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# Earnings shocks and tax-motivated income-shifting: Evidence from European multinationals

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ABSTRACT

This paper presents a new approach to estimating the existence and magnitude of tax-motivated income shifting within multinational corporations. Existing studies of income shifting use changes in corporate tax rates as a source of identification. In contrast, this paper exploits exogenous earnings shocks at the parent firm and investigates how these shocks propagate across low-tax and high-tax multinational subsidiaries. This approach is implemented using a large panel of European multinational affiliates over the period 1995–2005. The central result is that parents' positive earnings shocks are associated with a significantly positive increase in pretax profits at low-tax affiliates, relative to the effect on the pretax profits of high-tax affiliates. The result is robust to controlling for various other differences between low-tax and high-tax affiliates and for country-pair-year fixed effects. Additional tests suggest that the estimated effect is attributable primarily to the strategic use of debt across affiliates. The magnitude of income shifting estimated using this approach is substantial, but somewhat smaller than that found in the previous literature.



## 1. Introduction

In recent years, global economic integration has been associated with increasing activity by multinational enterprises (MNEs). Over the period 1990–2006, for example, global foreign direct investment (FDI) by MNEs grew at an annual rate of 12.4%, much faster than the 5% annual rate of economic growth, and global FDI flows totalled $1.3 trillion in 2006 (UNCTAD, United Nations Conference on Trade and Development, 2007). Thus, the effects of tax systems on MNEs are of growing interest and importance to scholars and policymakers. Differences across countries in tax rates and systems create opportunities for tax arbitrage by MNEs, in particular through the strategic choice of transfer prices for goods and services traded among affiliates and through the strategic use of debt financing across affiliates.[1] Anecdotal and empirical evidence suggests that MNEs avail themselves of these opportunities to shift profits from high-tax to low-tax jurisdictions.

In response, policymakers in many countries have sought to limit profit shifting activities through the introduction of transfer pricing regulations (e.g. Ernst and Young, 2010) and thin-capitalization rules (e.g. Buettner et al., forthcoming). The perceived problem of cross-border income shifting has also given rise to proposals for more fundamental reforms of the current system of international corporate taxation. In 2001, the European Commission proposed the abolition of separate accounting rules for corporate taxation of MNEs within the borders of the European Union (EU), to be replaced by a system of profit consolidation and formula apportionment (European Commission, 2001). Avi Yonah and Clausing (2008) also propose a system of formula apportionment for Federal corporate taxation by the United States. Both these proposals are motivated by a desire to limit the opportunities for profit shifting that are believed to exist under current rules.

The empirical identification of the existence and magnitude of tax-motivated profit shifting is inherently fraught with difficulty. Most existing studies thus pursue an indirect identification strategy that measures the impact of variations in corporate tax rates on the profitability of multinational subsidiaries (e.g. Grubert and Mutti, 1991; Hines and Rice, 1994; Huizinga and Laeven, 2008). A small number of papers pursue more direct approaches that examine the effect of corporate tax rate changes on specific profit shifting channels, in particular on distortions of transfer prices and the debt-equity structure.[2] All of these existing studies rely on identification through variation in corporate tax rates. While statutory corporate tax rate changes are likely to be exogenous

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[1] In particular, MNEs have an incentive to charge relatively low prices for goods and services transferred from high-tax to low-tax affiliates, and to finance the activities of high-tax affiliates using debt issued by low-tax affiliates (a practice that is sometimes termed "earnings stripping"). See, for example, Dharmapala (2008) for a simple discussion of these strategies.

[2] Swenson (2001), Clausing (2003) and Bartelsman and Beetsma (2003) investigate how corporate tax rates affect the choice of intra-firm transfer prices. While Swenson's study finds only small effects, Clausing (2003) and Bartelsman and Beetsma (2003) report substantial responses of transfer prices to corporate taxes. Buettner and Wamser (2007) analyze how tax rate changes affect the corporate debt-equity structure and find significant although quantitatively small effects that are consistent with the profit shifting hypothesis.

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with respect to firms' behavior, interpreting the estimated impact of corporate tax rate changes may not be straightforward for a number of reasons. Corporate tax rate changes impose a common shock to all firms in a country, and so may potentially be correlated with unobserved variables that also determine the profitability, transfer prices, and financing choices of MNEs. In addition, changes in the corporate tax rate may not only affect the MNE's incentive to engage in profit shifting, but may also impact other decision margins. A rise in the corporate tax rate may, for example, dampen incentives to exert effort and consequently lower corporate profitability.

