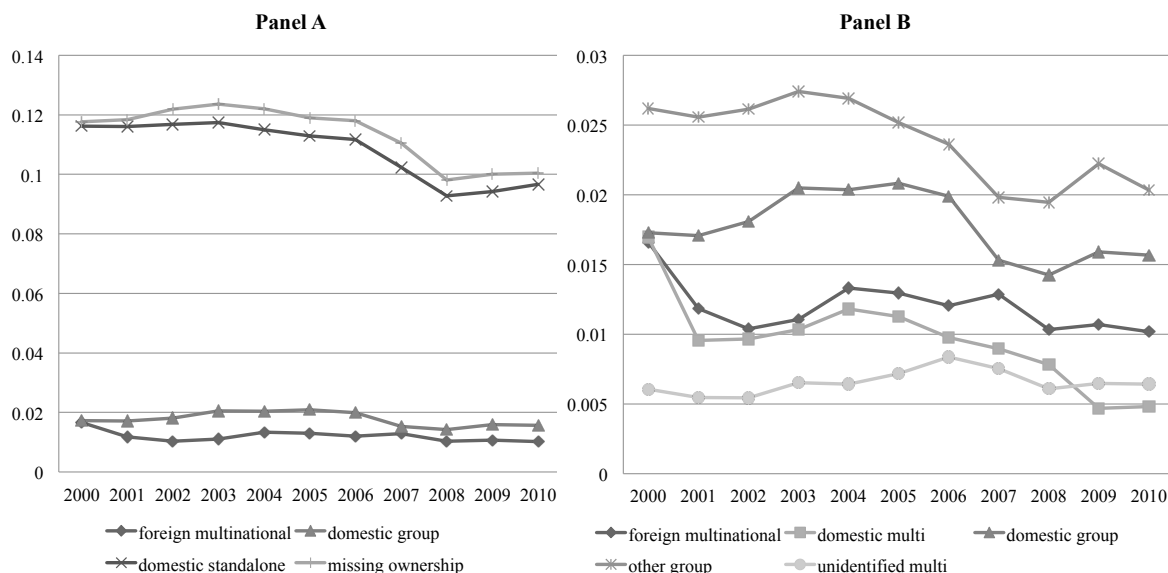
In Figure 1 I sum all taxable profits in each year by ownership type and do the same for total assets. I then divide one sum by the other to arrive at the weighted means of taxable profits scaled by total assets for each ownership type. In Panel A I show domestic standalones, missing ownership, foreign multinational subsidiaries and domestic group lines, while in Panel B I show in more detail the differences between different types of multinational companies and domestic groups. I can clearly see that domestic standalones and missing ownership companies report substantially more taxable profits as a proportion of their total assets than any type of groups; the difference amounts to 10-11 percentage points. What is more, domestic groups and other groups also report more taxable profits than foreign multinationals (Panel B). The difference in taxable profits to total assets between groups of companies and foreign multinationals is much smaller than the one between domestic standalones and groups of companies, and amounts to 0.5 percentage point between foreign multinationals and domestic groups at most with the largest difference between other group and unidentified multinationals, 2 percentage

<sup>25</sup>Net tax payable is the tax liability after accounting for double tax relief and marginal tax relief.

<sup>26</sup>Interestingly, the proportion of trading profits contributed by multinational companies looks similar to that of net tax (see Figure 10 Panel B).

points. These differences mean that foreign multinationals report 25 percent lower taxable profits than domestic groups.

Figure 1: Taxable profits divided by total assets by ownership type, 2000 - 2011, balanced selected sample. Panel A: domestic standalones vs multinationals vs domestic groups comparison, Panel B: groups comparison. Source: merged HMRC and FAME data.



If the primary driving factor for the differences in taxable profits reported by multinationals and domestic standalones lies in profit shifting, I would expect the difference between domestic groups and multinational companies to be larger. Domestic groups cannot shift profits abroad. On the other hand, I find that domestic groups report much lower taxable profits relative to total assets than domestic standalones. The evidence from the literature shows that larger companies tend to borrow more and hence domestic groups, which are larger than domestic standalones, might use more debt as a tax shield (Frank and Goyal (2009), Graham and Leary (2011)). This is confirmed in the data by looking directly at leverage (see Figure 5). Foreign multinationals and domestic groups report having much higher debt to assets ratio than domestic standalones. Their leverage is not very different from one another though.

The next section discusses possible sources of the difference between foreign multinational subsidiaries and domestic standalones and attempts to describe whether they can explain the observed gap.

## 3.1 Why Do Foreign Multinational Subsidiaries Report Lower Taxable Profits?

### 3.1.1 Proportion of zero taxable profit reporting companies

The first aspect of the difference between multinationals and domestic standalones is the proportion of observations where zero taxable profits are reported. Over 60 percent of observations identified as domestic multinationals and foreign multinationals report zero taxable profits. In contrast only 28.6 percent of domestic standalones and 50 percent of subsidiaries of domestic groups report taxable profits to be zero (Table 3).<sup>27</sup> These proportions fluctuate slightly over time and they all went up following the financial crisis. However, the ranking between ownership types have remained unchanged since the beginning of the sample.

Table 3: Proportions of observations reporting zero taxable profits by ownership type. Column 1: fraction of observations reporting zero taxable profits, Columns 2 and 3 sum up to column 1 and break zero taxable profits into observations with zero taxable profits, which report trading losses and those who report no trading losses. Selected sample, 2000 - 2011. Source: HMRC data.

	all observations	do not report trading loss	report trading loss
foreign multinational	61.1%	33.7%	25.6%
domestic multinational	62.1%	48.1%	14.4%
domestic group	50.0%	23.9%	22.1%
domestic standalone	28.6%	9.8%	17.7%
other group	51.7%	18.1%	31.0%
unidentified multinational	42.4%	26.2%	18.2%
missing ownership	36.8%	12.6%	22.3%

The zero taxable profit reporting behaviour is persistent, especially amongst foreign multinational companies. Specifically, the mean zero taxable profit reporting spell lasts 6 years for foreign multinational subsidiaries and 3 years for domestic standalones.<sup>28</sup> What is more, over 73 percent of foreign multinational subsidiaries report zero taxable profits more than once during the sample duration, while only 43 percent of domestic standalones do so.

Most of the zero taxable profit observations - 65 percent - come from observations where companies report in their tax statement having zero trading profits, no other sources of taxable income, and hence zero taxable profits. In Figure 2 these are companies called 'nothing to tax'. 24 percent of observations which have taxable profits equal to zero, come from companies claiming various deductions. Specifically, those companies report positive taxable profit before deductions, but zero taxable profits after deductions.

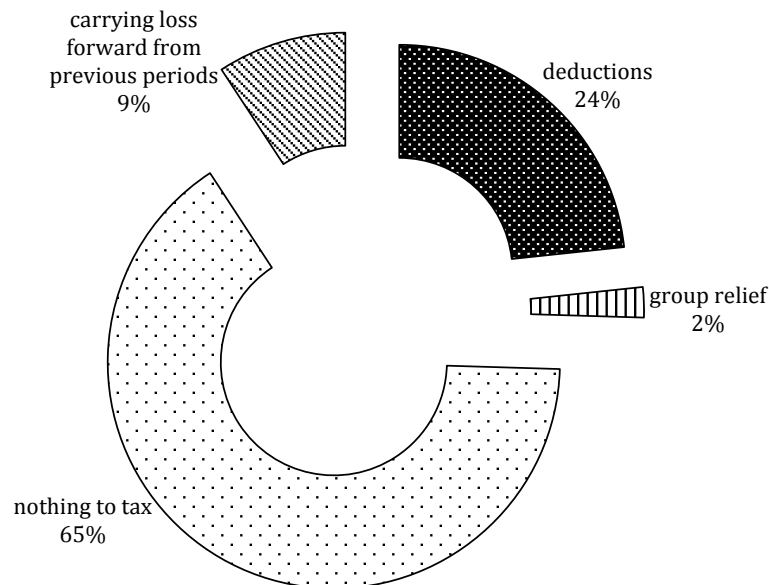
<sup>27</sup>Note that these fractions are very similar when I consider number of firms reporting zero taxable profits at least once during the sample period.

<sup>28</sup>Here I limit the sample to observations to those with full 12 years of observations only.



Companies claiming all of their remaining taxable profits in group relief constitute 2 percent of the zero taxable profits observations (see Figure 2). The contributions to zero taxable profits by source do not differ substantially between various ownership types; 67 percent of foreign multinationals report to have 'nothing to tax' relative to 63 percent of domestic standalones.

Figure 2: Zero taxable profit observations by source; selected sample, 2000 - 2011. Source: HMRC data.



There might be legitimate reason as to why companies report zero taxable profits. They may be loss making in the current year, they may be carrying losses back or forward or they may be investing and hence deducting capital allowances against their taxable profits. The most important reason is the presence of taxable losses. The UK tax system treats profits and losses asymmetrically. This means that when a company makes positive taxable profits, they pay tax on those. In turn, when they make losses, they do not receive tax credit on those losses, but instead pay no tax in that year. The portion of losses that is attributed to trading activities can be carried forward and offset against positive taxable profits in future years or alternatively carried back and offset against positive taxable profits in the previous year. In the tax return form, companies report losses separately from their taxable profits. The taxable profits are censored at zero, but part of the losses that arise from trading activities can be recovered to understand where the zero taxable profits are coming from.

I find that more than half of zero taxable profit reporting foreign multinational subsidiaries report to have no trading loss (using HMRC data). At the same time just under 30 percent of the zero taxable profit reporting domestic standalones do so. This means that 34 percent of all foreign multinational subsidiaries report zero taxable profits and no trading loss relative to only 10 percent of domestic standalones (see column 2 and

3 in Table 3). However, it is important to note that companies can use high leverage, abusive transfer pricing or royalty payments as part of their trading activities and hence manipulate trading profits to put themselves in the trading loss position. Therefore the trading loss position might not necessarily signify that a company is loss making in a traditional sense, it might also be a sign of aggressive tax avoidance.

To understand the difference between companies reporting zero and positive taxable profits, I look at the differences in their observable characteristics, in particular size, age, industry and headquarter location of those companies. In Figure 11 (Appendix) we can see that zero taxable profit reporting companies are very similar to positive taxable reporting profit companies in these dimensions. For both foreign multinationals and domestic standalones they seem to be slightly smaller, but not largely so. In Figure 12 we can see that the distribution of age between positive and zero taxable profits companies is not that much different for both foreign multinationals and domestic standalones alike. What is more, there are no marked differences in terms of whether their headquarters are located in higher or lower tax countries than the UK. Of all foreign multinational subsidiaries with headquarters in countries with tax rates higher than the UK one, 58 percent report zero taxable profits in the UK. This is not that different from the 54 percent of foreign multinational subsidiaries which have parents in countries with tax rates lower than the UK one that report zero taxable profits in the UK. What is more, about a half of foreign multinational subsidiaries in the UK is headquartered in countries with higher statutory corporate tax rates than the UK, while the other half is headquartered in countries with statutory corporate tax rate lower than the UK one. This suggests that companies which report zero taxable profits do not systematically come from countries where tax rates are much lower. Those multinationals might have more of an incentive to locate their profits in their lower tax headquarters, hence shifting them away from the UK and lowering their tax liability here. A large fraction of foreign multinational companies from finance and service sectors reports zero taxable profits (Table 18 in the Appendix). In case of domestic standalones more zero taxable profits are reported in agriculture and construction sectors than by finance and services companies. This is consistent with some of the recent media "naming and shaming" large foreign finance and services companies paying little or no tax in the UK.<sup>29</sup>

### **3.1.2 Uncomparable size distributions**

Another reason why domestic standalones and multinationals might have different ratios of taxable profits to total assets is because they are not comparable when it comes to their size. Multinationals and domestic groups may be larger, more productive and hence more profitable than domestic standalones. In this section I consider how multinational

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<sup>29</sup>For more discussion on potential determinants of reporting zero taxable profits see Appendix, section 7.3 and the results from LDV estimations.

and domestic companies outside of the comparable regions differ from the comparable firms.

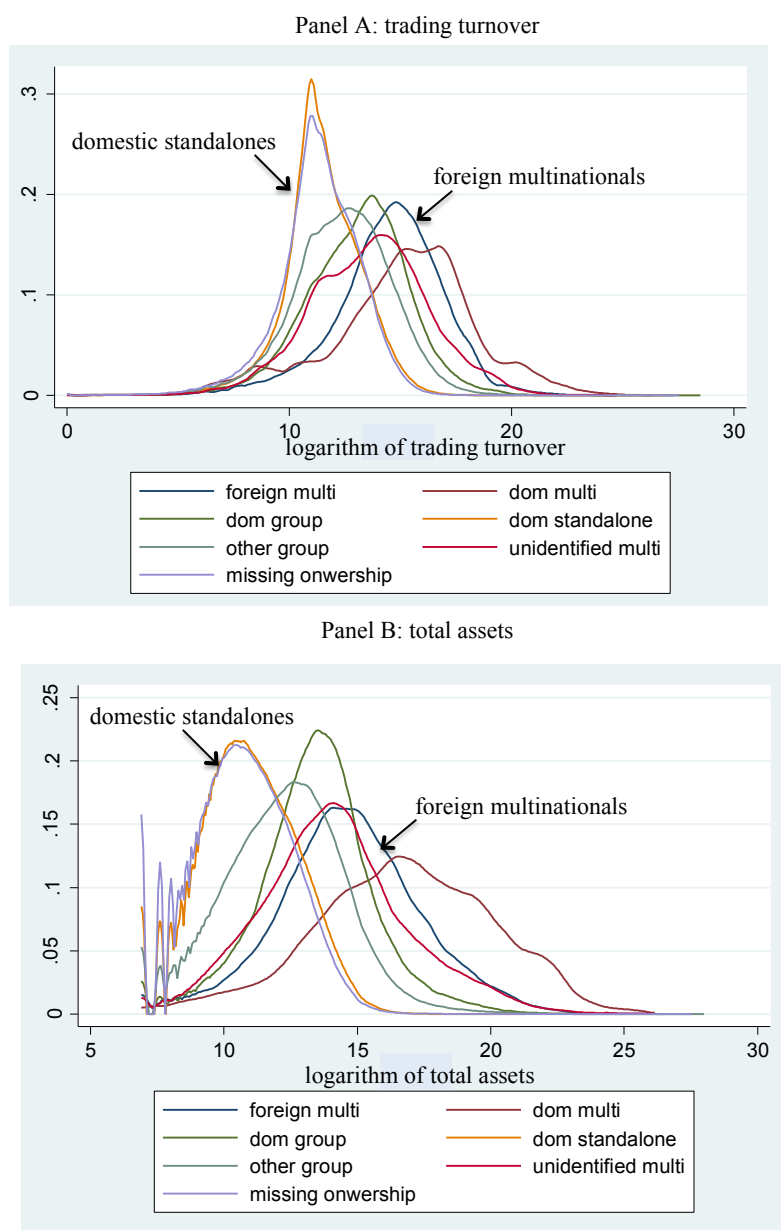
First, I look at the distribution plots of logarithm of trading turnover (Panel A) and logarithm of total assets (Panel B) by ownership type to see whether there are any overlapping regions between different types of companies (Figure 3). As expected domestic standalones are much smaller than foreign multinationals. The density plot of the size distribution of domestic multinationals seems to be furthest to the right, while domestic standalones furthest to the left, with foreign multinationals, unidentified multinationals, domestic groups and other groups in between. There are overlapping regions between the company ownership types, though in the empirical analysis to compare companies of similar size I will have to exclude the very large multinationals and very small domestic standalones. This may raise concerns about the external validity of the estimates obtained. To alleviate those concerns, I present descriptive evidence on the companies outside of the overlapping region.

I choose a sample of observations which includes the selected sample of foreign multinational subsidiaries and domestic standalones only. I take the largest domestic stand-alone in terms of total assets in each 2 digit industry and call all foreign multinational subsidiaries larger than that domestic stand-alone, unmatched. I then take the smallest foreign multinational subsidiary in terms of total assets and call all domestic standalones smaller than that multinational, unmatched. I now have what I call a matched and an unmatched samples, where using my method I excluded almost 9% of foreign multinationals and 3 % of domestic standalones (Table 4, Panel A).

One may worry whether the largest domestic stand-alone is representative of the population and whether it is not substantially larger than the average. The same concern can be raised about the representative nature of the smallest foreign multinational. To alleviate those concerns I also take top and bottom 1 percentile of the respective categories as a benchmark instead of the smallest and largest companies and perform the same analysis on this more limited sample. This excludes more observations in terms of multinationals, 43% of foreign multinationals, but only an extra 2 percentage points of domestic standalones (Table 4, Panel B). This suggests that the largest domestic stand-alone is not very representative of the rest of the sample, while the smallest multinational is.

In Table 4, I compare the characteristics of the matched and unmatched samples in terms of the main variables of interest, taxable profits and tax relative to total assets. Strikingly, across both matching methods the weighted mean taxable profits divided by total assets for the unmatched foreign multinationals is much smaller, e.g. 0.8% for min max matching, than that for the matched ones, e.g. 5.4% for min max matching, while the ratio of taxable profits divided by total assets for domestic standalones is much larger in the unmatched sample, 25.1% for min max matching, than in the matched one, 10.8%

Figure 3: Size distributions of companies by ownership type, Panel A: logarithm of trading turnover, Panel B: logarithm of total assets, selected sample, 2000 - 2011. Source: merged HMRC and FAME data.



for min max one. Generally, the matched ratios are much closer to each other than the unmatched ones across both methods. This means that more comparable companies in terms of size actually report more similar profits as a fraction of total assets and it is the ends of the distribution, i.e. the very large multinationals and the very small domestic companies that are mainly driving the difference in the weighted means.