In the existing literature (e.g. Weichenrieder, 2009), such potential confounding effects have been addressed by focusing on the tax rate differential between the home country (the location of the parent firm) and the host country (the location of the affiliate). Because the tax differential can change due to statutory tax rate changes in either country, this approach can potentially control for country-year effects (e.g. unobserved effects common to all MNE affiliates in Slovakia in 1998). However, it has not been possible in previous studies to control for unobserved country-pair-year effects – e.g. unobserved effects common to all Slovak affiliates of German parents in 1998 – as these are perfectly collinear with the tax differentials. Moreover, statutory tax rate changes tend to be relatively infrequent and episodic rather than continuous. Given the growing importance for public policy of MNE profit-shifting, it would also be valuable to complement the existing studies, all of which use identification strategies based on tax rates, with an analysis using a fundamentally different approach.

This paper develops an alternative approach to analyzing profit shifting behavior among MNEs. Our identification strategy exploits earnings shocks at the parent firm and analyzes how these shocks propagate across the affiliates of a multinational group. If MNEs engage in profit shifting behavior, an exogenous increase in the income of the parent firm should presumably be partially shifted towards affiliates in low-tax jurisdictions, assuming that the MNE has arranged its affairs so that some given fractions of the parent's profits are shifted. A simple theoretical model developed below shows that, under a very general formulation of the costs of profit shifting, the amount of profit shifted from the (high-tax) parent firm to low-tax affiliates is larger the higher are the parent's profits, for a given difference in the tax rates faced by the parent and the low-tax affiliate.

Of course, there are many reasons other than tax-motivated profit shifting – such as risk sharing within the MNE, or the operation of internal capital markets – for the propagation of earnings shocks through a multinational group. These alternative explanations, however, would (at least to a first approximation) apply to both high-tax and low-tax affiliates. This suggests an identification strategy that focuses on the shifting of exogenous earnings shocks at the parent firm to low-tax subsidiaries, *relative* to the corresponding shifting of exogenous earnings shocks at the parent firm to high-tax subsidiaries.

The challenge for this approach is of course to isolate a source of exogenous shocks to the income of the parent firm. We adapt for this purpose an approach developed in a different context by Bertrand et al. (2002) and construct an expected earnings shock variable based on the earnings of firms that operate in the same industry and the same country as the parent firm.[3] This provides a measure of the parents' exogenous income before taxes and before profit shifting activities. To construct these earnings shocks, we use a large European micro dataset (the AMADEUS data from the Bureau van Dijk) which provides detailed accounting and ownership information on 1.6 million firms within the countries of the EU. The data is provided in panel format and allows us to link information on parent firms and their subsidiaries. Importantly, the AMADEUS data is unconsolidated (i.e. data is reported separately for each affiliate, rather than being consolidated across the entire MNE). The analysis focuses on the impact on a multinational affiliate's income of an exogenous shock to its parent's income. The sample – which consists of over 18,000 observations on approximately 4800 multinational affiliates over the period 1995–2005 – is restricted to affiliates that operate in a different industry and country from their parent firms, so that the earnings shocks experienced by the parents do not directly impact the affiliates.

Our results show strong support for the profit shifting hypothesis. While the effect of earnings shocks at the parent firm on the income of high-tax affiliates is indistinguishable from zero, we find a significantly positive impact of earnings shocks at the parent firm on the income of low-tax affiliates (relative to the effect on the income of high-tax affiliates). This basic result is robust to the use of affiliate, year, industry-year, country-year, and country-pair-year fixed effects. The result also cannot be attributed to a number of potential alternative explanations relating to nontax differences between low-tax and high-tax affiliates (including differences in their industrial composition, differences in the degree of correlation between the economies of their host countries and those of their parents, and differences in the strength of the financial system in their host countries). Quantitatively, the estimates suggest that at the margin around 2% of additional parent earnings are shifted to low-tax subsidiaries. While substantial, this magnitude is somewhat smaller than that found in the previous literature.

Additional tests suggest that the estimated effect is attributable primarily to the strategic use of debt across affiliates. Unfortunately, AMADEUS does not separately report inter-affiliate and external debt, and so a direct test of debt-shifting is not possible. However, the financial income (which includes net interest payments, but excludes operating income) of low-tax affiliates increases relative to that of high-tax affiliates in the wake of positive parent earnings shocks. In contrast, there is no such effect for operating income. Moreover, the debt-to-asset ratio of parent firms responds more positively to positive parent earnings shocks when more of the parent's subsidiaries are located in low-tax countries.

The intuition underlying our approach extends beyond earnings shocks experienced by the parent firm — a positive earnings shock experienced by any high-tax affiliate should be associated with income shifting to low-tax affiliates. However, because AMADEUS data is restricted to European affiliates, it is not possible to construct worldwide earnings shocks to MNEs. Tests using the available (European) data yield results that are consistent with tax-motivated income shifting, albeit somewhat weaker than those using only earnings shocks experienced by parent firms.

More generally, several factors – including the inability to observe accounting data on tax haven affiliates outside Europe, the inability to observe the income reported to the tax authorities as distinct from accounting income on firms' financial statements, and the use of worldwide tax systems by some countries – potentially create a bias against the paper's findings. Excluding firms located in countries with a low degree of book–tax alignment (and the subsidiaries of parents located in these countries) leads to similar but quantitatively larger results. Excluding subsidiaries of parents located in countries with worldwide tax systems does not substantially affect the results.

The basic results are also robust to a variety of other checks. Thus, our analysis uses a very different approach from that in the previous literature to find support for the profit shifting hypothesis. In particular, we find evidence of profit shifting effects that are substantial in magnitude. That these effects are not larger, however, emphasizes the importance of the economic and legal frictions that constrain tax planning by multinational firms.

[3] Bertrand et al. (2002) use their approach to analyze "tunneling" — the phenomenon of individual or family shareholders who control a group of firms shifting income from those firms in which they own a relatively small stake to those firms in which they own a relatively large stake. This approach has not previously been used to analyze tax-motivated profit shifting. As discussed in Section 5 below, tunneling is unlikely to be of much relevance in our sample, which is restricted mostly to affiliates that are wholly-owned by their parents. Moreover, the results are robust to the exclusion of firms with parents based in countries where tunneling may be more likely.

The paper is structured as follows: in Section 2, we present a simple theoretical model to motivate our analysis. Sections 3 and 4 describe the estimation methodology and the data. Section 5 presents our results, and Section 6 concludes.

## 2. A simple theoretical model

In this section, we present a simple theoretical model to motivate our empirical analysis. Consider a representative MNE that consists of affiliates in countries $a$ and $b$. These affiliates earn (exogenous) pre-tax profits $\pi_i$ and face corporate tax rates $t_i$, where $i \in \{a,b\}$. Without loss of generality, we assume that country $a$ is the high-tax country (i.e. $t_a > t_b$). It is also assumed that the MNE's home country has a territorial (or exemption) tax system that does not seek to tax the MNE's profits earned abroad.[4] The MNE can shift accounting profits between the two affiliates, for instance by charging a lower transfer price for goods and services bought by affiliate $b$ from affiliate $a$, or by creating financial arrangements in which affiliate $a$ borrows from affiliate $b$. It is assumed that each country defines taxable income as being identical to accounting income.[5]

The fraction of affiliate $a$'s pre-tax profit that is shifted to the low-tax affiliate $b$ is denoted by $x$. As in the previous literature (e.g. Haufler and Schjelderup, 2000), we assume that profit shifting behavior imposes costs $C$ on the MNE. These costs may be interpreted in a variety of ways, which are not mutually exclusive. For instance, they may be payments for accounting or legal services associated with profit shifting. Of course, it is not generally thought that MNEs engage in egregiously illegal tax evasion. However, they may adopt more or less aggressive tax positions, in relation for example to the arm's-length standard used by many countries for transfer pricing, or to thin-capitalization rules for debt structure. More aggressive positions would, if challenged by the tax authorities, have a lower probability of being sustained by courts (or may require more resources to defend successfully). MNEs may also face negative publicity if their effective tax rates are disseminated by advocacy groups such as the Tax Justice Network. These considerations suggest that the costs of profit shifting are likely to depend on the fraction $x$ of the high-tax affiliate's profits shifted, as well as on the amount of income shifted (denoted here by $y = x\pi_a$).[6] In practice, some of the types of costs noted above may be tax-deductible, while others are not. For simplicity, it is assumed here that $C$ is non-deductible.[7]

In the light of the discussion above, we assume that the cost of profit shifting $C = C(x,y) = C(x, x\pi_a)$ is strictly positive, increasing in each argument, and convex in each argument:

**Assumption 1.**

$$C(.,.) > 0, C_x(.,.) > 0, C_y(.,.) > 0, C_{xx}(.,.) > 0, C_{yy}(.,.) > 0$$

The MNE's worldwide after-tax profits (denoted by $\Pi$) can be expressed as:

$$\Pi = (1-t_a)\ (1-x)\pi_a + (1-t_b)\ (\pi_b + x\pi_a) - C\ (x, x\pi_a) \tag{1}$$

or equivalently as:

$$\Pi = (1-t_a)\ \left(1-\frac{y}{\pi_a}\right)\pi_a + (1-t_b)(\pi_b + y) - C\left(\frac{y}{\pi_a}, y\right) \tag{2}$$

The MNE chooses $x$ (or equivalently $y$) to maximize $\Pi$. Using Eq. (1), the FOC with respect to $x$ is:

$$(t_a - t_b)\pi_a - \frac{\partial C}{\partial x} - \frac{\partial C}{\partial y}\pi_a = 0. \tag{3}$$