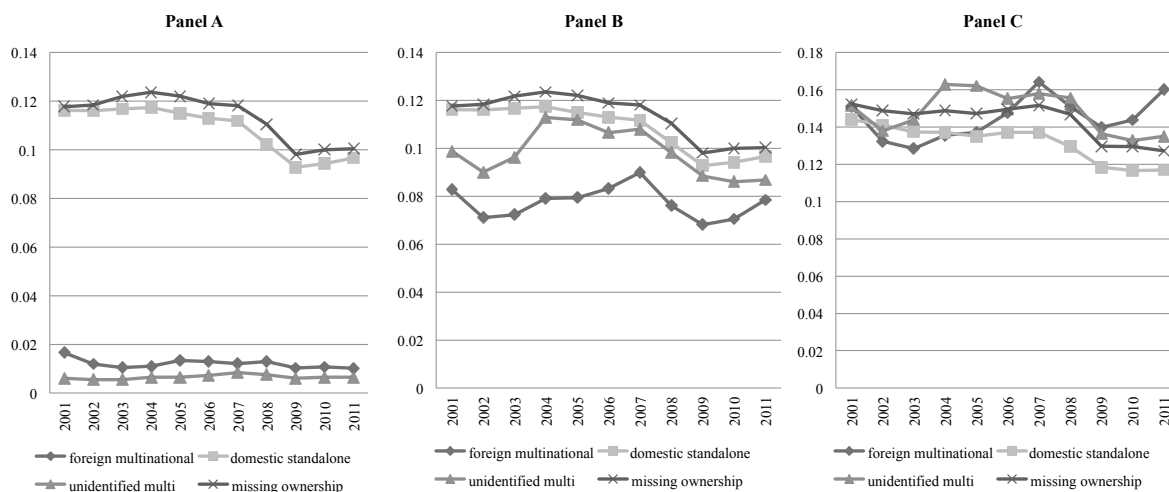
This is confirmed by removing unmatched companies and plotting the weighted means of taxable profits divided by total assets. The exclusion of the very large multinationals and very small domestic companies brings the lines closer together (see Figure 4, Panel B). Specifically, the weighted means of taxable profits to total assets do not change sub-

Table 4: Weighted means of taxable profits to total assets and tax to total assets split by manually matched and unmatched regions for various matching methods, selected sample, 2000 - 2011. Panel A: min and max matching, Panel B: top and bottom 1 percent excluded. Source: merged HMRC and FAME data.

		taxable profits/ total assets		tax/ total assets		% of matched obs
		matched	unmatched	matched	unmatched	
Panel A: min, max	foreign multinational	0.054	0.008	0.016	0.002	91.33
	domestic standalone	0.108	0.251	0.025	0.053	97.19
Panel B: 1 percentile	foreign multinational	0.077	0.012	0.021	0.003	57
	domestic standalone	0.108	0.395	0.025	0.052	95.1

stantially for domestic standalones and missing ownership categories, but foreign and unidentified multinationals now seem to report far higher taxable profits relative to their size. Foreign multinationals still report least profits as a fraction of their size, but the difference between them and domestic standalones has shrunk substantially. The difference was about 11 percentage points using all observations, while now it is about 4 percentage points at the start of the sample period and 2 percentage points at the end of it.<sup>30</sup>

Figure 4: Taxable profits relative to total assets (weighted means), selected sample, 2000 - 2011. Panel A: selected sample, Panel B: selected sample after removing very large multinationals and very small domestic companies, using top and bottom 1 percentile in each ownership group; Panel C: positive taxable profits only on manually matched sample. Source: merged HMRC and FAME data.



Furthermore, I remove all companies that have reported zero taxable profits in a given year and calculate weighted means of positive taxable profits divided by total assets for each ownership type (Fig 4 Panel C). I calculate those means on the manually matched sample to show how zero taxable profit reporting affects the differences between similarly sized companies. Firstly, the weighted means for all types of companies increase.

<sup>30</sup>When I remove smallest and largest multinationals and domestic standalones based on the minimum/ maximum strategy the difference is a bit larger than in Panel B, as expected, with the foreign multinational line at 0.07 at its highest and 0.04 at its lowest.

Secondly, the lines for foreign multinationals and domestic standalones are no longer different. This is the first indication of the importance of zero taxable profit reporting in accounting for the difference in the ratio of taxable profits to total assets between foreign multinationals and domestic standalones. In Panel A I replicate Figure 4 which includes all observations from the selected sample for comparison purposes.

### 3.1.3 Differences in leverage

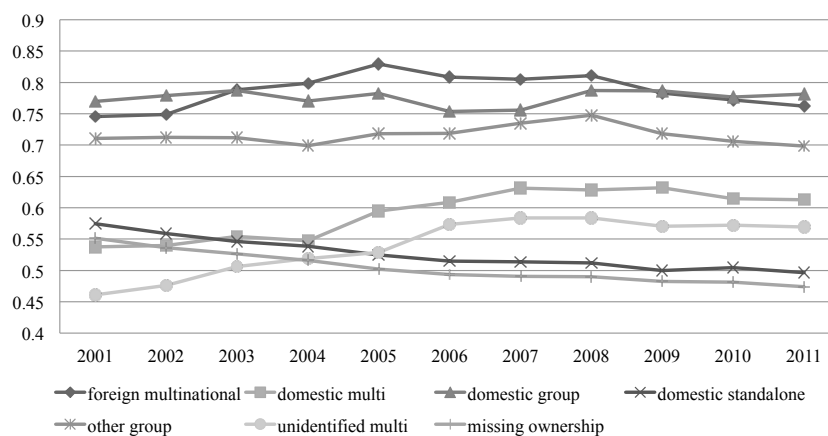
The FAME accounting dataset includes information on stock measure of leverage of companies, i.e. total liabilities divided by total assets. Therefore I consider the differences in debt scaled by total assets between ownership types; specifically, Figure 5 shows the weighted averages of total liabilities scaled by total assets. We can see that foreign multinationals, domestic groups and other groups have substantially higher leverage than other types of companies. Domestic standalones and missing ownership observations have the lowest leverage in later years, but only after 2005. Before 2005 their leverage was comparable with what unidentified and domestic multinationals reported. The total leverage of foreign multinational companies is the largest amongst all ownership categories and amounts to somewhere in the region of 0.75 - 0.85, while the total leverage of domestic standalones is somewhere around 0.55- 0.45. This shows that foreign multinationals are indeed more leveraged. To the extent that multinational companies use debt as part of their profit shifting strategies, this might also give an indication on the extent of their debt shifting practices.<sup>31</sup> Since interest payments are deductible against taxable profits in the UK, part of the difference in the taxable profits scaled by total assets between foreign multinational subsidiaries and domestic standalones, could be explained by the difference in leverage between these two ownership types.

As discussed in section 2.3 an alternative size measure for comparison purposes between ownership types is shareholder funds. Scaling taxable profits by total assets and comparing the results to scaling taxable profits by book value of equity will give me an indication on how much leverage is used by companies. Since total assets is a sum of liabilities and shareholders equity, we would expect the total assets numbers to be larger for firms that have higher liabilities in the UK. This implies that scaling by total assets makes the ratio of taxable profits to total assets smaller for highly leveraged firms. Figure 13 in the Appendix compares scaling taxable profits by total assets with scaling by shareholder funds. Taxable profit scaled by book value of equity are larger than those scaled by total assets with the relative difference largest for foreign multinationals. This confirms the direct evidence from the leverage plots in Figure 5.

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<sup>31</sup>The total leverage figure can be separated into group loans, which correspond to intra-group lending and other liabilities. Only domestic and foreign groups of companies have intra-group lending, which is even more direct evidence of debt shifting practices. Group loans constitute between 13 and 24 % of total liabilities of foreign multinational companies.

Figure 5: Weighted means of leverage measured as liabilities scaled by total assets by ownership type, selected balanced sample, 2000 - 2011. Source: merged HMRC and FAME data.



### 3.1.4 Different industries in which multinational and domestic companies operate

There is quite a large sectoral heterogeneity for companies in my sample (Table 5). Mining, transportation and public utilities, retail trade, construction, wholesale trade and manufacturing have substantially higher taxable profits to total assets ratio than finance, insurance, real estate, services, agriculture and public administration.<sup>32</sup> There is quite a large gap between the two groups, especially prior to 2006, where sectors which have higher taxable profits to total assets ratio are in region of 4-6%, whereas companies which have lower taxable profits to total assets ratio are in the region below 1%. The gap between the two groups has narrowed since 2006, due primarily to declining ratios of taxable profits to total assets from construction and wholesale trade. Mining always has the largest taxable profits to total assets ratio, because it includes North Sea oil companies, which pay much higher corporation taxes than other companies in the UK. Finance companies tend to have one of the lowest ratios of taxable profits to total assets. This appears to pre-date the financial crisis.

These differences are also quite pronounced between ownership types, where foreign multinationals report very low taxable profits to total assets ratio in finance and services relative to domestic standalones (see Table 5). With differences between sectors and within sectors between ownership types, it will be crucial to account for them in the econometric analysis to obtain comparable ratios of taxable profits to total assets.

<sup>32</sup>The sectors are created using SIC 4 digit industry codes from which I use 1st digit to construct a broad sector category. For the categories and corresponding digits see Table 5. The SIC 4 digit codes data comes from the FAME accounting dataset.

Table 5: Taxable profits divided by total assets, weighted averages, heterogeneity between sectors 2000-2011 and ownership types, selected sample. Source: merged HMRC and FAME data.

Sectors	all observations	foreign multinational	domestic standalone
1: agriculture, forestry and fishing (01-09)	0.009	0.008	0.100
2: mining (10-14)	0.103	0.124	0.028
3: construction (15-17)	0.032	0.036	0.097
4: manufacturing (20-39)	0.037	0.028	0.114
5: transportation & public utilities (40-49)	0.048	0.029	0.136
6: wholesale trade (50-51)	0.030	0.012	0.102
7: retail trade (52-59)	0.053	0.044	0.109
8: finance, insurance & real estate (60-67)	0.005	0.003	0.111
9: services (70-89)	0.008	0.011	0.113
10: public administration (91-98)	0.008	0.015	0.124
11: non-classified establishments (99)	0.010	0.001	0.093

### 3.1.5 Other possible explanations

Another possible explanation for lower taxable profits relative to total assets for foreign multinational subsidiaries could be that multinationals undertake more investment and spend more money on research and development (R&D) than comparable domestic firms. Therefore they may be entitled to legitimate tax deductions such as capital allowances that can be responsible for bringing their trading profits down. This may also partially explain the larger fraction of zero taxable profit reporting companies amongst foreign multinational companies as both capital allowances and R&D tax credits are part of trading profits number on the tax form and if they are large enough a company can report zero trading profit as a result.

In Table 6 I look at capital allowances as a fraction of total assets and mean capital allowances for each ownership type. I can see that domestic standalones tend to claim higher capital allowances as a fraction of their size than foreign multinational subsidiaries, e.g. the ratio of capital allowances to total assets claimed by domestic standalones is 0.046, while it is 0.019 for foreign multinationals. In terms of mean capital allowances, foreign multinationals do claim more. However, this is primarily due to the fact that they are much larger than domestic standalones. This suggests that capital allowances cannot be the driving force in explaining the lower taxable profits reported by foreign multinational subsidiaries.

Furthermore, it is important to note that the differences in profitability between firm ownership types do not come from the differences in productivity. There is a large international trade literature which investigates the productivity of multinationals relative to domestic companies (Yeaple (2013), Harris and Robinson (2003), Griffith (1999), Benfratello and Sembenelli (2006), Girma and Gorg (2007), Wang and Wang (2015)) and finds that multinationals tend to be much more productive than domestic companies.

To investigate this I use total factor productivity (TFP), which measures the portion of



output not explained by the amount of inputs used in production. Here I use a measure of TFP based on value added, which subtracts capital and labour inputs from firms outputs to measure the productivity residual, i.e.  $TFP_{it} = va_{it} - (1 - sl_{it}) \times k_{it} - sl_{it} \times l_{it}$ , where  $va_{it}$  is logarithm of value added, where value added is measured as a sum of wages and salaries and profit and loss before interest,  $sl_{it}$  is share of labour, which is a ratio of wages and salaries divided by value added,  $k_{it}$  is log of fixed assets,  $l_{it}$  is log of number of employees and  $i$  and  $t$  refer to firm and year.

Using the firm and year specific TFPs, I calculate the mean TFP for each ownership category (Table 6). The mean total factor productivity is much higher for foreign multinational companies than it is for domestic standalones, which is consistent with previous literature on productivity differences. The results suggests that the differences in profitability between foreign multinational companies and domestic standalones cannot stem from differences in productivity.

Table 6: Mean total factor productivity (TFP) by ownership type, mean of total capital allowances claimed against taxable profits, weighted means scaled by total assets; ca is capital allowances, ta is total assets; selected sample, 2000 to 2011. Source: merged HMRC and FAME data.

	mean TFP	mean ca	ca/ta
foreign multinational	14.5	554,680	0.019
domestic multinational	15.1	1,746,700	0.011
domestic group	14.1	151,510	0.021
domestic standalone	11.1	7,270	0.046
other group	13.9	53,395	0.030
unidentified multinational	14.4	406,751	0.017
missing ownership	11.2	5,920	0.043

## 4 Empirical methodology

I have established a substantial difference between domestic standalones and foreign multinationals in terms of their taxable profits relative to total assets. In this section I describe empirical strategy that I use to estimate the size of this difference. The most straightforward and commonly used in the literature approach would be to use panel estimators, such as pooled OLS or within firm transformation to estimate the average difference in the taxable profits relative to total assets between multinationals and domestic standalones. Previous approaches have used changes in the tax rate differential between countries to identify the relationship between tax rates and reported accounting profits.

However, this yields two types of biases. Firstly, because the overlapping regions between the ownership types in terms of size exclude the largest multinationals and smallest

domestic standalones, the OLS results will include companies which are not comparable with each other. Since descriptive statistics have shown that the largest multinationals report lower taxable profits relative to total assets than domestic standalones, the OLS results on the whole sample may be upward biased. What is more, trade literature over the last decades has documented that multinational and domestic firms differ in terms of main observable characteristics such as productivity, size and wages (Harrison and Aitken (1999), Javorcik (2004), Sabirianova *et al.* (2005), Yasar and Morrison Paul (2007)).<sup>33</sup>

The econometric approach that has been used extensively in trade and industrial economics literature to alleviate the raised concerns has been a non-parametric matching method.<sup>34</sup> This method creates a propensity score based on the observable characteristics and finds observations with similar propensity scores. Instead of comparing the average differences between two groups of companies, propensity score matching method will compare companies with similar propensity scores and infer average difference from the comparable pairs.

In the first stage a logit model is estimated with multinational dummy on the left hand side and determinants of being a multinational company on the right hand side, which produces predicted probabilities, known as propensity scores (Paul R. Rosenbaum (1983), Rosenbaum and Rubin (1985)):

$$multinational_i = \alpha_i + \delta \mathbf{K}_{it} + \delta ind_i + \zeta_t + \epsilon_{it}. \quad (1)$$

where  $multinational_i$  is a multinational dummy equal to 1 if a company is a multinational and 0 otherwise,  $\mathbf{K}_{it}$  is a set of determinants of being a multinational (in the baseline matching total assets),  $\delta ind_i$  and  $\zeta_t$  are industry and year fixed effects. I use a nearest neighborhood matching strategy within a 0.1 caliper radius without replacement which for each foreign multinational subsidiary tries to find a closest comparable domestic standalone within the 0.1 radius in terms of the propensity score.<sup>35</sup> That particular domestic standalone is used only once, hence the sample of foreign multinational subsidiaries and domestic standalones used for matching without replacement is the same.<sup>36</sup>

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<sup>33</sup>This endogeneity has also been explored theoretically (Markusen and Venables (1998), Helpman *et al.* (2004)).

<sup>34</sup>The non-parametric nature of propensity score matching is important since it avoids misspecification of the equation as could be the case with OLS. To ensure OLS specification to yield similar results to matching, we would need to control for a fully flexible industry size matrix. However, if OLS is correctly specified, it is more efficient (Hirano *et al.* (2003), Abadie and Imbens (2006)).

<sup>35</sup>Various robustness checks have been performed using different caliper and the results are not very sensitive to the choice of the radius. William G. Cochran (1973), Rosenbaum and Rubin (1985) suggest using a caliper width that is a proportion of the standard deviation of the logit of the propensity score, specifically 0.2 of standard deviation was suggested to eliminate approximately 99% of the bias due to the measured confounders. This is how I choose the 0.1 caliper.

<sup>36</sup>The replacement feature enables the same domestic standalone to be used as a comparable company for foreign multinational subsidiaries multiple of times. This might be important in the right hand side tail of the distribution where there are not very many large domestic standalones to create a comparable group for foreign multinational subsidiaries. Therefore I use this method later for robustness test.

Furthermore, I impose common support restriction for total assets, hence no company larger than the largest domestic standalone and no company smaller than the smallest foreign multinational is in the sample. This last condition is crucial and makes the propensity score matching (PSM) method a preferred approach to OLS especially in the light of very different size distributions between ownership types.

There are various other algorithms which can be used to obtain matched samples based on propensity scores, such as kernel or radius. Radius matching uses all domestic standalone companies with propensity scores within a certain radius from a given multinational to estimate the size of the difference. Kernel matching uses all domestic standalones, but weights the control observations inverse-proportionally to the propensity score difference to the multinational company. Using more observations for matching increases precision, but the more observations you use the less suitable they are as comparisons. This could lead to large biases. Since the descriptive statistics have shown that larger multinationals are not comparable to smaller ones in terms of the ratio of their taxable profits to total assets, I use nearest neighborhood matching to avoid large biases and trade off efficiency of the estimates.

The critical difficulty of this paper is in finding the appropriate group of companies to achieve the best matching possible. For each foreign multinational affiliate I want to find a comparable domestic standalone from the same industry of the same size. Therefore I keep the set of matching variables as simple as possible and in the baseline results use the following observable characteristics: industry, year and total assets.<sup>37</sup>

The propensity score generated in the first stage divides the sample into a group of "treated" foreign multinational subsidiaries for which a comparable domestic standalone with a similar propensity score was found, and remaining companies, which constitute the unmatched sample. Since the main outcome of interest is the ratio of taxable profits to total assets, in the second stage a difference in taxable profits relative to total assets can be estimated as the difference between the mean for foreign multinational subsidiaries and the mean for domestic standalones in the matched sample (Paul R. Rosenbaum (1983)). This effect is presented as the average treatment effect on the treated (ATT, Imbens (2004)). The ATT gives me the percentage point difference in taxable profits reported as a fraction of total assets between foreign multinational subsidiaries and domestic companies accounting for selection into being a multinational. This approach is applied to other outcome variables.

The PSM results may be directly comparable to the OLS estimates. However, this hinges on including a fully flexible size and industry interaction matrix together with exclusion of companies outside of the overlapping regions. This is why PSM is preferred approach to OLS. For more discussion on the differences between PSM and OLS see Appendix 7.3.

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<sup>37</sup>I check the robustness of the choice of baseline matching variables in section 5.1.

As descriptive statistics have shown the difference in the unconditional mean of taxable profits to total assets between foreign multinational subsidiaries and domestic standalones is not the only interesting aspect of the comparison of taxable profits reporting behaviour between ownership types. The unconditional mean can be decomposed into the share of zeros and mean conditional on reporting positive taxable profits in the following way:

$$E(y) = (1 - p)E(y|y = 0) + pE(y|y > 0) = 0 + pE(y|y > 0) = pE(y|y > 0) \quad (2)$$

where  $p = \text{prob}(y > 0)$  and  $y = \frac{\text{taxable profits}}{\text{total assets}}$ . This suggests dividing the analysis into three main components; the already described unconditional mean of taxable profits relative to total assets, the mean of taxable profits conditional on reporting positive taxable profits and the binary outcome analysis of zero taxable profit reporting, that will get directly at  $p$ . Dropping observations with  $y = 0$  is a first attempt to consider the conditional mean, while selectivity correction may be considered a refinement. Since applying selectivity correction does not change the main results substantially, I do not discuss it in the main body of the paper. For more details on the two-stage Heckman selection approach and the results please see Appendix 7.3.