Equivalently, using Eq. (2), the FOC with respect to $y$ is:

$$(t_a - t_b) - \frac{\partial C}{\partial x}\frac{1}{\pi_a} - \frac{\partial C}{\partial y} = 0. \tag{4}$$

The comparative statics of this problem imply that the optimal fraction $x$ and the amount of profit shifted ($y$) are both increasing in the tax differential between countries $a$ and $b$:

$$\frac{\partial^2 \Pi}{\partial x \partial (t_a - t_b)} = \pi_a > 0 \text{ and } \frac{\partial^2 \Pi}{\partial y \partial (t_a - t_b)} = 1 > 0. \tag{5}$$

Intuitively, if the tax rate differential between countries $a$ and $b$ increases, the marginal gain from shifting one unit of profit between the affiliates rises and consequently it becomes more attractive to shift profit from the high-tax to the low-tax firm. This is the basic insight underlying the existing literature on income shifting (using tax rate differentials as the source of identification).

The result described above regarding tax rate differentials also holds in a simpler model in which the cost function depends only on the amount of income shifted (i.e. $C = C(y)$). The more general formulation used here (where $C = C(x,y)$) also yields results on how income-shifting responds to changes in affiliate $a$'s pre-tax profit $\pi_a$. The optimal fraction $x$ is increasing in $\pi_a$ if the following expression:

$$\frac{\partial^2 \Pi}{\partial x \partial \pi_a} = (t_a - t_b) - \frac{\partial C}{\partial y} \tag{6}$$

is positive — i.e. if the derivative of the cost of profit shifting with respect to the amount of profit shifted (evaluated at the optimal choice) is sufficiently small in relation to the tax differential between the affiliates. When this condition is satisfied, it is optimal for the MNE to shift a larger fraction of affiliate $a$'s profit to the low-tax affiliate in $b$ when $\pi_a$ increases. This condition, however, is not necessary to derive the result that the amount of profit shifted ($y = x\pi_a$) is increasing in affiliate $a$'s pre-tax profit:

$$\frac{\partial^2 \Pi}{\partial y \partial \pi_a} = \frac{\partial C}{\partial x}\frac{1}{{\pi_a}^2} > 0. \tag{7}$$

As the optimal choice of $y = x\pi_a$ increases in $\pi_a$, even in circumstances in which $x$ falls, it follows that affiliate $b$'s profit before taxes

[4] For instance, if $a$ is the residence country of the parent firm, the assumption is that country $a$ only taxes the domestic profits of affiliate $a$, and not the profits earned in country $b$ by affiliate $b$. Some of the countries in the empirical analysis (Greece, Ireland, and the UK) used worldwide systems of taxation during the sample period (Markle, 2010). Under worldwide taxation, foreign profits are subject to taxation by the home country (in terms of our example, country $a$ taxes profits earned in country $b$). A pure form of worldwide taxation would eliminate the incentive to shift profits. In reality, however, worldwide systems have features – such as the deferral of country $a$'s tax on income earned in $b$ until affiliate $b$ pays a dividend to the parent in country $a$ – that result in incentives for profit shifting. Empirically, the exclusion of parents from worldwide countries does not affect the results, as discussed in Section 5.

[5] That is, both $a$ and $b$ are assumed to be "one-book" countries with systems of book-tax conformity. Most countries in the sample have high levels of book-tax conformity, but some are "two-book" countries in which the definitions of financial and taxable income may diverge. Excluding firms located in these countries leads to somewhat stronger empirical results, as discussed in Section 5.

[6] For example, thin capitalization rules may typically be formulated to require that interest payments are below some fraction of income, or to restrict deductibility of interest when debt exceeds some fraction of assets (e.g. Buettner et al., forthcoming).

[7] The results are not fundamentally affected if the costs are deductible. However, taking account of deductibility adds considerable complexity, as it is not entirely obvious in which country the costs would be incurred, and there would be an incentive to shift these deductions from country $b$ to country $a$.

and after income shifting (i.e. $\pi_b + x\pi_a$) increases with exogenous increases in $\pi_a$.

This last result suggests a new empirical test for income shifting. The results above on the effects of earnings shocks in country $a$ on the pre-tax profit declared by the affiliate in country $b$ are derived under the assumption that the tax rate in country $b$ is lower than the tax rate in country $a$. On the other hand, if country $b$'s tax rate is higher, earnings shocks at the affiliate in country $a$ should have no effect on the pre-tax profit reported in country $b$. This asymmetry implies an identification strategy for our empirical analysis. As profit shifting activities are predicted to show up through a positive effect of earnings shocks on the pre-tax profit level of foreign subsidiaries in low-tax countries only, foreign subsidiaries in high-tax countries can be used as a control group that captures other potential linkages between the pre-tax profits of affiliates in the same multinational group. This approach is described in more detail in the following section.