The difference in the ATT between the unconditional and conditional means would tell me how much of the difference in taxable profits between foreign multinational subsidiaries and domestic standalones I can attribute to zero taxable profit reporting. Furthermore, I consider zero taxable profits dummy defined as one when the company is reporting zero taxable profits and zero otherwise as an outcome variable. The ATT coefficient on that outcome variable will tell me the difference in the proportion of companies that are reporting zero taxable profit between the two ownership types in the matched sample.

Another possible explanation for the differences in the taxable profits relative to total assets between foreign multinational subsidiaries and domestic standalones is differences in leverage. This leads me to consider leverage as an additional outcome variable in the propensity score matching approach. I consider two measures of leverage, total liabilities divided by total assets - stock measure of leverage - and net interest (interest paid minus interest received) divided by profit and loss before interest - flow measure of gearing.

Furthermore, propensity score matching approach allows me to consider the proportion of the difference in taxable profits between foreign multinational subsidiaries and domestic standalones explained by the differences in leverage. To do so, in the first stage of PSM I use leverage as a matching variable. Therefore now, in the second stage, I will be comparing companies of similar size with similar leverage. The difference in the ATT coefficient between matching with and without leverage (on the same sized samples) will show the fraction of the difference explained by leverage. This may help to explain the amount of tax avoidance by the UK companies that can be attributed to debt shifting.

Of course, it may well be that companies want to locate their debt in the UK due to highly advantageous tax system (low interest, CFC rules, etc.).

The question also arises whether we are only interested in taxable profits as they are recorded on the tax return form, i.e.  $\text{taxable profits} = \max(0, \text{taxable income})$ , or whether we are also interested in the underlying taxable income which may be either positive or negative. This is conceptually unclear, given asymmetric treatment of profits and losses. In the UK tax system when a company makes a loss it does not receive a tax credit on that loss, but instead records to have zero taxable income and hence pays no corporation tax on that income. It is then allowed to bring some of the losses it made forward into future periods and offset them against positive taxable profits, once it is profitable again. Alternatively, it can also bring the losses back one period and offset them against last year profits, if those profits were positive. When taxable profits are positive, the corporation tax liability is paid. This means that the taxable profits are censored at zero.

What it implies for the purpose of this paper is that with fully symmetric treatment, we would only be interested in taxable income, with fully asymmetric treatment (no carry back or carryforward of losses), we would only be interested in recorded taxable profits. With actual treatment (some carry back and carryforward at nominal value) we may be interested in both. We can potentially use other information from the tax return, e.g. on losses, to recover or estimate the underlying taxable income. One of the possible sources of information is trading losses information in the CT600 form, which gives the amount of losses arising from trading activities. The advantage of this measure is that we could simply subtract those trading losses from recorded taxable profit to recover some of the actual taxable income. This measure would be more closely related to tax payments in the same year. The disadvantage is that we have no information on other sources of losses that companies may be incurring, which means that we are introducing a measurement error into the analysis.

The main issue with matching estimates is their external validity. Multinationals tend to be larger and the overlapping size region between foreign multinationals and domestic standalone companies is excluding the larger multinationals and the smaller domestic standalone companies. The descriptive statistics reveal that the largest multinationals are substantially different from smaller ones in terms of how much taxable profits relative to total assets they report. It is the largest multinationals that seem to report the lowest taxable profits and to fully understand the tax avoidance behaviour of the multinational companies it is crucial to analyze the very large multinationals. The propensity score matching method will by assumption exclude all companies that are outside comparable region, therefore it may well be underestimating the full extent of potential tax avoidance.

## 5 Results

In this section I present the results from propensity score matching. I further test their robustness and discuss channels through which companies could minimize their taxable profits. I finally compare my results with those using accounting profits and consider heterogeneity of the estimates.

Using the first stage of PSM to create matched and unmatched samples, I first present descriptive statistics on foreign multinational subsidiaries and domestic standalones. I show mean unweighted outcome variables such as size (total assets and trading turnover), age, marginal<sup>38</sup> and average tax rates (tax liability divided by taxable profits), fraction of zero taxable profit reporting companies (ztp), capital allowances, total factor productivity (TFP), leverage (liabilities to total assets) and taxable profits to total assets (taxable profits divided by total assets). The results in Table 7 suggest that the matching procedure makes the two analyzed ownership types more comparable to each other in terms of main observable firm level characteristics. In the first row I show that the two ownership categories are very similar in terms of the matching variable (logarithm of total assets) after matching is performed. Further, foreign multinational subsidiaries in the matched sample are on average smaller than in the unmatched sample, while domestic standalones are larger, both in terms of total assets and trading turnover. Foreign multinationals are younger in matched sample than in the unmatched one, while domestic multinationals are older. Importantly, the average and marginal tax rates for foreign multinationals in the matched sample are lower than in the unmatched one, while they are higher for domestic standalones. The fraction of zero taxable profit reporting companies and mean capital allowances and mean TFP are lower in the matched sample than in the unmatched one for both ownership types. The mean ratio of liabilities to total assets is lower for domestic standalones, but higher for foreign multinational subsidiaries in the matched sample than in the unmatched one. The taxable profits to total assets ratio is higher for foreign multinationals in the matched sample than in the unmatched one, while it is lower for domestic standalones. Crucially, the pattern observed here is very similar to the one presented in the stylized facts section.

The matching algorithm is based on size and industry, hence in the first stage the logit model is run including logarithm of total assets, 2 digit industry and year dummies.<sup>39</sup>

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<sup>38</sup>The calculation of marginal tax rates follows Maffini *et al.* (2016). Special thanks to Giorgia Maffini for sharing her code.

<sup>39</sup>The PSM analysis assumes that we have matched on all relevant characteristics and that there is no unobserved confounders that may account for this difference across the treatment and control groups. I test that assumption using Rosenbaum bounds sensitivity analysis (Rosenbaum (2002), see Appendix Table 19). The Rosenbaum analysis tests how much the unobserved covariate would need to increase the odds of being a multinational company before we could attribute the difference between foreign multinational subsidiaries and domestic standalones to unobserved factors. The results indicate that the unobserved factor would need to increase the likelihood of being a multinational more than three times before we could attribute the observed difference in the outcome variables to that unobserved factors.

Table 7: Unweighted means of observed firm characteristics: comparison of whole matched and unmatched samples between foreign multinational subsidiaries and domestic standalones, 2000 - 2011, selected sample. Source: merged HMRC and FAME data.

	whole sample		matched sample		unmatched sample	
	foreign multinationals	domestic standalones	foreign multinationals	domestic standalones	foreign multinationals	domestic standalones
log total assets	14.642	10.9596	13.1319	13.0662	16.5284	10.8429
total assets	118,000,000	272,250	1,827,552	1,761,714	255,000,000	192,084
trading turnover	26,000,000	1,059,763	3,171,683	2,287,808	58,600,000	993,493
log trading turnover	14.494	11.5198	13.6021	13.0961	15.8760	11.4339
age	20.568	13.2785	17.9118	19.8125	23.6907	12.9268
avg tax rate	0.546	0.2047	0.5063	0.2285	0.6059	0.2033
marginal tax rate	0.064	0.1028	0.0652	0.1337	0.0636	0.1011
zero taxable profits	0.592	0.2749	0.5467	0.2280	0.6456	0.2774
capital allowance	963,000	1,574,137	800,173	862,605	1,154,422	1,612,434
TFP	14.480	11.1395	13.9195	13.1726	14.8698	10.1606
liabilities/ total assets	6.167	1.1381	6.4872	0.7696	5.8726	1.1704
taxable profits/ total assets	0.094	0.6166	0.1241	0.2587	0.0560	0.6364

First, I use the propensity score from this baseline regression to perform the nearest neighborhood matching procedure and look at the ATT from those estimations. The outcome variables I consider are taxable profits divided by total assets, tax divided by total assets, zero taxable profits dummy and taxable profits divided by total assets for positive taxable profits only. I then limit the matching sample to positive taxable profits only and repeat the matching exercise to obtain the ATT on the ratio of taxable profits to total assets for that smaller sample.

Table 8: Results from matching estimates, 2000 - 2011, selected sample. Full sample: all foreign multinational subsidiaries and domestic standalones, Positive taxable profits only sample: foreign multinational subsidiaries and domestic standalones with positive taxable profits. Treated observations are foreign multinational subsidiaries, control observations are domestic standalones. Source: merged HMRC and FAME data.

sample	variable	treated	control	ATT	SE	obs treated	obs control
Baseline	taxable profits/total assets	0.1241	0.2517	-0.1276	0.0118	149,581	149,581
Baseline	corporation tax/ total assets	0.0286	0.0537	-0.0251	0.0011	149,581	149,581
Baseline	taxable profits/total assets>0	0.2640	0.2830	-0.0189	0.0243	72,313	72,313
Baseline	zero taxable profits	0.5466	0.2288	0.3179	0.0014	149,581	149,581
Positive taxable profits only	taxable profits/total assets>0	0.2630	0.2775	-0.0145	0.0241	72,843	72,843
Positive taxable profits only	corporation tax/ total assets	0.0612	0.0598	0.0014	0.0022	72,313	72,313

The first column in Table 8 shows the mean of treated observations: foreign multinational subsidiaries, while column 2 gives me the mean of control observations: domestic standalones, both for matched sample. The average treatment effect is the difference between those two means. The last two columns show the number of observations in treated and control groups. The ATT estimates for tax and taxable profits scaled by total assets in the baseline sample are negative and significant (standard errors are in the column titled SE). The difference between domestic standalones and foreign multinational subsidiaries is estimated to be 12.76 percentage points for taxable profits to total assets

This suggests that the matching procedure is insensitive to hidden bias.

ratio, while the difference in the tax to total assets ratio is 2.51 percentage points. The mean taxable profit divided by total assets for foreign multinational subsidiaries is 12.41 percent while that same ratio is 25.17 percent for domestic standalones. This implies that if we attribute all the difference between the two groups to tax avoidance, foreign multinational subsidiaries underreport just over 50 percent of their taxable profits and avoid 46.7 percent of their tax liability.

The reason for the difference in the tax and taxable profit estimates is due to the proportion of small and medium companies that pay lower tax rate in the UK. We are matching companies on size measured by total assets rather than profits, the latter being the determinant of which tax band applies to the company. If all companies were subject to the same tax rate in the UK, the difference between multinationals and domestic standalones for tax and taxable profits should be the same. However, UK has lower tax rate for small and medium companies and these companies constitute a much larger proportion of domestic standalones than foreign multinational subsidiaries. This is the case even after matching procedure is applied, as the average tax rate is lower for domestic standalones than for foreign multinational subsidiaries in both whole and matched samples (see Table 7). We would expect domestic standalones on average to pay lower tax on the same taxable profits, if they were subject to lower tax rate. Therefore we would expect the difference between multinationals and domestic standalones in terms of taxable profits to be larger than that on tax.

Furthermore, the ratio of tax liability to total assets divided by taxable profits to total assets ratio would give me an implied tax rate. Comparison of those ratios for the treated and control groups reveals that the implied tax rate for foreign multinational subsidiaries is actually higher - 23 percent - than that of domestic standalones, 21.3 percent. However, a substantial portion of domestic standalones was subject to much lower small and medium statutory tax rate over the sample period in the UK. Therefore, absent tax avoidance we would expect the difference in the implied tax rates between the two groups to be much larger.<sup>40</sup>

I also find that foreign multinational subsidiaries are 31.79 percent more likely to report zero taxable profits in the matched sample; 56.7 percent of foreign multinational subsidiaries and 22.9 percent of domestic standalones report zero taxable profits. This leads me to explore the mean taxable profits to total assets ratio conditional on making positive taxable profits as an outcome variable. The ATT for taxable profits divided by total assets is -1.45 percentage points and is insignificant, while the ATT for tax relative to total assets turns positive and also insignificant. These results imply that there is a 1.45 percentage point difference between foreign multinational subsidiaries and domestic standalones in terms of taxable profits relative to total assets once zero profit reporting is

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<sup>40</sup>The top statutory tax rate in the UK over the sample period was mostly 30%, while the SME one was around 20%.



not taken into account. This means that over 85 percent of the difference in taxable profits between the two ownership types can be attributed to the differences in the proportions of companies reporting zero taxable profits.<sup>41</sup>

## 5.1 Robustness checks

In this section I test the robustness of the baseline estimate of the difference in taxable profits relative to total assets for foreign multinational subsidiaries and domestic stand-alones (Table 9). I first consider how various first stage matching specifications affect the main result. I use non-linear form of total assets, such as square and cube of the logarithms. I also use a cross-section regression with one observation for each firm, and with the average logarithm of total assets over the sample period to identify the matched observations, i.e. I match on static data so that a company is either always in the control or treatment group or never. I further test whether the estimates are robust to disaggregated industries and hence match using 3 digit rather than 2 digit industry codes. These changes to the first stage matching procedure alter the ATT estimates to a very small extent. The estimated size of the difference between ownership types varies between 12.53 and 13.42 percentage points.

To understand the effects that overseas income may have on my results I exclude profits sheltered by double tax relief from my taxable profits numbers. Alternatively, I use only years before the 2009 dividend tax reform. Since my analysis is done on foreign subsidiaries without any subsidiaries themselves, most of the foreign multinational subsidiaries in the matched sample have no subsidiaries which could be paying dividend income back to the UK. However, 2.6 percent of foreign multinational subsidiaries in the matched sample report to have some overseas income. This may be because their headquarters have paid dividends to their subsidiaries in the UK or because I have no data on their subsidiaries and hence I did not exclude them in the selection process. Exclusion of overseas income sheltered by double tax relief increases the coefficient on the difference slightly, but not by much. Excluding later years in the sample decreases the size of the baseline coefficient. I will discuss the heterogeneity over time within my baseline estimates in more detail in section 5.4.

I exclude ring-fenced profits from taxable profits number to see whether my results are not driven by North Sea oil rig companies reporting large taxable incomes. In similar spirit I exclude mining sector altogether, since I have shown that it is reporting incomparably high ratios of taxable profits to total assets (see Figure 5). These exclusions do not change the results significantly.

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<sup>41</sup>Alternatively, I do PSM on all companies and present the results for conditional mean of taxable profits to total assets. The results for matching on baseline sample, but using restricted outcome variable show the ATT estimate to be -1.89 percent which is not that different from the one obtained from PSM on restricted sample.

I further exclude companies that have investments (which approximate for equity value of their subsidiaries) larger than zero. This effectively excludes all companies that may have any subsidiaries, but which reported no information on this in the ownership data and hence have not been excluded during the sample selection process; 29 percent of foreign multinational subsidiaries and 5 percent of domestic standalones report data on investments in the FAME dataset. This does not seem to affect the main results; it increases the size of the difference slightly.

I then consider matching on companies with zero trading loss only to make sure that my estimates are not driven by companies reporting trading losses. The ATT estimate is 12.28 percentage points and implied tax avoidance is around 40 percent. This would suggest that the results are truly driven by zero taxable profit reporting foreign multinationals with no trading losses and possibly aggressive tax avoidance strategies in place.

Furthermore, I explore whether matching with replacement affects my results and whether utilizing more than one domestic standalone to match with foreign multinational subsidiary makes a difference. As discussed in the empirical methodology using more observations as a control group increases the efficiency of the estimates but might affect the bias of the coefficient. Using matching with replacement I can use the same large domestic standalone in the right hand side tail of the company size distribution few times, if it is the best match for a particular foreign multinational subsidiary. Therefore it is conceivable that I am using more comparable domestic standalones in this approach. Using matching with replacement results in the ATT increasing to 13.17 percentage points. In turn using 5 nearest neighborhood matching decreases the size of the estimated difference to 9.98 percentage points.

Finally, I test how different is the taxable profit to total assets ratio between foreign multinational subsidiaries and domestic group subsidiaries. I find that the gap in taxable profits between foreign multinational subsidiaries and domestic group subsidiaries is just over a third of what it is between foreign multinational subsidiaries and domestic standalones; the ATT is -4.82 percentage points. This implies that foreign multinational subsidiaries avoid almost 30 percent of their taxable profits relative to domestic groups. This is 20 percentage points lower than the implied tax avoidance relative to domestic standalones.

This is to be expected for two reasons. As I have already shown, we are not certain whether some of the domestic groups subsidiaries are not part of the foreign multinational category. Secondly, domestic groups have been shown to have as high leverage as foreign multinationals and since leverage can be used to shelter taxable profits, we would expect their taxable profits to be more comparable. However, foreign multinational companies can still shift debt abroad as well as use other strategies to shift profits abroad (abusive transfer pricing, royalty licensing). Therefore we would expect the difference in taxable profits between domestic group subsidiaries and foreign multinational

subsidiaries to signify the difference in pure foreign profit shifting ability. In turn, the difference between foreign multinational subsidiaries and domestic standalones signifies a broader tax avoidance opportunities available to groups of companies.<sup>42</sup>

I further the robustness analysis with the exploration of various company size measures which could be used as alternatives to total assets. As such, I use number of employees, fixed assets and trading turnover instead of total assets in the first stage of PSM. In each case I compare the results to matching on total assets (baseline matching procedure) on the limited sample of observations for which I have data on each of those alternative variables. This allows me to say whether various matching alternatives change the inference in terms of the size of the gap in taxable profits to total assets ratio between foreign multinational subsidiaries and domestic standalones.

I find that matching on number of employees, fixed assets or trading turnover instead of total assets increases the ATT estimates twofold. Most of the difference is coming from the much higher ratio of taxable profits to total assets for domestic standalones. Foreign multinational subsidiaries often have a large proportion of their total assets held in intangible assets, while domestic standalones do not have the same proportion of intangible assets. Therefore when matching only on fixed assets, a multinational with larger intangible assets that was previously a match for a domestic standalone, with no intangible assets will now be matched with much smaller domestic standalone company. As we have seen in descriptive statistics smaller domestic standalones tend to report higher taxable profits to total assets ratios. This explains why the ratio of taxable profits to total assets in the control group is much higher when matching on fixed assets. In case of matching on trading turnover this indicates that domestic standalones which have similar trading turnover to foreign multinational subsidiaries report higher taxable profits to total assets ratio than domestic standalones with similar total assets.

Finally, I explore what happens when instead of having taxable profits to total assets ratio as an outcome variables, I perform the baseline matching analysis with trading profits to trading turnover as an outcome variable. These results are subject to the caveats discussed in section 2.3. The mean ratio of trading profits to trading turnover for foreign multinational subsidiaries is lower than that for taxable profits to total assets. Since a large proportion of foreign multinational subsidiaries taxable income comes from other sources than trading profits, we would expect the size of the difference estimated here to be much smaller than the one for taxable profits to total assets ratio. This seems to be the case, as the ATT estimate is -6.2 percentage points; foreign multinational subsidiaries underreport trading profits by about 41%.

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<sup>42</sup>Note that I can include comparisons for companies with subsidiaries to consider how different is the taxable profits to total assets ratio for domestic multinationals relative to foreign multinationals. For details of the approach and results see Appendix 7.2.