## 3. Empirical strategy and specification

In the previous section, it was argued that the hypothesis of tax-motivated corporate profit shifting implies that parents' earnings shocks exert a positive impact on profit shifting to subsidiaries with a lower corporate tax rate than the parent firm, relative to the impact on profit shifting to subsidiaries with a similar or higher corporate tax rate than the parent firm. Thus, identifying profit shifting activities involves computing earnings shocks to the multinational parent firm and tracking their propagation among foreign subsidiaries within the same multinational group. Specifically, we expect a positive effect of earnings shocks at the parent firm on the pre-tax profitability of the treatment group (subsidiaries in low-tax countries) compared to the control group (subsidiaries in high-tax countries). Formally, this difference-in-difference approach is captured by the following regression model:

$$\log \pi_{it} = \alpha_0 + \alpha_1 \log a_{it} + \alpha_2 \log \tilde{\pi}_{it} + \alpha_3 (d_{it} \cdot \log \tilde{\pi}_{it}) + \alpha_4 x_{it} + \phi_i + \rho_t + \varepsilon_{it} \quad (8)$$

where the dependent variable is the log of the balance sheet item "profit before taxation". Following the previous literature, we use the log of profits, as the distribution of this variable is highly skewed.

In the baseline analysis, we follow earlier research (e.g. Huizinga and Laeven, 2008) and limit the sample to affiliates with positive pre-tax profits, for which profit-shifting incentives are most likely to be relevant. However, as discussed in more detail in Section 5.3 below, incentives for profit shifting may persist even when the affiliate's income is negative if tax systems allow loss carryforwards and carrybacks. As reported in Section 5.3, the results using an extended sample that includes affiliates with negative income are similar to the baseline results, but somewhat weaker. This is consistent with limitations on loss offsets that exist in most tax systems leading to attenuated incentives for income-shifting.

The explanatory variable of central interest $\tilde{\pi}_{it}$ measures the parent firm's profits before taxes and before shifting activities. The parent's observed pre-tax profit is potentially affected by profit shifting activity, so it is necessary to construct a proxy for "pre-shifting" profits. To do this, we follow the approach developed in a different context by Bertrand et al. (2002). They construct a measure of firms' expected profits before "tunneling" activity (the practice of individual or family shareholders who control a group of firms and shift income from those firms in which they own a relatively small stake to those firms in which they own a relatively large stake). Although tunneling within business groups and tax-motivated profit shifting among MNEs are very different phenomena, it is possible to adapt their approach to construct a measure of expected earnings (prior to any shifting activity) for the parent firm. Specifically, this involves determining the pre-tax profitability of comparable firms which operate in the same 4-digit industry and in the same country. The construction of this variable is described in more detail in the next section.

In the presence of multinational profit shifting activities, this earnings shock at the parent level is expected to exert an asymmetric effect on subsidiaries with lower and higher corporate tax rates than the parent firm. We thus define a dummy variable $d_{it}$ which takes on the value 1 if the subsidiary faces a lower corporate tax rate than the parent firm, and the value 0 otherwise. The results in the previous section imply that we expect a positive coefficient estimate $\alpha_3$ for the interaction of this dummy variable with the parent's expected profit. The sign of the coefficient estimate of the parent's expected profit $\alpha_2$ is a priori undetermined and depends on other potential (e.g. technological and financial) linkages between parent and subsidiary profitability. If, for example, technological advances at the parent firm enhance the profitability of the parent's capital and also positively affect subsidiary productivity, we expect this coefficient to be positive. However, the sign of $\alpha_2$ does not affect the main results.

The constructed shock $\tilde{\pi}_{it}$ may be either positive or negative. A negative shock implies that the parent is predicted to make a loss in pretax and pre-shifting terms. The incentive to shift income to low-tax affiliates is likely to be attenuated for loss-making parents because of the limitations on loss offsets in most tax systems. Thus, the baseline analysis excludes observations for which the parent's constructed shock $\tilde{\pi}_{it}$ is negative. However, a robustness check that adds these observations to the sample leads to results that are similar to the baseline results, but somewhat weaker, as reported in Section 5.3.[8]