## 5.2 Channels through which companies may be lowering their taxable profits

In this section I explore potential sources driving the wedge in taxable profits to total assets ratio between foreign multinational subsidiaries and domestic standalones. For each potential factor I first run PSM using each possible profit minimization channel as an additional matching variable and then run baseline matching on the sample of observations which have data on this additional matching factor. This way I can estimate whether the change in the ATT estimate is due to the sample composition or whether the variable itself affects the size of the estimate. I then use the potential source of the difference as an outcome variable in the baseline matching to explore the direct differences between foreign multinational subsidiaries and domestic standalones. The choice of the potential sources of the difference was guided by the differences between mean unweighted outcomes for the ownership types in the matched sample (Table 7). As such, I consider flow measure of gearing, leverage, capital allowances and total factor productivity (see Table 10 for results).

Firstly, I consider the amount of debt that foreign multinational subsidiaries can take on. I look at both stock and flow measures of gearing, where stock measure is leverage, i.e. total liabilities divided by total assets, while flow measure is net interest divided by profit and loss before interest. To estimate the importance of leverage I run PSM using debt as an additional matching variable. Leverage seems to be an important factor. The ATT from matching on leverage is -2.67 percentage points which is about 40 percent of what it is when performing baseline matching on the sample of observations with non-missing data on leverage (ATT of -4.21 percentage points). This would suggest that leverage explains just under a half of the difference in taxable profits to total assets ratio between foreign multinational subsidiaries and domestic standalones. In addition, using leverage as an outcome variable I find that foreign multinational subsidiaries seem to take on about 14.1 percentage points more debt than domestic standalones. Both of these facts are consistent with the descriptive statistics which have shown a much higher debt to assets ratio for foreign multinational subsidiaries than for domestic standalones. This suggests that 40 percent of taxable profits underreporting done by foreign multinational subsidiaries could be driven by debt shifting.<sup>43,44</sup>

The other - unexplained - portion of the difference in taxable profits to total assets between foreign multinational subsidiaries and domestic standalones can be attributed to other profit shifting strategies, such as abusive transfer pricing and royalties licensing. I am unable to investigate this further since the effects of both abusive transfer pricing and royalties licensing are already incorporated in the taxable profits (or trading losses)

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<sup>43</sup>Note that this evidence stands in stark contrast to Buettner and Wamser (2013), who provide evidence that debt shifting is unimportant for German affiliates.

<sup>44</sup>I find that differences in the flow measure of gearing do not alter the size of the baseline estimates.

figure reported by foreign multinational subsidiaries on their taxable income statements.

I further explore the effects of matching on the ratio of capital allowances to total assets and TFP; capital allowances are insignificant as an outcome variable which suggests there is no significant difference between the two ownership types, while foreign multinationals tend to report higher total factor productivity. However, matching on either of those variables does not seem to significantly affect the size of the difference in taxable profits to total assets between foreign multinational subsidiaries and domestic standalones. This is a further confirmation the differences in profitability of companies are not driven by differences in productivity. In any case, foreign multinational subsidiaries are more productive than domestic standalones, yet conditioning on productivity they report lower taxable profits to total assets ratio than domestic standalones.

Table 9: Results from Propensity Score Matching estimates, various robustness tests. Selected sample, 2000 - 2011. Source: merged HMRC and FAME data.

sample	variable	treated	control	ATT	SE	obs treated	obs control
1st stage total assets enter as a square	taxable profits/total assets	0.1250	0.2503	-0.1253	0.0118	148,842	148,842
1st stage total assets enter as a square & a cube	taxable profits/total assets	0.1250	0.2523	-0.1274	0.0118	148,759	148,759
1st stage: matching on static data in logit model	taxable profits/total assets	0.1206	0.2548	-0.1342	0.0117	147,794	147,794
1st stage: 3 digit industry FEs	taxable profits by total assets	0.1235	0.2549	-0.1315	0.0117	150,370	150,370
use only years 2000 - 2008	taxable profits/total assets	0.1346	0.2333	-0.0987	0.0172	99,622	99,622
taxable profits less those sheltered by dtr	taxable profits (less sheltered overseas income) by total assets	0.1194	0.2543	-0.1348	0.0117	149,584	149,584
exclude comps with ring fenced profits	taxable profits by total assets	0.1228	0.2518	-0.1290	0.0117	149,584	149,584
exclude mining sector from analysis	taxable profits by total assets	0.1230	0.2589	-0.1359	0.0118	148,024	148,024
take out companies with larger investment to total assets ratio >0	taxable profits by total assets	0.1287	0.2664	-0.1377	0.0132	132,734	132,734
match of companies which report zero trading loss	taxable profits/total assets	0.1772	0.2999	-0.1228	0.0169	104,055	104,055
matching with replacement	taxable profits/total assets	0.1043	0.2360	-0.1317	0.0102	197,064	2,848,342
5 nearest neighbourhood	taxable profits/total assets	0.1043	0.2041	-0.0998	0.0099	197,064	2,848,342
foreign multitis vs domestic groups	taxable profits/total assets	0.1182	0.1664	-0.0482	0.0379	135,296	163,093
Different size measures							
match on employment	taxable profits/total assets	0.0827	0.2260	-0.1433	0.0050	30,214	30,214
baseline (employment sample)	taxable profits/total assets	0.1050	0.1690	-0.0640	0.0082	30,214	30,214
match on fixed assets	taxable profits/total assets	0.0887	0.2430	-0.1543	0.0015	106,452	106,452
baseline (fx assets sample)	taxable profits/total assets	0.0959	0.1776	-0.0817	0.0018	106,452	106,452
match on trading turnover	taxable profits/total assets	0.1220	0.3262	-0.2042	0.0135	122,125	122,125
baseline (tr turnover sample)	taxable profits/total assets	0.1308	0.2319	-0.1011	0.0141	122,125	122,125
baseline (tr turnover sample)	trading profits/trading turnover	0.0939	0.1580	-0.0642	0.0006	122,125	122,125

Table 10: Results from Propensity Score Matching estimates, channels through which companies can reduce their taxable profits. Selected sample, 2000 - 2011. Source: merged HMRC and FAME data.

sample	variable	treated	control	ATT	SE	obs treated	obs control
match on leverage	taxable profits/total assets	0.0878	0.1145	-0.0267	0.0008	53,064	53,064
baseline (leverage sample)	taxable profits/total assets	0.0843	0.1264	-0.0421	0.0009	54,512	54,512
baseline (leverage sample)	leverage	0.7618	0.6207	0.1411	0.0018	54,512	54,512
match on flow of gearing	taxable profits/total assets	0.0863	0.1393	-0.0530	0.0055	32,263	32,263
baseline (flow of gearing sample)	taxable profits/total assets	0.0866	0.1420	-0.0554	0.0052	32,672	32,672
baseline (flow of gearing sample)	flow of gearing	-0.0933	-0.1749	0.0817	0.0029	32,672	32,672
match on TFP	taxable profits/total assets	0.0878	0.1300	-0.0422	0.0021	19,877	19,877
baseline (TFP sample)	taxable profits/total assets	0.0870	0.1431	-0.0560	0.0022	20,552	20,552
baseline (TFP sample)	TFP	2.5623	2.4795	0.0828	0.0031	20,552	20,552
match on capital allow	taxable profits/total assets	0.1241	0.2558	-0.1317	0.0118	149,581	149,581
baseline (capital allow sample)	capital allowance	800,254	760,477	39,777	848,497	149,581	149,581

### 5.3 Comparison of taxable and accounting profits

Most of the previous literature on tax avoidance uses accounting profits to proxy for taxable profits. The FAME dataset includes variables related to taxable profits: gross operating profits less depreciation from FAME which would be comparable to trading profits from HMRC data, while profit and loss before taxes is closer to taxable profits. In Figure 6 I look at the positive taxable and accounting profits and compare logarithms of distributions of 4 different measure of profits, according to the comparable pairs described above.

Accounting profits as measured by profit in loss before tax (Panel A, Figure 6) or by operating profits less depreciation (Panel B) overestimate the taxable profits reported by foreign multinational subsidiaries. However, accounting profits seem to be a better approximation of taxable profits of domestic standalones.<sup>45</sup> Accounting depreciation is smaller than tax depreciation which is why we would expect accounting profits less accounting depreciation to be larger than trading profits, but to the same extent for all ownership types.<sup>46</sup>

The baseline PSM estimates suggest the main difference in the taxable profits to total assets between foreign multinational subsidiaries and domestic standalones lies in the differences in the fractions of zero taxable profit reporting companies. Therefore I consider a comparison of distributions of taxable profits minus trading loss scaled by total assets relative to profit and loss before taxes scaled by total assets around zero.

Figure 7 contains 4 panels; the left hand side panels refer to comparisons of accounting and taxable profits, the right hand side panels compare foreign multinational subsidiaries with domestic standalones. Bunching around zero profits is prevalent in both accounting data (as shown by Johannesen *et al.* (2016)) as well as tax returns. What is more interesting is that bunching around zero is much larger for taxable profits relative to accounting profits for foreign multinational companies than for domestic standalones (see LHS figures, Figure 7). In addition, foreign multinational subsidiaries bunch around zero taxable profits to a larger extent than domestic standalones. However, there is no difference in bunching around zero accounting profits between foreign multinational subsidiaries and domestic standalones. What this means is that bunching is much more common on tax returns.<sup>47</sup>

Furthermore, zero taxable profit reporting companies come from the missing mass to the right of the taxable profits distribution, where the accounting profits distribution is

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<sup>45</sup>Interest and royalty payments both are deducted at the operating profit levels already.

<sup>46</sup>The observed bunching at the lower end of the size distribution for the accounting data variables comes primarily from domestic standalones and missing ownership observations. This arises because those smaller companies have an unusual number of reported statement rounded up to nearest 1000, hence the spikes at  $\log(1000)$  which is 7 and  $\log(2000)$  which is 7.2 etc.

<sup>47</sup>For additional evidence on the discrepancies between tax and accounting profits see Devereux *et al.* (2015) and Maffini *et al.* (2016).



much smoother. This suggest that some of the zero taxable profits reporting companies may be foreign multinational subsidiaries which report near zero positive accounting profits on their accounting statements.

If accounting profits overestimate the taxable profits for foreign multinational subsidiaries reporting positive taxable profits, but underestimates the extent of zero taxable profit reporting, the direction of the bias generated by using accounting profits to estimate taxable profits is ambiguous. Therefore I consider PSM using accounting variables as outcome variables to quantify the extent of the difference. I use profit and loss before tax divided by total assets and then turn all the negative values into zeros as they would be reported in the tax return form. On the sample of observations which has accounting profits data, I use taxable profits divided by total assets and then taxable profits (including losses) divided by total assets as outcome variables.

The comparison of taxable profits divided by total assets with profit and loss before tax with negative values converted to zeros divided by total assets shows that the size of the difference between foreign multinational subsidiaries and domestic standalones is estimated to be -5.39 percentage points using taxable data and -2.66 percentage points using accounting data. In turn, the comparison using taxable profits (including loss) divided by total assets with that of accounting profits divided by total assets reveals the difference between ownership types to be -14.73 percentage points in the tax returns data and -7.03 percentage points in the accounting data. In both cases the estimates of the difference between foreign multinational subsidiaries and domestic standalones are much smaller when using accounting profits data than with taxable profits data. What is more, the ratios of taxable profits to total assets for foreign multinational subsidiaries are generally smaller than the ones for accounting profits to total assets for both methods. This suggests that the previous estimates of tax avoidance obtained using accounting data might be underestimating the true size of tax avoidance of foreign multinational companies. Since the PSM results are driven by the zero taxable profit reporting companies, this is not at all surprising. Foreign multinational subsidiaries seem to be overstating their profits in their accounts, while at the same time reporting zero taxable profits on their tax returns. This would bias the estimates obtained using accounting data downwards.

The more rigorous comparison of taxable and accounting data is outside the scope of this paper. Understanding how using tax returns data relative to accounting data will help us to better understand the reporting behaviour of multinational companies is an interesting avenue for further research.

Figure 6: Distribution of logarithm of profits: comparison between FAME and CT600, propensity score matched baseline sample, 2000 - 2011. Source: merged HMRC and FAME data.

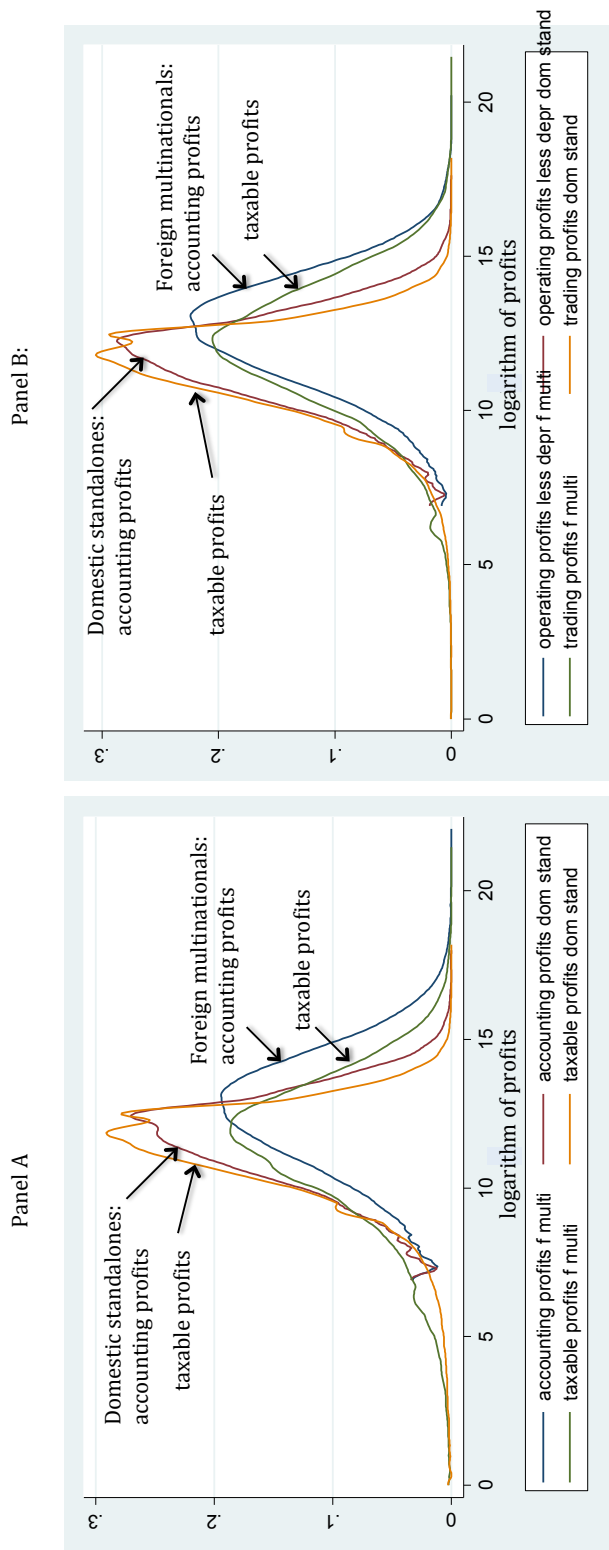
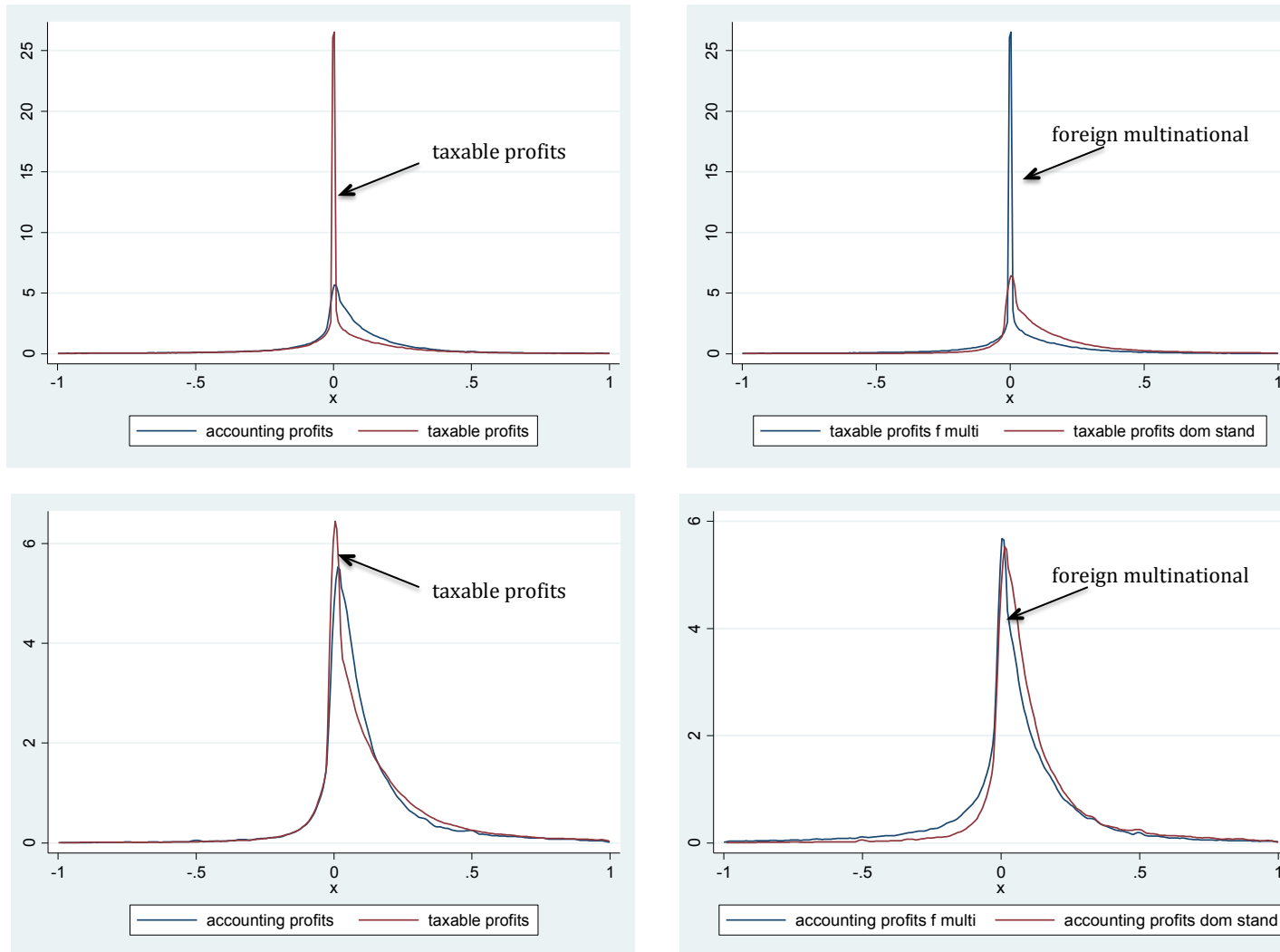


Table 11: Results from Propensity Score Matching estimates, Comparison of taxable and accounting profits. Selected sample, 2000 - 2011. Source: merged HMRC and FAME data.

robustness test	variable	treated	control	ATT	S.E.	obs treated	obs control
accounting profits sample	taxable profits by total assets	0.0801	0.1340	-0.0539	0.0021	65,543	65,543
accounting profits sample	accounting profits (negative is zero) by total assets	0.1140	0.1407	-0.0266	0.0008	65,543	65,543
accounting profits sample	taxable profits (incl loss) by total assets	-0.0408	0.1065	-0.1473	0.0180	65,543	65,543
accounting profits sample	accounting profits by total assets	0.0503	0.1206	-0.0703	0.0012	65,543	65,543
accounting profits sample	tax by plbt	0.2057	0.2454	-0.0397	0.0135	47,406	47,406

Figure 7: Distribution of the ratios of taxable profits (including trading losses) from HMRC and profit and loss before taxes from FAME scaled by total assets, propensity score matched baseline sample, 2000 - 2011. The left hand side panels refer to comparisons of accounting and taxable profits for foreign multinational subsidiaries (top LHS figure) and domestic standalones (bottom LHS figure), the right hand side panels compare foreign multinational subsidiaries with domestic standalones for taxable profits (top RHS panel) and accounting profits (bottom RHS panel). Source: merged HMRC and FAME data.



## 5.4 Heterogeneity of the estimated coefficients

In this section I explore the heterogeneity of the baseline estimates of the difference in taxable profits to total assets between foreign multinational subsidiaries and domestic standalones. I specifically focus on the yearly variation in the estimated coefficients as well as differences between foreign multinational subsidiaries depending on the location of their headquarters.

Throughout the last decade the fight against tax avoidance has intensified both globally and in the UK. Therefore it is interesting to see whether the size of the estimated difference in taxable profits to total assets between foreign multinational subsidiaries and domestic standalones has decreased accordingly. To do so, I estimate the PSM for each year separately and generate the ATT for taxable profits to total assets ratio for each of the years 2000 - 2011. I then plot those ATT estimates alongside the confidence intervals in Figure 8. In addition to taxable profits to total assets ratio, I also use zero taxable profits differences as an outcome variable in the PSM.

I find the size of the difference between the two ownership types has increased from 5.1 percentage points in 2000 to 20.6 percentage points in 2011 with some fluctuations around the financial crisis. What is more, this increase can possibly be attributed to a constantly increasing difference in the fraction of zero taxable profit reporting companies. This has increased from 26 percentage points in 2000 to 37 percentage points in 2011.

Secondly, I explore differences in the taxable profits to total assets reported by foreign multinationals depending on where they are headquartered. There is some evidence in the literature that companies with affiliates in tax havens tend to report lower accounting profits, which is interpreted as sign of profit shifting (Desai *et al.* (2006), Slemrod and Wilson (2009), Grubert and Slemrod (1998), Hines and Rice (1994)). Should that be the case, we would expect foreign multinational subsidiaries with parents in tax havens to be reporting lower taxable profits to total assets ratios in the UK. What is more, media has been pointing towards the US headquartered companies, such as recently 'named and shamed' Google, Amazon, Apple or Starbucks as those which tend to pay very little tax in the UK.<sup>48</sup>

To estimate the differences in the size of tax avoidance by foreign multinational subsidiaries depending on where their headquarters are located I do PSM. I use taxable profits relative to total assets as an outcome variable. I divide a sample of foreign multinational subsidiaries according to the location of their global ultimate owner. I then perform PSM separately for each of those groups of foreign multinational subsidiaries finding the nearest neighborhood match among all domestic standalones. I use the whole population of domestic standalones for each of the subgroups of foreign multinational subsidiaries with various headquarter locations, hence same domestic standalones can be used in each

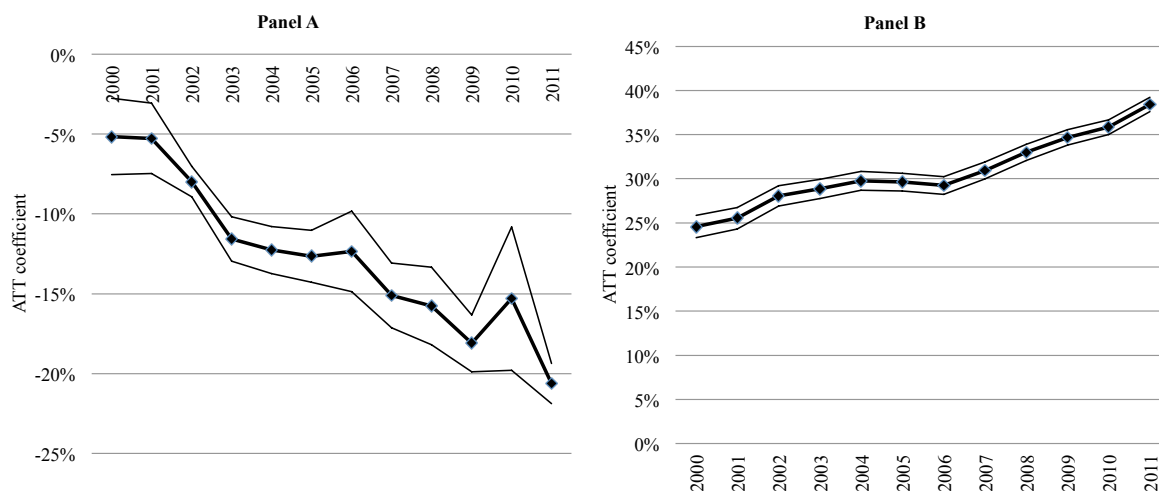
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<sup>48</sup>See articles in e.g. BBC, which talk about the very large companies avoiding tax in the UK.

subsample, but only once within each headquarter group. I distinguish between the following headquarter locations: tax haven (excluding large tax havens), large tax haven such as Hong Kong, Singapore, Netherlands and Ireland, French multinationals, German multinationals, other European multinationals, US multinationals, Asian multinationals, other foreign multinationals.

The results for this matching procedure are presented in Table 12 and are ranked according to the size of the estimated ATT, from largest to smallest. The number of foreign multinational subsidiaries headquartered in each of the country groups can be seen in the observation treated column. I find that foreign multinational subsidiaries headquartered in tax havens report much lower taxable profits to total assets ratio in the UK relative to domestic standalones (the size of the difference is -16.95 percentage points). They are followed by foreign multinational subsidiaries headquartered in large tax havens. The smallest difference to domestic standalones, by far, is reported by other foreign multinationals (-3.34 percentage points).<sup>49</sup>

Figure 8: Results from the Propensity Score Matching estimation run year by year, foreign multinational subsidiaries and domestic standalones, Panel A: taxable profits to total asstes, Panel B: zero taxable profits as output variables. Selected sample, 2000 - 2011. Source: merged HMRC and FAME data.



<sup>49</sup>I can alternatively compute the weighted means of taxable profits to total assets for each of the headquarter location groups to see which foreign multinational subsidiaries report lowest taxable profits to total assets ratios. In Figure 14 in the Appendix we can see that foreign multinationals located in large tax havens tend to report lowest taxable profits in the UK. US headquartered companies do not report particularly low taxable profits in the UK relative to companies headquartered in other countries. Interestingly, subsidiaries of multinationals HQ in other European countries (apart from France, Germany, Netherlands and Ireland) tend to report relatively high taxable profits in the UK.

Table 12: Results from Propensity Score Matching estimates, headquarter heterogeneity. Selected sample, 2000 - 2011. Source: merged HMRC and FAME data.

sample	variable	treated	control	ATT	SE	obs treated	obs control
tax haven	taxable profits/total assets	0.0925	0.2621	-0.1695	0.0068	27,127	27,127
large tax haven (HK SG NL IE )	taxable profits/total assets	0.0997	0.2322	-0.1325	0.0051	30,387	30,387
French multinationals	taxable profits/total assets	0.0926	0.2162	-0.1235	0.0081	9,269	9,269
Asian multinationals	taxable profits/total assets	0.0781	0.1976	-0.1195	0.0054	13,913	13,913
other European multinationals	taxable profits/total assets	0.1113	0.2197	-0.1084	0.0147	18,043	18,043
US multinational	taxable profits/total assets	0.1308	0.2345	-0.1037	0.0085	47,941	47,941
German multinationals	taxable profits/total assets	0.0926	0.1872	-0.0947	0.0100	9,853	9,853
other foreign multinationals	taxable profits/total assets	0.0182	0.0516	-0.0334	0.0007	19,445	19,445

## 6 Conclusion

This paper uses the full population of UK companies to present new stylized facts related to taxable profit reporting of the UK companies. In particular, I show that foreign multinational companies report lower taxable profits relative to their size than domestic standalone companies. The propensity score matching approach controls for the differences between the two groups coming from size and industry variation, and estimates the remainder of the difference to be 12.76 percentage points. Assuming that similar sized companies from similar industries should be reporting similar taxable profits, unless they are involved in tax avoidance practices that aim at minimizing their tax liability in the UK, the difference estimated in this paper suggests a large tax avoidance of foreign multinational subsidiaries in the UK. Specifically, the baseline propensity score estimates suggest that foreign multinational subsidiaries underreport their taxable profits by about 50% relative to domestic standalones. This is the first study of that type which measures the size of the potential tax avoidance of the UK companies.

Using the net tax payable from the tax returns together with the implied tax avoidance estimates, we can calculate the implied revenue gain from equalizing the taxable profits of domestic standalones and foreign multinationals. From the yearly PSM estimates, we know that the size of the avoidance varies between 30 and 70 percent. Back of the envelope calculations show that the potential revenue gains would vary from £3 billion pounds at the beginning of the sample to £25 billion in 2011. This would imply that a full elimination of the differences in taxable profits between domestic standalones and foreign multinational subsidiaries would lead to enormous revenue gains. This is extremely important, if governments think that eradicating tax avoidance could be used as means of recovering revenues lost during financial crisis.

According to the propensity score matching estimates almost all of the difference between the two groups can be attributed to the large fraction of zero taxable profit reporting companies amongst foreign multinationals. Once multinational companies decide to report positive taxable profits, their reporting behaviour does not differ substantially from that of domestic standalones. This suggests that most of the tax avoidance is ac-

tually quite aggressive and occurs via reporting zero taxable profits. Further, this has implications for theoretical models of profit shifting which assume convex marginal costs of shifting. A large number of zero taxable profit reporting companies would suggest presence of constant marginal costs of shifting profits abroad.

I find that previous estimates of tax avoidance based on accounting data might be underestimating the true size of the problem. The extent of zero taxable profit reporting is much larger than near-zero accounting profit reporting for foreign multinational subsidiaries, but not for domestic standalones. Further work in this area is required to shed more light on the size of the book-tax gap.

I also estimate that about 40 percent of the difference in the taxable profits to total assets between foreign multinational subsidiaries and domestic standalones in the matched sample comes from the differences in leverage between ownership types. Since difference in leverage suggest presence of debt shifting, this would mean that 40 percent of foreign multinational tax avoidance can be explained by debt shifting. The remaining 60 percent can be attributed to either abusive transfer pricing or royalty licensing.

Furthermore, descriptive statistics have shown that the carefully matched foreign multinational subsidiaries pay on average more tax than their unmatched counterparts. This implies that the effects shown in this paper might be underestimating the extent of the tax avoidance of multinational companies in the UK. This is inevitably more speculative since we do not have large enough domestic standalones to compare them to the largest multinationals and hence we are unable to say whether larger domestic standalones would have also reported lower taxable profits as a fraction of their size.

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## 7 Appendices

### 7.1 Further description of variables and data

#### 7.1.1 Detailed ownership definitions

In this section I present detailed discussion of ownership categories used in the empirical analysis and discuss additional data and sample selection issues.

Comparing multinational companies to domestic companies means that one of the crucial parts of this paper is the identification of companies into the right ownership category. To do so, I start by using the ownership information available in the FAME dataset which allows me to distinguish between multinationals and purely domestic companies. I define a multinational as a company that

- has an ultimate parent which is not located in the UK<sup>50</sup>, OR
- has a (wholly-owned) direct subsidiary which is not located in the UK, OR
- has a (wholly-owned) affiliate in the chain of ownership which is not located in the UK (ownership chain goes 10 levels down), OR
- has an ultimate parent which is located in the UK, but the ultimate parent itself has a foreign subsidiary.

I also distinguish between domestic and foreign multinationals and multinational subsidiaries and multinational headquarters. In the FAME data headquarter status is equivalent to the ultimate owner status. This leads to effectively having the following multinational categories:

- foreign multinational subsidiary,
- domestic multinational subsidiary,
- domestic multinational parent.

For 70 percent of cases, FAME does not provide me any information on the ownership structure. For those companies with missing ownership information, I supplement the FAME ownership data with other variables in FAME and HMRC dataset to identify companies into two additional ownership categories, which I call 'unidentified multinational'

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<sup>50</sup>"To define an Ultimate Owner, FAME analyses the shareholding structure of a company having an Independence Indicator different from A+, A or A- (which means that the company is independent and consequently, has no Ultimate Owner). It looks for the shareholder with the highest direct or total % of ownership. If this shareholder is independent, it is defined as the Ultimate Owner of the subject company and a UO link is created between the subject company and the Ultimate Owner. If the highest shareholder is not independent, the same process is repeated to him until FAME finds an Ultimate Owner." The quote is taken directly from the FAME ownership Help file.

and 'other groups'. I define a company to belong to the 'unidentified multinational' category if:

- it has overseas income (box 9 on the CT600 form is larger than 0), OR
- it has claimed double tax relief (box 73 on the CT600 form is larger than 0).<sup>51</sup>

I define a company to belong to 'other group' category if:

- it has internal debt that is larger than 0 (using FAME long and short term internal borrowing), OR
- it does indicate on the CT600 form that it is part of the group (part of a group 'X' in the CT600 form), OR
- it claims group relief in the CT600 form (group relief in any of the years it existed is larger than 0 in box 36 on the CT600 form), OR
- it has losses to be surrendered as group relief (box 123 on the CT600 form is non zero).

For unidentified multinational and other group categories I have a time dimension to the ownership data. To avoid a situation where in some ownership categories I have companies being various types in different years, I assume that if a firm ever claimed any of the deductions it belongs to that given category in all other years.

### 7.1.2 Criteria to select the sample for the analysis

Table 13 summarizes the characteristics of the selected sample where the last row gives the size of the sample after all selection criteria have been applied. The table also outlines how each selection criteria affects the number of observations, the total tax liability, trading turnover, trading profits and total assets. In what follows, I discuss each selection criteria in turn.

Firstly, to be in the selected sample, I require the HMRC companies to be matched with the FAME data<sup>52</sup>. The matching is performed using firm and time identifier. Specifically, the unique firm identifiers from the FAME dataset and HMRC data are anonymized and matched by the HMRC. The accounting period end date from FAME and the statement date from the CT600 form are merged as time indicators. Most of the unmatched companies come from the missing ownership category.

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<sup>51</sup>Note that overseas income refers to a narrow notion of income that has been generated by a foreign company abroad and is paid back to the UK affiliate of that company.

<sup>52</sup>Special thanks to Strahil Leopev and Giorgia Maffini for sharing their matching strategy and baseline dataset with me.

Further, I require the company from the FAME data to be reporting an unconsolidated statement and not consolidated or missing. Since companies report unconsolidated tax returns data on the CT600 forms, I require the firm level data to be reported at the unconsolidated level too. FAME never provides both consolidated and unconsolidated data for the same firm in the same year. Hence the matching algorithm can match a consolidated account from FAME with unconsolidated data from the HMRC.<sup>53</sup> Since it is often the company headquarters that report consolidated statements, I also exclude them from the selected sample.

Removing consolidated and missing financial reporting observations constitutes only 2% of companies, but those 300,000 observations account for over 20% of total tax liability, 16% of trading turnover and 70% of total assets. The fraction of observations with missing financial reporting type is very small and the fraction of tax that they pay is also very small. Most of these 300,000 observations come from consolidated statements. The fact that the exclusion of consolidated statements accounts for 70% of total assets is unsurprising since the consolidated statement would include information on total assets of multinational groups abroad. More importantly, those 2% of companies seem to contribute 20 percent of the tax liability in the UK, and together with the fact that they have large total assets it suggests that they might be large and profitable companies. Therefore omitting them from the analysis might affect the results. However, since those 2 percent of companies report only consolidated accounting statements in FAME, I have no measure of the size of their operations in the UK. Importantly, domestic multinationals report 27% of their accounts as consolidated ones while foreign multinationals and unidentified multinationals report 7%. Most of the tax liability excluded from the selected sample comes from the consolidated accounts of various types of multinationals (see Table 14).<sup>54</sup>

Specifically, Table 14 shows the proportions of tax, trading profits, trading turnover and taxable profits excluded through sample selection by ownership category. Firstly, the sample selection process discards almost half of domestic multinationals. The companies with the largest fraction of remaining observations are domestic standalones, domestic groups and foreign multinationals (all above 70%). However, it is unidentified multinationals closely followed by foreign multinational companies for which we lose largest fraction of their tax liability (40 and 38%), trading turnover (29 and 27%) and taxable

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<sup>53</sup>For smaller companies FAME will sometime have alternating consolidated and unconsolidated data, switching from one to another depending on the year. In that case, if the trading turnover in the FAME dataset matches the trading turnover in the HMRC data I keep that company in the sample and assign it to unconsolidated group. If the trading turnover is different by more than 10% between tax and accounting datasets I exclude that company from my selected sample.

<sup>54</sup>As another selection criteria to be included in the selected sample, I require companies to have 12 months of accounting data and positive total assets. This does not alter the sample in any meaningful way. There are other outliers that have been removed from the sample for analysis purposes. See Appendix for discussion of those.

profits (41 and 29%) due to the sample selection process.