The specification in Eq. (8) also accounts for variations in firm size as measured by total assets $a_{it}$. This absorbs potential heterogeneous effects of profit shocks at the parent firm on affiliate investment in high-tax and low-tax countries and implies that the coefficient estimate $\alpha_3$ captures income (as opposed to investment) shifting activities. Moreover, we control for variations in country characteristics over time and include several host country characteristics captured by the vector $x_{it}$ (GDP per capita, population and the host country's corporate tax rate) in the set of regressors.[9] In addition, affiliate fixed effects are included to control for unobserved time-invariant firm characteristics. A full set of year fixed effects are used to control for unobserved shocks over time that are common to all firms in our sample. In some specifications, we augment the model with a full set of industry-year dummies at the two-digit level using the *Nomenclature statistique des activités économiques dans la Communauté Européenne* (NACE) classification, to account for shocks specific to certain industries. We also run specifications which add a full-set of country-year effects to the model and thus control for country-specific shocks over time (and hence for any country-specific trends or variations in the corporate tax rate and corporate tax base definition). Finally, we also run specifications with a full set of country-pair-year effects, where a country-pair consists of the affiliate's country and the parent's country.

Our estimation approach has two main advantages compared to previous papers that identify profit shifting through changes in the corporate tax rate. First, we identify profit shifting behavior by exploiting the rich and continuous variation in the parent's earnings measure rather than relying on infrequent and episodic changes in corporate tax rates. Additionally, the approach allows us to control for unobserved country-year and country-pair-year fixed effects, which was not possible in the previous literature due to the perfect

[8] The basic empirical specification (Eq. (8)) uses the constructed shock $\tilde{\pi}_{it}$ directly as an explanatory variable in the regression. This follows the approach developed by Bertrand et al. (2002), described in more detail in Section 4. An alternative possibility is to use the constructed shock $\tilde{\pi}_{it}$ as an instrument for the observed (post-shifting) profit of the parent. This alternative approach yields results that are very similar to the baseline findings described in Section 5.

[9] Using other size controls such as sales or the number of employees yields similar results to those reported below. Note also that redefining the dependent variable as pretax profit scaled by total assets leads to comparable results.

collinearity of these effects with changes in the host country corporate tax rate or the corporate tax rate differential between home and host countries.

## 4. Data

Our empirical analysis relies on the commercial database AMADEUS which is compiled by Bureau van Dijk. The version of the database available to us contains detailed information on firms' ownership structure and financial statement data for 1.6 million national and multinational corporations in 38 European countries from 1995 to 2005, but is unbalanced in structure. We restrict our sample to countries within the EU-25 (the 25 states that were members of the EU at the end of our sample period), as these countries are the most extensively represented in the database. The observational units in our empirical analysis are subsidiaries of multinational groups that are located within the EU-25. Our criterion for defining a multinational subsidiary is the existence of a foreign corporate immediate shareholder (parent) that owns at least a 90% stake in the subsidiary.[10] Since our aim is to investigate the propagation of earnings shocks at the parent firm to (foreign) subsidiaries in the multinational group, it is necessary to restrict our sample to subsidiaries with a parent that is also located in an EU-25 country.[11]

In line with previous studies on multinational profit shifting (e.g. Huizinga and Laeven, 2008), we restrict our baseline analysis to firms with positive pre-tax profits and with more than five employees.[12] Our basic sample consists of 18,408 observations from 4806 subsidiaries over the years 1995 to 2005. Hence, we observe each affiliate for 3.8 years on average. Given all these restrictions, our sample contains firms from all EU-25 countries except Cyprus, Malta and Slovenia. The country statistics are presented in Table 1.

Although our estimation sample consists only of multinational subsidiaries, we use data on all national and multinational firms contained in AMADEUS to construct the earnings shock variable for the parent companies in our sample. In total, we employ data on 1.3 million firms for which information on profits and total assets is available. Following Bertrand et al. (2002), we calculate the earnings level before taxation and shifting at the parent firm by constructing a proxy based on the profitability of comparable firms in the same time period. We follow three alternative assumptions to construct sets of comparable firms. In the baseline analysis, we include all firms which belong to the same 4-digit NACE industry and which are located within the same country. In robustness checks, we alternatively use all firms within the same 4-digit NACE industry located within the EU-25, and use all firms located in the same country. In all cases, the parent firm for which the expected profit is being calculated is itself excluded from the set of comparable firms.