Table 13: Sample selection criteria: summary statistics on how many observations we loose at each step; currency, pound; unit, million. Source: HMRC data.

	number of observations	total tax liability	trading turnover	total trading profits	total assets
CT 600 population	16.70	591,730.58	44,701,859.07	2,368,996.17	451,888,189.70
matched with FAME	12.70	525,673.23	41,004,434.12	2,130,083.52	451,888,189.70
unconsolidated	12.40	402,668.44	33,844,108.38	1,659,807.93	140,577,156.80
12 months accounts	12.10	396,192.21	32,945,801.55	1,638,448.11	137,618,696.30
non missing total assets	12.00	395,960.33	32,902,133.58	1,636,946.65	137,618,696.30
		percentages			
matched with FAME	76%	89%	92%	90%	-
unconsolidated	74%	68%	76%	70%	31%
12 months accounts	72%	67%	74%	69%	30%
non missing total assets	72%	67%	74%	69%	30%

Table 14: Proportion of observations in the selected sample relative to the whole sample by ownership type. Source: HMRC data.

	no of obs	tax	trading profits	trading turnover	taxable profits
foreign multinational	72%	62%	72%	64%	63%
domestic multinational	52%	71%	54%	73%	71%
domestic group	75%	70%	76%	75%	71%
domestic standalone	82%	90%	90%	96%	90%
other group	76%	69%	73%	79%	70%
unidentified multinational	66%	60%	63%	71%	59%
missing ownership	65%	75%	79%	71%	76%

### 7.1.3 Additional information about variables in the merged dataset

I further define and describe in detail the variables I use in the descriptive statistics and empirical analysis to compare the profit reporting behaviour of foreign multinational companies with that of domestic standalones. Since most of my comparisons use profit and size measures, I discuss the options available here.<sup>55</sup>

The CT600 data is my primary source for the data on the tax liability and the tax base (Table 15). The most relevant variables are taxable profits (box 37) and tax liability (box 63). However, it is possible to break the taxable profits into profits before deductions (box 21) minus deductions (box 33) minus group relief (box 36).<sup>56</sup>

Moreover, the CT600 data offers unique information on the items that contribute to the taxable profits before deductions (boxes 3 - 20). The breakdown of profits before deductions<sup>57</sup> includes major items such as trading profits (box 5), bank, building society

<sup>55</sup>Schedule D Case V refers to income from overseas possessions (property, shares etc.)

<sup>56</sup>Box numbers correspond to the CT600 form.

<sup>57</sup>Note that box 21 on the CT600 is missing for most of the observations therefore I constuct it manually using the formula outlined on the CT600 form.

Table 15: Description of box numbers and corresponding variables in the CT600 data.

<b>box number</b>	<b>variable name</b>	<b>Ct600 name</b>	<b>variable description</b>
<b>box 1</b>	trading turnover	total turnover from trade of profession	turnover from trading activities
<b>box 5</b>	trading profits	trading and professional profits	profits arising from trading activities
<b>box 9</b>	overseas income	overseas income within Sch D Case V	income from overseas activities, such as dividend income
<b>box 18</b>	net gains	net chargeable gains	gross chargeable gains minus allowable losses including losses brought forward
<b>box 21</b>	profits before deductions	profits before other deductions and reliefs	total taxable income from all activities
<b>box 33</b>	deductions	total of deductions and reliefs	sum of all deductions variable to companies, apart from group relief
<b>box 34</b>	profits before group relief	profits before charges and group relief	difference between box 21 and box 33
<b>box 37</b>	taxable profits	profits chargeable to corporation tax	difference between box 34 and sum of boxes 35 (charges paid) and box 34
<b>box 63</b>	tax	corporation tax	corporation tax liability calculated based on box 37 profits

or other interest, and profits and gains, from non-trading loan relationships (box 6)<sup>58</sup>, overseas income (box 9), net gains (box 18) and other items (sum of box 8, 10, 11, 12, 13, 14, 15 less boxes 19 and 20).<sup>59</sup> The trading activity refers to any activity which is a result of a company carrying on its trade, i.e. operations; for example, selling goods in case of Tesco.

Figure 9 shows that there are marked differences in the sources of income between company types depending on their ownership.<sup>60</sup> Domestic standalones derive most of their income from trading activities in the UK, while foreign multinational companies derive only two thirds of theirs from this source. Overseas income constitutes quite a substantial fraction of total income of multinational companies over the sample period. However, large fractions of overseas income have been sheltered by double tax relief and no tax has been paid on the sheltered portion of income. Excluding the overseas income sheltered by double tax relief it appears that the unsheltered overseas income did not contribute significantly to the overall UK tax base (see Figure 9).<sup>61</sup>

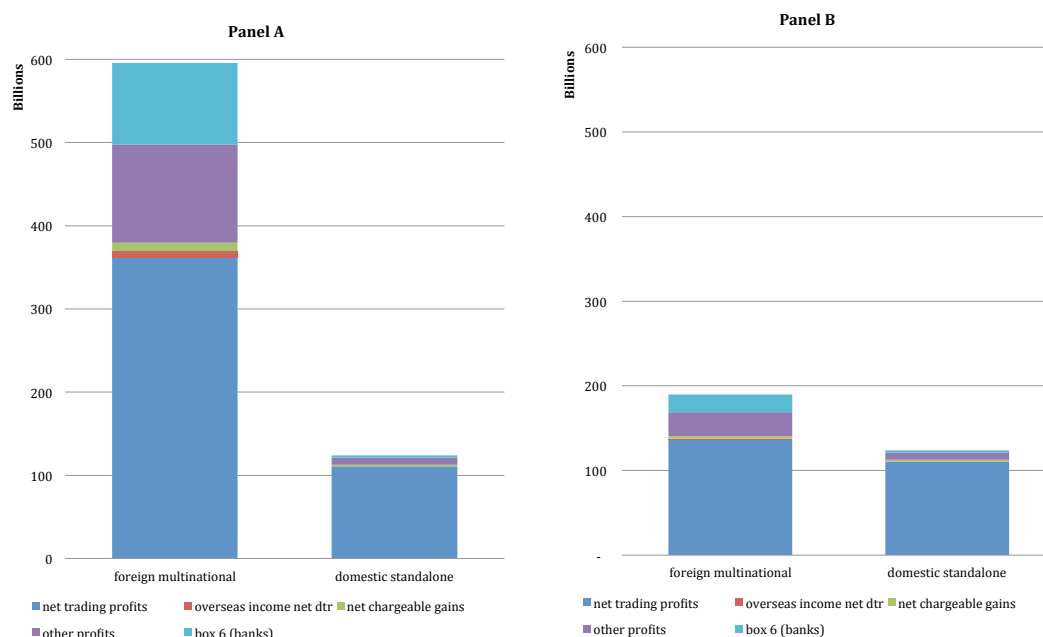
<sup>58</sup>This is simply the interest on deposits held by companies in banks, building societies and others.

<sup>59</sup>For definitions and description of each box on the CT600 form see Appendix.

<sup>60</sup>Note that since companies do not have to fill in all the boxes in the CT600, some companies which have no deductions to be itemised and no profits apart from trading ones will only fill in the taxable profits box. Therefore Figure 9 does not include all the profits before deductions in the UK.

<sup>61</sup>There was a tax reform in the UK in 2009 which switched UK from worldwide to territorial tax system. After the reform firms no longer had to report dividends received from abroad since they received no tax credit on them (Grubert (2009), Lohse and Riedel (2013)). There is a large decrease in overseas income numbers reported on the CT600 form from 2010 onwards. This decrease means that multinationals which derived a substantial part of their profits from overseas income in the UK, would report lower taxable profit numbers from 2010 onwards. However, the decrease in the tax paid is not as large as the decrease in overseas profits. This is because part of the overseas income was sheltered by

Figure 9: Components of profits before deductions by type and ownership. Panel A: whole sample, Panel B: matched sample; years 2000 - 2011.



Many companies in HMRC data have missing trading turnover information in spite of reporting positive taxable profits and positive trading profits. In Table 16 panel A, I look at the whole population of companies from the HMRC dataset and calculate the proportion of missing observations for trading turnover and total assets. In panel B Table 16 I do the same exercise but for the selected sample only (hence no missing observations on total assets). The best coverage is offered for foreign multinationals and domestic standalones, 80% and 93% respectively<sup>62</sup>.

We can see in Table 16 that in the whole sample of HMRC observations the fractions of missing observations are larger for trading turnover than for total assets in case of multinationals, but not in case of domestic standalones and missing ownership categories. This would imply that using trading turnover as a size measure would bias the sample composition towards domestic standalones, while using total assets would bias it towards multinationals.

The CT600 data contains some outliers. 122 of observations in the CT600 data report negative tax liabilities. Since HMRC has informed me that should not be the case, I discard those observations. They are mainly part of the missing ownership group, hence I am inclined to believe that they might be genuine mistakes. There are several cases where trading profits are larger than trading turnover itself. I exclude those companies

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double tax relief in the UK. Therefore multinational companies only paid tax on part of their overseas income before 2009.

<sup>62</sup>Interestingly, the majority of domestic multinationals that report missing trading turnover are also those that report consolidated statements in their accounts. Therefore it is impossible to know the size of their operations in the UK.



Table 16: Proportions of missing observations for trading turnover and total assets; whole vs selected sample. Source: HMRC and FAME data.

	whole sample				
	missing trading turnover	%	missing total assets	%	no of obs
foreign multinational	88,831	23%	49,374	13%	382,353
domestic multinational	18,534	43%	4,420	10%	43,249
domestic group	174,602	19%	105,188	12%	911,670
domestic standalone	274,376	8%	601,604	17%	3,573,689
other group	496,374	16%	620,396	20%	3,105,551
unidentified multinational	125,965	29%	90,234	21%	427,459
missing ownership	1,260,113	15%	2,727,700	33%	8,304,161
	selected sample				
	missing trading turnover	%	missing total assets	%	no of obs
foreign multinational	54,628	20%	-	-	276,818
domestic multinational	9,705	43%	-	-	22,443
domestic group	114,197	17%	-	-	686,083
domestic standalone	190,511	7%	-	-	2,928,737
other group	292,489	12%	-	-	2,365,955
unidentified multinational	63,613	22%	-	-	283,205
missing ownership	464,683	9%	-	-	5,423,953

from the sample as well.

The selected sample contains observations where taxable profits of a company are larger than its trading turnover, in some cases even 10 fold. This can arise for two main reasons; the first is that companies selling assets or shares are liable to pay capital gains tax on those sales. This will mean that a company with a small trading turnover in the UK, could be reporting larger taxable profits in one year due to shares or assets sales and the profits arising from those. The CT600 form includes net gains that are added to the total tax base.

The second reason why taxable profits are larger than trading turnover could be that companies are receiving dividend payments from their subsidiaries abroad. This applies only to the multinational companies. In this case, the taxable profit is often higher than turnover for several years in a row. A substantial fraction of both foreign and domestic multinational subsidiaries in the UK reports zero trading profits, while at the same time pays a non-zero tax in the UK. Those are very likely holding companies which often receive substantial amounts of overseas income, while having no other profits.

After UK switched from credit to exemption system in 2009, those firms will cease to report overseas income and hence will report no taxable profits. I discuss this in more detail in the descriptive statistics and account for overseas income sheltered by double tax relief prior to the 2009 reform in the empirical analysis.

Table 17: Balance sheet formulas - FAME data.

Line	Formula	Label	Comments
<b>93</b>	87+88	shareholders' Funds	equivalent to total assets less total liabilities
	66+85	total liabilities	
<b>66</b>	51+52+60	current liabilities	includes group loans (short term)
<b>85</b>	72+79+82+84a+84b	long term liabilities (-)	includes group loans (long term)
<b>70</b>	37+48	total assets	
<b>37</b>	31+35+36	fixed assets	
<b>31</b>	32+33+34+34	tangible assets	
<b>35</b>		intangible assets	
<b>36</b>		Investments	
<b>48</b>	38+41+42+43+47	current assets	includes investments

Table 18: Proportion of zero taxable profit reporting observations in each sector for foreign multinationals, domestic standalones and for the whole sample; selected sample, 2000 - 2011.

	foreign multinationals	domestic standalones	all obs
1: agriculture, forestry and fishing (01-09)	67.2%	32.7%	43.5%
2: mining (10-14)	53.5%	32.4%	38.6%
3: construction (15-17)	51.3%	36.8%	44.5%
4: manufacturing (20-39)	53.2%	31.3%	40.3%
5: transportation & public utilities (40-49)	63.6%	20.2%	28.2%
6: wholesale trade (50-51)	43.6%	28.0%	36.4%
7: retail trade (52-59)	61.4%	32.7%	40.6%
8: finance, insurance & real estate (60-67)	56.3%	27.3%	39.7%
9: services (70-89)	62.2%	24.5%	34.9%
10: public administration (91-98)	60.0%	30.7%	42.1%
11: non-classified establishments (99)	60.0%	44.6%	51.5%

Figure 10: Net tax payable (Panel A) and trading profits (Panel B), contributions to total tax and total trading profits by ownership type, 2000 - 2011, selected sample.

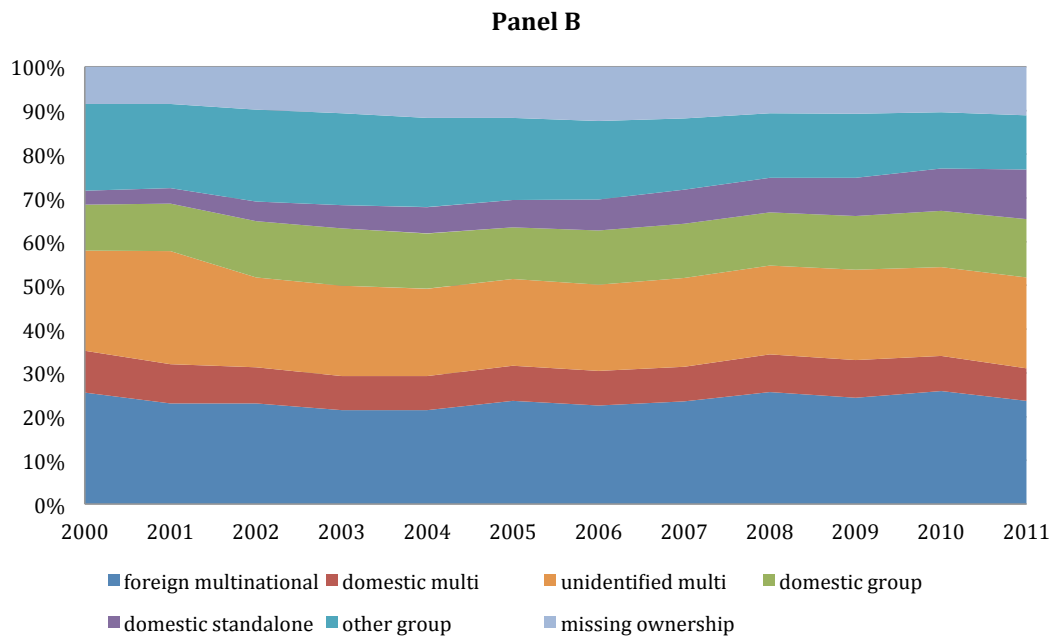
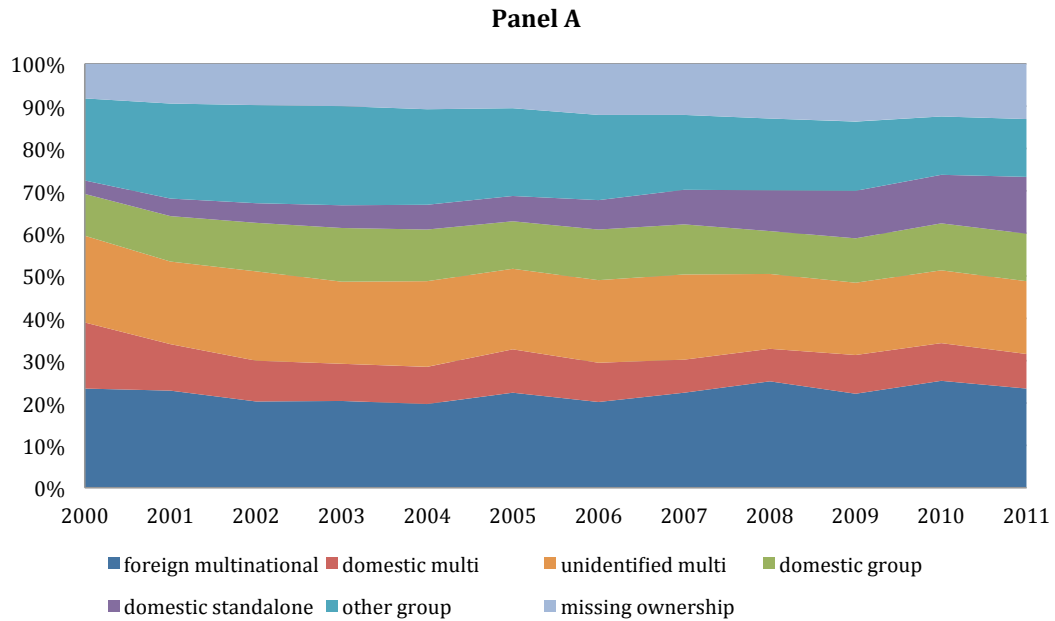
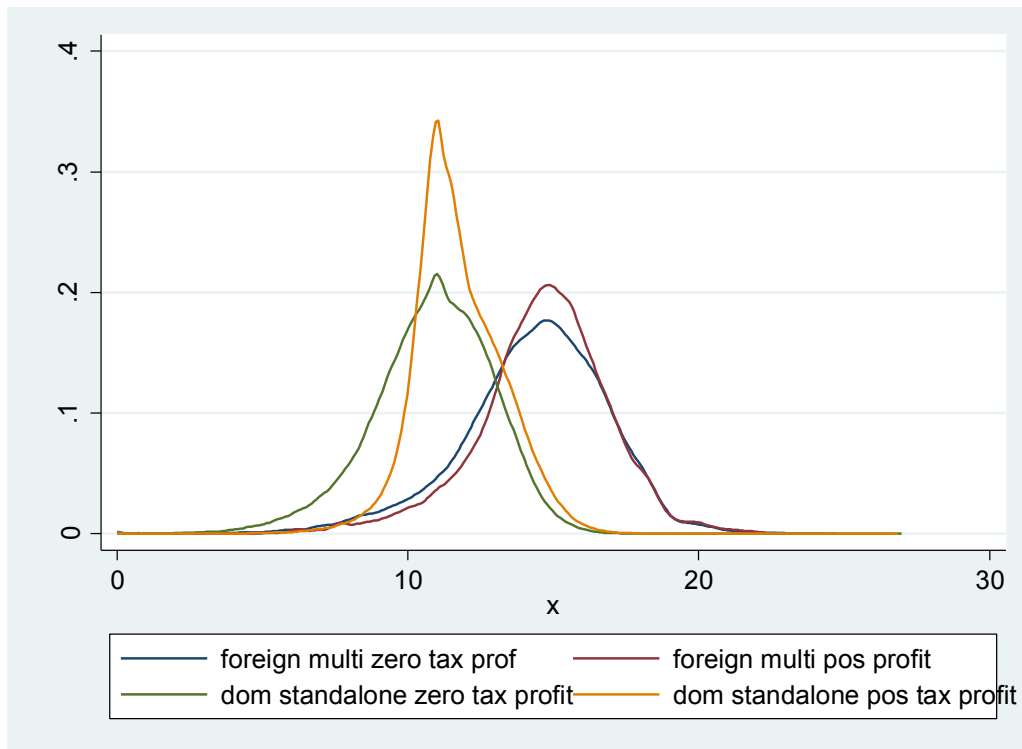


Figure 11: Distributions of logarithm of trading turnover (Panel A) and logarithm of total assets (Panel B) for positive and zero taxable profits and for foreign multinationals and domestic standalones; selected sample, 2000 - 2011.

Panel A: trading turnover



Panel B: total assets

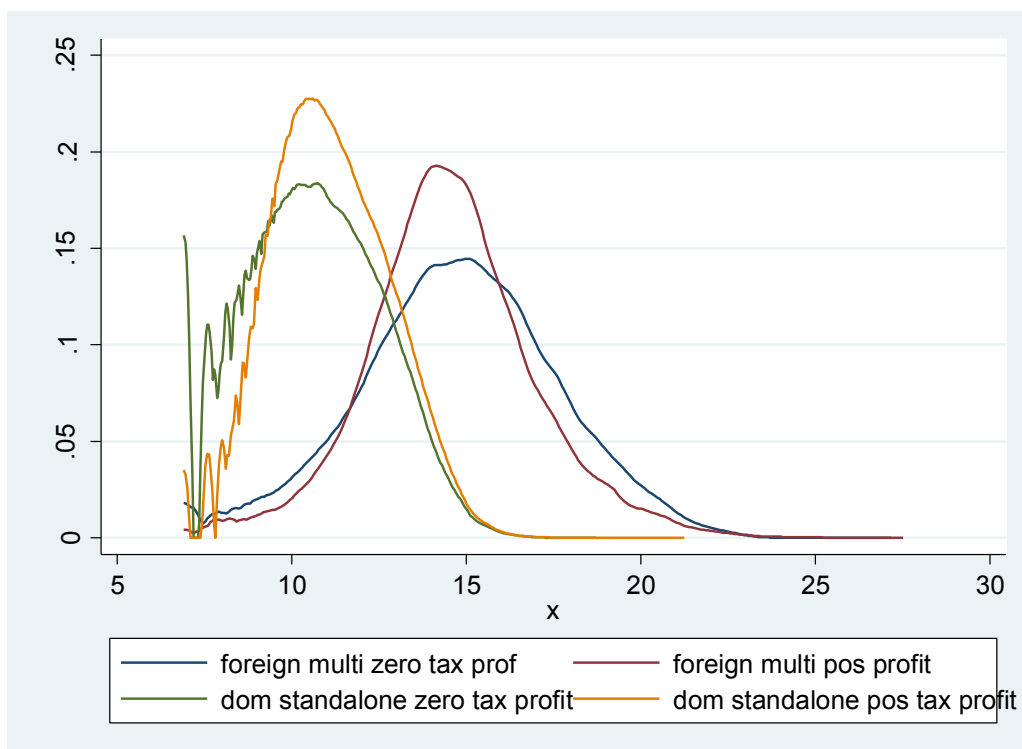


Figure 12: Distributions of firms age for positive and zero taxable profits and for foreign multinationals and domestic standalones; selected sample, 2000 - 2011.

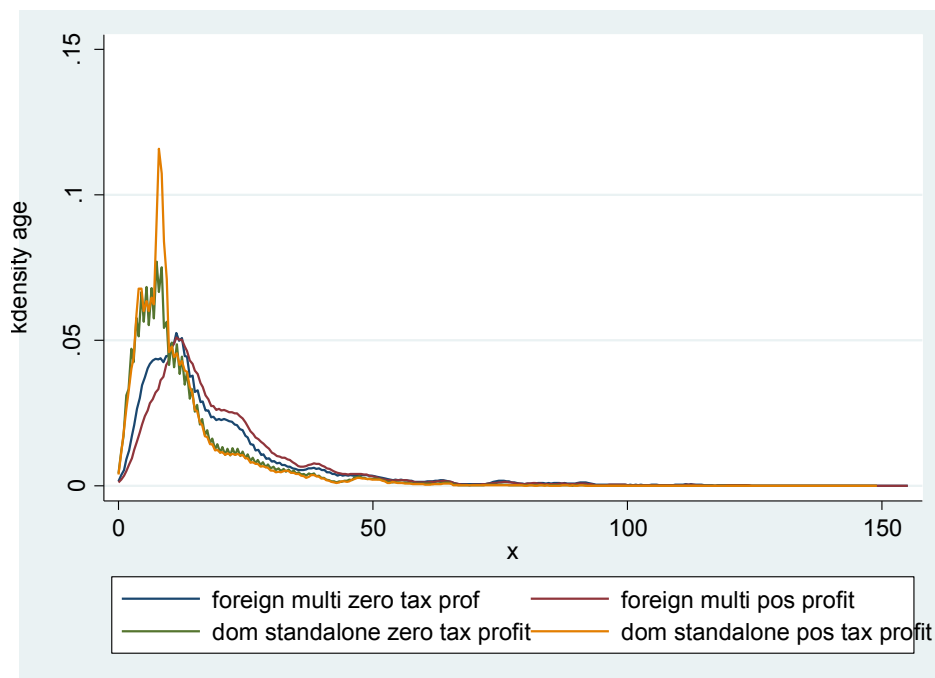


Figure 13: Panel A: Taxable profits relative to total assets, Panel B: Taxable profits divided by book value of equity, both selected balanced sample.

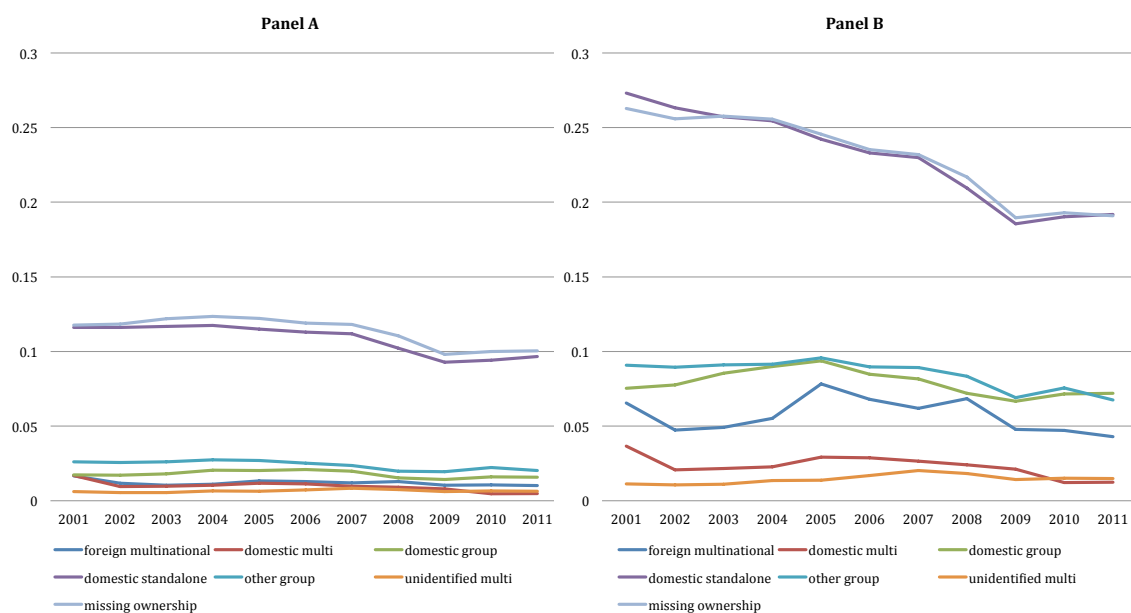
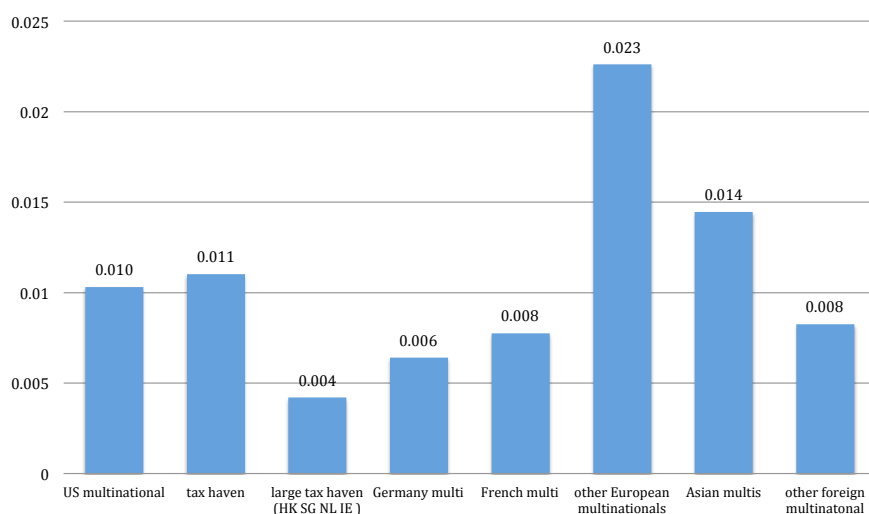


Table 19: Results from Rosenbaum sensitivity tests for unobserved factors affecting the PSM estimates.

Rosenbaum bounds for delta (N = 260617 matched pairs)						
Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1	0	0	-0.06688	-0.06688	-0.06763	-0.06614
1.2	0	0	-0.08267	-0.05234	-0.08347	-0.05167
1.4	0	0	-0.09685	-0.04102	-0.09772	-0.04037
1.6	0	0	-0.10994	-0.03187	-0.11087	-0.03128
1.8	0	0	-0.12219	-0.02433	-0.12319	-0.02376
2	0	0	-0.1336	-0.01798	-0.13465	-0.01741
2.2	0	0	-0.14439	-0.0125	-0.14551	-0.01195
2.4	0	0	-0.15467	-0.00771	-0.15585	-0.00719
2.6	0	0	-0.16451	-0.00356	-0.16575	-0.00307
2.8	0	0	-0.17392	-0.00023	-0.17522	-1.6E-05
3	0	0.010836	-0.18295	-4.30E-07	-0.18432	-4.30E-07

\* gamma - log odds of differential assignment due to unobserved factors  
sig+ - upper bound significance level  
sig- - lower bound significance level  
t-hat+ - upper bound Hodges-Lehmann point estimate  
t-hat- - lower bound Hodges-Lehmann point estimate  
CI+ - upper bound confidence interval (a= .95)  
CI- - lower bound confidence interval (a= .95)

Figure 14: Weighted taxable profits relative to total assets by the global ultimate owner of the foreign multinational group, foreign multinational subsidiaries. Selected sample, 2000 - 2011.



## 7.2 Regression analysis

The propensity score matching results can be directly compared to OLS estimates. The difference in the unconditional mean of taxable profits to total assets between foreign multinational subsidiaries and domestic standalones can be estimated using an OLS regression of taxable profits scaled by total assets on the left hand side on a multinational dummy and further control variables on the right hand side:

$$y_{it} = \alpha + \beta_1 \text{multinational}_i + \gamma X_{it} + \delta \text{ind}_i + \zeta_t + u_{it} \quad (3)$$

In these regressions the main variable of interest is  $\text{multinational}_i$ , which is a time-invariant dummy equal to one if the company is a multinational and 0 otherwise. Specifically, in the case of regressions on the sample of foreign multinational subsidiaries and domestic standalones, multinational dummy reflects being a foreign multinational subsidiary. With the dependant variable,  $y_{it}$ , being the ratio of taxable profits to total assets for firm  $i$  in year  $t$ , the coefficient  $\beta_1$  on the multinational dummy will tell me what is the difference in the taxable profits to total assets ratio between domestic standalones and foreign multinational subsidiaries. The vector  $X_{it}$  controls for total assets (size measure) of the company.  $\delta \text{ind}_i$  and  $\zeta_t$  are year and industry fixed effects. The constant in this type of regression would give a mean taxable profits to total assets ratio for domestic standalones.

The coefficient on the multinational dummy in these type of regression without any controls will give an estimate of the total size of the difference between foreign multinational subsidiaries and domestic standalones. Inclusion of fixed effects and further controls will attribute parts of that difference to observable firm and industry level characteristics. Including flexible form of industry and size variables into the estimation, i.e. controlling for size and industry in the full sample would bring the coefficient on the multinational dummy closer to the PSM estimates of the difference. When we restrict the sample on which such OLS regression is run to propensity score matched sample and use multinational dummy as the only explanatory variable, the coefficient on that multinational dummy will be equivalent to the ATT estimated by the PSM.

Similar to PSM, we can utilize the decomposition of the unconditional mean into conditional one and the binary outcome. Therefore I run the OLS regression on the positive taxable profits only using both full and propensity score matched samples. I also estimate a binary regression model for the likelihood of reporting zero taxable profits depending on the ownership status. I estimate the following equation:

$$d_{it} = \alpha + \varphi_1 \text{multinational}_i + \varphi X_{it} + \delta \text{ind}_i + \zeta_t + \epsilon_{it}. \quad (4)$$

where  $d_{it}$  is a dummy equal to 1 when a company reports taxable profits to be zero and zero otherwise and other variables defined as in equation x. I estimate this binary model using linear probability model (OLS) and maximum likelihood estimate (probit). I include leverage and other possible determinants of zero taxable profit reporting that I discussed in the descriptive statistics. This estimation is designed to understand what determines the zero taxable profit reporting behaviour of companies. One could also interact the explanatory variables with the multinational dummy to understand the differences between determinants for foreign multinational and domestic standalone companies.<sup>63</sup>

### 7.2.1 Results from OLS and LDV specifications

In this section I show the results from the unconditional (Table 21) and conditional (Table 22) OLS estimations of the mean difference in taxable profits to total assets as well as limited dependant variable estimations of the zero taxable profit reporting determinants (Table 23).

The results from the OLS estimates (Table 21) on the unrestricted sample of foreign multinational subsidiaries and domestic standalones suggest a large difference between the ownership types in terms of taxable profits relative to total assets. The coefficient on the multinational dummy in the regression of the ratio of taxable profits to total assets on multinational dummy is the total extent of the difference between foreign multinational subsidiaries and domestic standalones; this is 52.3 percentage points (column 1). This is partially explained by industry fixed effects (column 2) and size differences (column 3). As in the propensity score matching estimates about 40 percent of the difference between the analyzed ownership types is explained by differences in leverage (column 4), where the coefficient on multinational dummy decreases substantially. Inclusion of total factor productivity (column 5) halves the coefficient on the multinational dummy, but this is primary due to sample composition. Controlling for capital allowances ratio to total assets (column 6) does not change the size of the coefficient on the multinational dummy.

In columns 7 - 10 instead of including linear function of size, I include size bins, which is more similar to what propensity score matching does. It turns out that controlling for size bins the coefficient on the multinational dummy declines substantially (column 7) suggesting that larger multinationals report even lower taxable profits than the ones

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<sup>63</sup>For more detailed analysis of loss making behaviour of UK companies please see Arulampalam, Guceri and Devereux (2016). Also, more information on the empirical methodology used to determine the zero taxable profits behaviour of companies is given in section 4.



for which we can find comparable domestic standalones. Inclusion of leverage (column 8) and TFP again reduce the coefficient further while capital allowances do not alter it. In column 11 I provide the results from running OLS without any controls on the PSM matched sample, as in the baseline regression. The coefficients are identical to the PSM estimates and are included for comparison purposes. The constant from that OLS regression is the mean taxable profits divided by total assets for domestic standalones - control group - in the PSM results table.

Limiting the sample to positive taxable profits (Table 22) the results looks very similar to the ones with unconditional mean taxable profits to total assets. This suggests that in the unrestricted sample, the difference between foreign multinational subsidiaries and domestic standalones still exists and it is only when we use bins of total assets to control for size differences (column 7-10) that it disappears. The coefficients on multinational dummy become insignificant and get smaller in column 7 and including further controls for leverage, TFP and capital allowances reduces the coefficient to be almost zero and insignificant.

In Table 23 I present results from estimating the limited dependant variable model via OLS (the results using probit models are not significantly different).<sup>64</sup> I am interested in the coefficient on the multinational dummy that will tell me how much more likely it is for a foreign multinational subsidiary to report zero taxable profits relative to a domestic standalones. In all cases the coefficient of interest is positive and significant implying that foreign multinational subsidiaries report taxable profits to be zero significantly more often than domestic standalones companies.

Table 20: Definitions of control variables used in LDV and in Heckman estimations.

<b>variable</b>	<b>definition</b>
liabilities_ta	total liabilities divided by total assets
ztp2yrs	zero taxable profits reported in at least last 2 out of 3 years; dummy 1 or 0
previous_losses_ta	dummy 1 if company has brought in forward losses from previous year to claim against taxable profits this year
guo_stattau	statutory tax rate in the country of global ultimate owner
lastyr_loss	dummy 1 if company reported zero taxable profits last year
tax_haven	dummy 1 if the global ultimate owner is located in tax haven
Ln_trading_turnover	logarithm of trading turnover (box 1) from CT600 data

These results are interesting in so far as in columns 2 - 9 in both tables I explore

<sup>64</sup>Running the LDV models on the PSM sample generate very similar results. The results are available upon request.

potential factors that could be determining the likelihood of reporting zero taxable profits. Table 20 defines each of the variables used. I find that higher leverage, bringing losses forward from the previous period, reporting taxable profits to be zero in at least last 2 out of 3 years, reporting zero taxable profits in the previous year and parent company located in tax haven increase the likelihood of reporting zero taxable profits. What is more, the higher the tax rate in the parent company and the higher the trading turnover, the less likely a company is to report zero taxable profits in the UK. When put together, the results on previous years losses and previous years zero taxable profit reporting remain significant, which would suggest that persistency in reporting zero taxable profits is more important than any observable firm level characteristics. The evidence on leverage and tax haven parent are broadly consistent with what the PSM results and descriptive statistic show. They confirm that both leverage and the presence of tax haven parents affect the zero taxable profit reporting behaviour of companies as well.<sup>65</sup>

What is more, for the binary part, the difference between the matched (smaller) foreign multinational subsidiaries and the matched (larger) domestic standalones companies is very similar to the difference between all foreign multinational subsidiaries and all domestic standalones (PSM matching coefficient was 31.7 vs column 1 Table 23 31.6). For the ratio of taxable profits to total assets, the difference between the matched sub-samples is much smaller than the difference in the full sample (Table 21 column 1 vs 11). This contrast suggests that the differences in the propensity to report zero taxable profits are not so important in explaining differences in the ratio of taxable profits to total assets between matched (smaller) foreign multinational subsidiaries and unmatched (larger) foreign multinational subsidiaries and between matched (larger) domestic standalones and unmatched (smaller) domestic standalones.

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<sup>65</sup>I can interact each explanatory variable to with the multinational dummy to see whether their effects differs depending on which ownership category the company belongs to. The results are available upon request. They show that there are differences between determinants between ownership categories but each of the variables discussed in Table 25 is significant for both of the ownership groups.

Table 21: Results from OLS estimation, unconditional means; foreign multinational subsidiaries and domestic standalones, Selected sample, 2000 - 2011.