Following Bertrand et al. (2002), we determine the total asset weighted average profitability of all firms in these groups (apart from the parent firm under consideration) where the profitability of firm $j$ at time $t$ is represented by $p_{jt}$ and is defined as pre-tax profits over total assets, i.e. $p_{jt}=\pi_{jt}/a_{jt}$. For each year $t$, subsidiary $i$'s parent firm is assumed to experience a pre-tax and pre-shifting profitability $\tilde{p}_i$ as measured by the total-asset-weighted average pre-tax profitability of comparable firms $j$, given by:

$$\tilde{p}_i = \sum_j \frac{a_j}{\sum_j a_j} \cdot p_j, i \neq j. \quad (9)$$

In line with the analysis of Bertrand et al. (2002), we only include subsidiary-year combinations in our sample if we observe at least 10 comparable firms for the calculation of the parent earning level $\tilde{p}_{it}$ in Eq. (9).[13] Moreover, to avoid obvious endogeneity problems, subsidiaries are only included in the sample if they operate in a different 4-digit NACE industry than their parent company.[14] To determine a predicted value for the pre-tax profit at the parent firm level, we again follow Bertrand et al. (2002) and calculate the parent's pre-tax and pre-shifting profit $\tilde{\pi}_{it}$ as the product of its predicted profitability $\tilde{p}_{it}$ and its total asset stock $\tilde{a}_{it}$, i.e. $\tilde{\pi}_{it} = \tilde{p}_{it} * \tilde{a}_{it}$.

Table 2 reports the sample statistics for the parent firms' predicted profitability measures. As discussed above, the sample is restricted to subsidiaries with parent firms that earn a positive predicted pre-tax and pre-shifting profit. To address outliers, we drop profitability rates in the upper 1% of the distribution.[15] As presented in Table 2, the ratio of the parent firms' average constructed pre-tax and pre-shifting profit to total assets is 5%, but exhibits strong variation across observations. Multiplying by the parent's total assets stock gives the parents' predicted pre-shifting profits, with a sample average of $220 million.

The subsidiaries in our sample are considerably smaller than their parent firms. This partly reflects the fact that AMADEUS does not consolidate the multinational subsidiary information at the country level. Hence, the parent firms in our sample tend to have a large number of wholly owned subsidiaries, on average 23.11 in our European sample

**Table 1**
Country statistics.

| Country | Subsidiary country | Parent country |
|---|---|---|
| Austria | 67 | 90 |
| Belgium | 391 | 512 |
| Czech Republic | 184 | 1 |
| Denmark | 321 | 461 |
| Estonia | 106 | 5 |
| Finland | 259 | 317 |
| France | 645 | 1263 |
| Germany | 241 | 930 |
| Great Britain | 800 | 166 |
| Greece | 51 | 12 |
| Hungary | 86 | 3 |
| Ireland | 98 | 8 |
| Italy | 429 | 279 |
| Latvia | 44 | 0 |
| Lithuania | 25 | 0 |
| Luxembourg | 23 | 102 |
| Netherlands | 265 | 235 |
| Poland | 336 | 5 |
| Portugal | 93 | 28 |
| Slovakia | 35 | 0 |
| Spain | 535 | 161 |
| Sweden | 364 | 820 |
| Sum | 5398 | 5398 |

[10] Note that the results are robust to including only wholly-owned subsidiaries in the sample. Note also that the 90% stake is defined to include both the parent's direct and indirect holdings in situations where there are chains of ownership (e.g. suppose a parent owns a subsidiary with 100% of the ownership shares and this subsidiary owns another firm with an ownership share of 91%. Then, the latter firm would be in the sample, as the total ownership share of the parent exceeds 90%).

[11] Note in this context that the AMADEUS data has the drawback that information on the ownership structure is available for the last reported date only which is the year 2005 for most observations in our sample. Thus, in the context of our panel study, there is some scope for misclassifications of parent-subsidiary connections since the ownership structure may have changed over the sample period. However, in line with previous studies, this is not a serious concern since these misclassifications introduce noise to our estimations that will bias our results towards zero (see e.g. Budd et al., 2005).

[12] Note, however, that the basic results are robust to including firms with five or fewer employees.

[13] The restriction is binding in a number of cases for the baseline definition of comparable firms which comprises firms in the same 4-digit industry and in the same country.

[14] To keep the information set as large as possible, we include multinational affiliates in the calculation of $\tilde{p}_i$. This may raise concerns since multinational affiliates' pre-tax profitability might itself be distorted by profit shifting behavior. As a robustness check, we thus re-estimate the regressions calculating parent profitability shocks on the basis of national firms only (see Section 5).

[15] Note that winsorizing the data yields similar results to those presented below.