VARIABLES	1	2	3	4	5	6	7	8	9	10	11
	all obs	all obs	all obs	all obs	all obs	all obs	all obs	all obs	all obs	all obs	all obs
multinational	-0.523***	-0.469***	-0.469***	-0.284***	-0.129***	-0.129***	-0.170***	-0.109***	-0.047***	-0.047***	-0.128***
	-0.082	-0.084	-0.084	-0.052	-0.029	-0.029	-0.043	-0.025	-0.009	-0.009	-0.027
total_assets			-0.000*	-0.000**	-0.000***						
	0.000	0.000	0.000	0.000	0.000			0.000	-0.002*	-0.002*	
liabilities_ta				0.000	0.000	0.000		0.000	-0.001	-0.001	
				0.000	0.000	0.000		0.000	-0.002***	-0.002***	
TFP_Solow				-0.003***	-0.003***			0.000	0.000	0.000	
				-0.001	-0.001			0.000	0.000	0.000	
capallowance				0.000	0.000			0.000	0.000	0.000	
				0.000	0.000			0.000	0.000	0.000	
2.pct_totass				-0.473***	-0.377***	-0.592***	-0.473***	-0.377***	-0.592***	-0.592***	
				-0.082	-0.047	-0.102	-0.082	-0.047	-0.102	-0.102	
3.pct_totass				-0.852***	-0.708***	-0.977***	-0.852***	-0.708***	-0.977***	-0.977***	
				-0.088	-0.056	-0.118	-0.088	-0.056	-0.118	-0.118	
4.pct_totass				-1.006***	-0.851***	-1.093***	-1.006***	-0.851***	-1.093***	-1.093***	
				-0.103	-0.072	-0.130	-0.103	-0.072	-0.130	-0.130	
5.pct_totass				-1.038***	-0.901***	-1.175***	-1.038***	-0.901***	-1.175***	-1.175***	
				-0.105	-0.076	-0.125	-0.105	-0.076	-0.125	-0.125	
Constant	0.617***	0.425***	0.425***	0.161***	0.148***	0.148***	1.182***	0.966***	1.297***	1.297***	0.252***
	-0.085	-0.022	-0.022	-0.013	-0.033	-0.033	-0.061	-0.071	-0.129	-0.129	-0.029
Observations	3,117,744	3,117,744	3,117,744	1,150,615	70,325	70,325	3,117,744	1,150,615	70,325	70,325	299,162
R-squared	0.003	0.012	0.012	0.066	0.079	0.079	0.026	0.152	0.247	0.247	0.000
Industry FE	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO
Year FE	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO
St err cluster	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Type of matching	-	-	-	-	-	-	-	-	-	-	propensity score

Table 22: Results from OLS estimation, conditional means; foreign multinational subsidiaries and domestic standalones, Selected sample, 2000 - 2011.

VARIABLES	1	2	3	4	5	6	7	8	9	10	11
	pos profits	pos profits	pos profits	pos profits	pos profits	pos profits	pos profits	pos profits	pos profits	pos profits	pos profits
multinational	-0.606*** -0.086	-0.475*** -0.086	-0.475*** -0.086	-0.287*** -0.051	-0.052** -0.023	-0.052** -0.023	-0.052 -0.045	-0.055*** -0.019	-0.005 -0.009	-0.005 -0.009	-0.019 -0.028
total_assets											
liabilities_ta				0.000 0.013*** 0.000	0.000 0.031 -0.019	0.000 0.031 -0.019		0.012*** -0.001	0.016 -0.017	0.016 -0.017	0.016 -0.017
TFP_Solow					-0.034*** -0.006	-0.034*** -0.006			-0.010*** -0.002	-0.010*** -0.002	-0.010*** -0.002
capallowance										0.000** 0.000	0.000** 0.000
2.pct_totass							-1.102*** -0.069	-0.930*** -0.030	-0.946*** -0.125	-0.946*** -0.125	-0.946*** -0.125
3.pct_totass							-1.611*** -0.077	-1.381*** -0.048	-1.402*** -0.133	-1.402*** -0.133	-1.402*** -0.133
4.pct_totass							-1.816*** -0.095	-1.575*** -0.064	-1.552*** -0.146	-1.552*** -0.146	-1.552*** -0.146
5.pct_totass							-1.893*** -0.098	-1.653*** -0.067	-1.650*** -0.136	-1.650*** -0.136	-1.650*** -0.136
Constant	0.831*** -0.098	-2.674*** -0.057	-2.674*** -0.057	0.182*** -0.016	0.796*** -0.067	0.796*** -0.067	2.143*** -0.052	1.797*** -0.068	1.900*** -0.144	1.900*** -0.144	0.283*** -0.035
Observations	2,226,637	2,226,637	2,226,637	828,437	40,515	40,515	2,226,637	828,437	40,515	40,515	144,626
R-squared	0.001	0.012	0.012	0.141	0.149	0.149	0.041	0.306	0.338	0.338	0.000
Industry FE	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO
Year FE	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO
St err cluster	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Type of matching	-	-	-	-	-	-	-	-	-	-	propensity score

Table 23: Results from limited dependant variable estimation, foreign multinational subsidiaries and domestic standalones, Selected sample, 2000 - 2011; columns 1 - 4 OLS coefficients from linear probability model (LPM), columns 5-8 coefficients from probit model.

VARIABLES	1	2	3	4	5	6	7	8	9
multinationalnew	0.316*** (0.030)	0.309*** (0.028)	0.185*** (0.019)	0.324*** (0.030)	0.311*** (0.027)	0.286*** (0.031)	0.314*** (0.031)	0.410*** (0.024)	0.194*** (0.011)
liabilities_ta		0.000** (0.000)							0.000* (0.000)
ztp2yrs			0.520*** (0.004)						0.404*** (0.008)
previous_losses_ta				0.011*** (0.004)					-0.004 (0.003)
guo_stattau					-0.124*** (0.036)				-0.031 (0.028)
lastyr_loss						0.416*** (0.013)			0.212*** (0.006)
tax_haven							0.020** (0.010)		0.007 (0.011)
ln_trading_turnover								-0.055*** (0.004)	-0.016*** (0.001)
Constant	0.626*** (0.010)	0.234*** (0.013)	0.478*** (0.007)	0.900*** (0.044)	0.897*** (0.016)	0.549*** (0.007)	0.678*** (0.008)	1.103*** (0.042)	0.234*** (0.018)
Observations	3,205,555	1,150,615	3,205,555	3,117,744	456,125	3,205,555	2,974,833	2,834,906	167,367
R-squared	0.059	0.065	0.228	0.061	0.123	0.169	0.062	0.091	0.315
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
St err cluster	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	NO	NO	NO	NO	NO	NO	NO	NO	NO
Type of matching	-	-	-	-	-	-	-	-	-

### 7.3 Selection Models

Descriptive statistics and propensity score matching have revealed that the explanation for the differences in taxable profits relative to total assets between matched foreign multinational subsidiaries and matched domestic standalones lies in the binary part of the distribution. The fact that the coefficient on the multinational dummy from the binary regressions is shown to be significant suggests that the estimate of the mean difference in taxable profits relative to total assets between foreign multinational subsidiaries and domestic standalones from a simple OLS regression may be inconsistent and downward biased. There seems to be selection of companies into zero and positive taxable profit reporting groups, which suggests that the more appropriate model to be estimated is a selection type, such as Heckman, which takes into account the bounded nature of the data. This type of model will allow me to disentangle the importance of the extensive and intensive margins for taxable profit reporting differences between ownership types. There are two choices here, either a simple censored regression model, such as Tobit (Tobin (1956)), or a more sophisticated selection model, such as Heckman (Heckman (1974), Heckman (1976)).

Tobit models assume that there is an unobservable latent variable  $y_{it}^*$ , which linearly depends on  $X_{it}$  via a parameter  $\gamma$ . In addition, there is a normally distributed error term  $u_{it}$ . The observable variable  $y_{it}$ , in my case the ratio of taxable profits to total assets, is defined to be equal to the latent variable whenever the latent variable is above zero and zero otherwise.

$$y_{it} = \begin{cases} y_{it}^* & \text{if } y_{it}^* > 0 \\ 0 & \text{if } y_{it}^* \leq 0 \end{cases} \quad (5)$$

where  $y_{it}^*$  is defined as :

$$y_{it}^* = \alpha + \beta_1 \text{multinational}_i + \gamma X_{it} + \delta \text{ind}_i + \zeta_t + u_{it}. \quad (6)$$

This is the same equation as the one estimated for the OLS model of taxable profits divided by total assets. A company can choose to report zero or positive taxable profits, the choice of which is determined by their profitability as well as propensity to aggressively avoid tax. In case of Tobit models the latent variable absorbs both the process of reporting positive vs zero profits and the 'outcome' of interest. Therefore both processes are determined by the same parameters. For a continuous variable from the vector  $X_{it}$  the partial effects of that variable in the zero taxable profit reporting equation,  $P(y_{it} > 0|x)$ , and its effect in the outcome equation  $E(y|x, y > 0)$  have the same sign. Therefore it

is impossible for an explanatory variable to have a positive effect of the likelihood of making positive taxable profits, but negative effect on how much profits the company makes in general. This is quite a large limitation of the Tobit approach and in the case of comparing the taxable profits of foreign multinational subsidiaries with those of domestic standalones might be crucial. This is because the baseline OLS and Probit model suggest that being a multinational has an effect on both the binary (extensive) and continuous (intensive) parts of the distribution. As such, it seems to be of primary importance to understand which part drives the difference in taxable profits between the two ownership types.

An alternative to Tobit that allows to separate the two margins is an estimation of Heckman selection model, which introduces a second latent variable that allows the process of reporting zero taxable profits and the outcome to be independent from each other, conditional on  $x$ .

$$y_{2it} = \begin{cases} y_{2it}^* & \text{if } y_{1it}^* > 0 \\ 0 & \text{if } y_{1it}^* \leq 0 \end{cases} \quad (7)$$

Using Heckman selection model the variables determining whether the company reports a positive profit are separate from variables determining how much profit the company is reporting once it decides to do so at all. Therefore the first equation would determine why companies report positive profits

$$(1)y_{1it}^* = \beta z_{it} + e_{it} \quad (8)$$

$$(2)d_{it} = 1 \text{ if } y_{1it}^* > 0 \text{ and } d_{it} = 0 \text{ if } y_{1it}^* \leq 0 \quad (9)$$

where  $y_{1it}^*$  is a latent variable indicating the utility from reporting taxable profits,  $d_{it}$  is an indicator for profit reporting status, the  $z_{it}$  denotes the determinants of this status,  $\beta$  is a vector of associated parameter estimates, and  $e_{it}$  is an error term having a standard normal distribution.

The second equation involves estimating an regression of taxable profits scaled by total assets conditional on  $d_{it} = 1$  and a vector of explanatory variables  $x_{it}$ . This would be the same equation as the one estimated in the OLS model

$$y_{2it} = \alpha + \beta_1 \text{multinational}_i + \gamma X_{it} + \delta_{indi} + \zeta_t + u_{it}. \quad (10)$$

The model, which comprises an equation determining sample selection and a regression model, can be estimated jointly using the maximum likelihood technique, with  $(e_{it}, u_{it})$  assumed to be bivariate normal. For identification purposes estimating Heckman selection model requires at least one variable in the first stage (part of  $z_{it}$ ) that is not a determinant in second stage (not part of  $x_{it}$ ).

Crucially, the distinction between (Heckman) selection models and (Tobit) censored regression models could be important if there is heterogeneity within the sample of multinationals, for example between 'aggressive tax avoiders' (who reported zero taxable profits most of the time) and 'unsophisticated tax planners' (who report zero taxable profits no more frequently than domestic standalones). In that case the binary part of the selection model is where the differences lay and that would be reflected appropriately in a selection model, but not in a Tobit.

This suggest that including dummies for (e.g.) reporting zero taxable profits in at least 2 of the last 3 years in the probit part of the Heckman procedure, could help identification. Further variables that could be considered as identifying factors in the first stage regression can be for example the presence of a tax haven parent which determines whether a company is an aggressive tax avoider. This will affect whether it decides to report any profits in the UK or whether it shifts everything to, for example, its tax haven headquarter. The presence of the tax haven parent per se does not affect the profitability of the company in the UK. Another variable that I could potentially use in  $z_{it}$  could be last years losses carried forward. In box 4 in the tax return form, each company has to report whether is has any losses from previous periods that it wants to use to offset against taxable profits in this period. They affect whether the company reports zero taxable profits as it can use those losses to reduce its taxable profits, but they do not affect how much profit the company made this year. Additionally, I use the average industry turnover, which is a business cycle approximation that would affect the proportion of companies reporting zero taxable profits in a particular year. Average industry turnover is calculated for each year and each 2 digit industry code using mean trading turnover from the CT600 data.

I use those four variables together with total assets in the first stage equation that determines whether a company reports zero or positive profits ( $z_{it}$ ). In the second stage equation I use the same variables as in the case of OLS model.

### **7.3.1 Results from Heckman selection model specifications**

Tables 24 and 25 show the results from estimating Heckman selection model. Table 24 shows second stage marginal effects while Table 25 shows first stage coefficients from the binary part of the distribution. Note that in the first stage regressions the zero taxable profits dummy is coded as 1 when positive taxable profits arise (reverse of what it was



before). This is due to the specific nature of the Heckman selection model, whereby in the first stage one lists determinants of reporting continuous positive profits. Therefore negative coefficients shown in Table 25 correspond directly to the positive ones from LDV regressions.

Columns 1-3 estimate the model using unrestricted and then manually matched samples of foreign multinational subsidiaries and domestic standalones, while columns 4- 8 use the propensity score matched sample (without replacement) but experiment with various sets of the explanatory variables defined above in the first stage regression.

Firstly, in most of the estimations the inverse mills ratio - lambda (which estimates the significance of the selection problem) is significant suggesting that selection into reporting positive taxable profits is indeed an issue in my data. The most important feature of tables 24 and 25 is that the estimate of the coefficient on the multinational dummy is larger and always significant in the first stage regression. This suggests that being a multinational significantly negatively affects whether the company will report any taxable profits in the UK. Once it does so, being a multinational reduces taxable profits relative to total assets reported relative to domestic standalone in unrestricted and manually matched samples only. When I use comparable companies as matched through PSM, the coefficient on the multinational dummy in the second stage becomes insignificant. This suggests that being a multinational no longer matters once you report positive taxable profits (columns 4 and 5). What is more, column 1 results from second stage suggest that larger (unmatched) foreign MNCs report lower ratio of taxable profits to total assets than smaller (unmatched) domestic standalone, conditional on reporting positive taxable profits.

When the coefficients from the first stage regressions are converted to marginal effects, their magnitude oscillates around 0.3, which means that they are very similar to the ones obtained as outcome variables in PSM.

In columns 6 - 8 I use dummies signifying zero taxable profit reporting last year (*ztp\_11*), zero taxable profit reporting 2 years ago (*ztp\_12*) etc. However, the coefficient on lambda is insignificant here, which would suggest that selection is not a problem anymore. In columns 6-8 the coefficient on a multinational dummy in the second stage of Heckman selection model is marginally significant and negative which would suggest that being a multinational marginally reduces the taxable profits of positive taxable profit reporting companies relative to domestic standalones. Importantly, this coefficient is much smaller and much less significant than the one from the first stage regression on the binary part of the distribution.

The results shown here broadly confirm earlier impression of little or no difference between matched (smaller) foreign MNCs and matched (larger) domestic standalones, conditional on reporting positive taxable profits. In turn, the results from first stage show that being a multinational matters for reporting zero taxable profits.

Table 24: Results from Heckman estimation, second stage marginal effects, foreign multinational subsidiaries and domestic standalones, Selected sample, 2000 - 2011.

VARIABLES	(1) Heckman	(2) Heckman	(3) Heckman	(4) Heckman	(5) Heckman	(6) Heckman	(7) Heckman	(8) Heckman
multinational	-0.281*** (0.007)	-0.286*** (0.007)	-0.203*** (0.008)	0.002 (0.011)	-0.005 (0.010)	-0.024*** (0.009)	-0.018* (0.010)	-0.018** (0.009)
Observations	2,894,020	2,868,221	2,718,025	488,431	488,431	488,431	521,234	521,234
Industry FE	YES	YES	YES	YES	NO	NO	NO	NO
Year FE	YES	YES	YES	YES	NO	NO	NO	NO
St err cluster	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	NO	NO	NO	NO	NO	NO	NO	NO
Type of matching	-	min max	1 percentile	propensity score	propensity score	propensity score	propensity score	propensity score

Table 25: Results from Heckman estimation, first stage coefficients, foreign multinational subsidiaries and domestic standalones, Selected sample, 2000 - 2011. Columns 5-8 propensity score matched sample without replacement.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
multinational	-0.936*** (0.004)	-0.911*** (0.004)	-0.758*** (0.004)	-0.769*** (0.004)	-0.769*** (0.004)	-0.651*** (0.005)	-0.774*** (0.004)	-0.673*** (0.004)
ln_total_assets	0.071*** (0.000)	0.080*** (0.000)	0.072*** (0.001)	0.018*** (0.001)	0.018*** (0.001)	0.029*** (0.001)	0.027*** (0.001)	0.030*** (0.001)
zip2yrs	-1.138*** (0.002)	-1.132*** (0.002)	-1.119*** (0.003)	-1.176*** (0.005)	-1.176*** (0.005)	0.132*** (0.012)	-1.343*** (0.005)	
avg_indyrtturnover	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)		
previous_losses_ta	-0.001 (0.001)	-0.000 (0.001)	-0.000 (0.001)	0.002* (0.001)	0.002* (0.001)	0.005*** (0.001)		
tax_haven	-0.011 (0.008)	-0.029*** (0.008)	-0.033*** (0.010)	-0.055*** (0.008)	-0.055*** (0.008)	-0.052*** (0.008)		
lastyr_loss	-0.777*** (0.002)	-0.785*** (0.002)	-0.809*** (0.002)	-0.514*** (0.005)	-0.514*** (0.005)	0.170*** (0.007)		
zip_11						-1.473*** (0.007)		-1.359*** (0.005)
zip_12						-0.400*** (0.009)		-0.327*** (0.006)
zip_13						-0.185*** (0.008)		-0.147*** (0.007)
zip_14						-0.078*** (0.008)		-0.084*** (0.007)
zip_15						-0.071*** (0.008)		-0.075*** (0.008)
zip_16						-0.074*** (0.008)		-0.078*** (0.008)
lambda	-0.075*** (0.010)	-0.024** (0.011)	-0.161*** (0.011)	-0.108*** (0.028)	-0.093*** (0.028)	-0.017 (0.024)	-0.009 (0.028)	-0.009 (0.023)
Constant	0.230*** (0.005)	0.143*** (0.005)	0.241*** (0.006)	0.858*** (0.013)	0.858*** (0.013)	0.827*** (0.014)	0.648*** (0.012)	0.815*** (0.013)
Observations	2,894,020	2,868,221	2,718,025	488,431	488,431	488,431	521,234	521,234
Industry FE	YES	YES	YES	YES	NO	NO	NO	NO
Year FE	YES	YES	YES	YES	NO	NO	NO	NO
St err cluster	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	NO	NO	NO	NO	NO	NO	NO	NO
Type of matching	-	min max	1 percentile	propensity score	propensity score	propensity score	propensity score	propensity score