**Table 2**
Descriptive statistics.

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| *Subsidiary characteristics* | | | | | |
| Pre-tax profits [a] | 18,408 | 7657.6 | 54,861.2 | 1 | 3,926,446 |
| Total assets [a] | 18,408 | 116,979.1 | 886,819.1 | 6 | 5.48e+07 |
| GDP per capita [b] | 18,408 | 21,662.6 | 8377.7 | 1811.24 | 60,311.23 |
| Population [c] | 18,408 | 35,173.4 | 24,582.8 | 411.6 | 82,536.68 |
| Corporate tax rate | 18,408 | 0.3324 | 0.0659 | 0.1 | 0.57 |
| Financial depth [d] | 17,470 | 0.6765 | 0.2743 | 0.1036 | 3.2074 |
| Low tax subsidiary | 18,408 | 0.6022 | 0. 4895 | 0 | 1 |
| *Parent characteristics* | | | | | |
| Total assets [a] | 18,408 | 3,957,753 | 1.08e+07 | 10 | 1.61e + 08 |
| *Profitability shock* | | | | | |
| Profitability ($\tilde{p}_{it}$) [e] | 18,408 | 0.05 | 0.04 | 0.00 | 0.33 |
| *Pre-tax and pre-shifting profits* | | | | | |
| Pre-shifting profits [a] ($\tilde{\pi}_{it}$) [f] | 18,408 | 220,211.1 | 1,003,638 | 0.22 | 2.24e + 07 |

[a] In thousands of US dollars, at current prices.
[b] In US dollars, at current prices.
[c] In thousands.
[d] Financial depth represents the ratio of financial system deposits to GDP, a proxy for financial development obtained from Bek et al. (2000, 2010).
[e] Profitability $\tilde{p}_{it}$ represents the pre-tax and pre-shifting profitability of the parent of the affiliate under consideration, constructed as the asset weighted average of all firms in the same 4-digit NACE industry and the same country.
[f] Profitability $\tilde{\pi}_{it}$ represents the pre-tax and pre-shifting profit of the parent of the affiliate under consideration, constructed as the product of the asset weighted average profitability $\tilde{p}_{it}$ of all firms in the same 4-digit NACE industry and the same country and the parent firm's total asset stock.

countries and 31.26 subsidiaries worldwide.[16] The subsidiaries have, on average, total assets of $117.0 million and earn a pre-tax profit of $7.7 million. Additionally, the data includes information on the host country's statutory corporate tax rate, GDP per capita and population size.[17] The average statutory tax rate for the subsidiaries in our sample is 33.2%, varying between 10% and 57%. In general, parent firms tend to face higher corporate tax rates than do their subsidiaries (as headquarters tend to be disproportionately located in higher-tax countries). Consequently, for 60% of the subsidiaries in our sample, the local corporate tax is lower than that faced by its parent firm.[18]

## 5. Results

### 5.1. Basic results

The basic results are presented in Table 3, using a set of specifications based on Eq. (8) and augmented in various ways as described below. All regressions include a full set of subsidiary fixed effects. Heteroscedasticity-robust standard errors that are clustered at the firm level are shown in brackets below the coefficient estimates.[19] Table 3 presents model specifications that use the parent profit measure calculated based on firms in the same industry and country, as described in Section 4. However, calculating the parent profit measure based on firms in the same industry throughout the EU-25, or doing so based on firms in the same country (regardless of industry), leads to very similar results.

Following the difference-in-difference approach articulated in Section 3, Column (1) regresses the subsidiary's pre-tax profit on the parent's pre-tax and pre-shifting earnings ($\tilde{\pi}_{it}$) and its interaction term with a dummy variable indicating low-tax subsidiaries ($d_{it} * \tilde{\pi}_{it}$). Common correlations between parent and subsidiary earnings are accounted for through the parent profit variable $\tilde{\pi}_{it}$ and the profit shifting effect is identified by allowing for a differential impact on the group of subsidiaries with lower local corporate tax rates than their parents. Column (1) also controls for a full set of subsidiary fixed effects and the subsidiary's total assets.

The coefficient estimate for the parent's pre-shifting profit ($\tilde{\pi}_{it}$) is positive, suggesting that parent earnings tend to exert a positive impact on subsidiaries' profits (which may reflect, for example, technological spillover effects within multinational entities). However, the variable of interest is the interaction term $d_{it} * \tilde{\pi}_{it}$. Its coefficient is positive and statistically significant, suggesting that increases in parent earnings have a systematically stronger impact on the pre-tax profit reported by subsidiaries with a lower tax rate than the parent firm, relative to subsidiaries with a higher tax rate than the parent firm. Put differently, low-tax subsidiaries receive extra profits in the wake of positive earnings shocks at the parent level, consistent with the income shifting hypothesis. This result is robust to the inclusion of a full set of year dummies to absorb common shocks to all sample subsidiaries over time (Column (2)). While this renders the coefficient estimate for the parent's pre-tax and pre-shifting profit insignificant, the coefficient estimate for the interaction term remains positive and statistically significant. In the following discussion, we assess the robustness of this finding to controlling for additional sources of heterogeneity between high-tax and low-tax affiliates.

As discussed earlier, the sample is restricted to affiliates that operate in industries that are different from those of their parent firms. However, it is possible that low-tax affiliates may happen to be concentrated in industries with earnings shocks that are more strongly correlated with those of their parents than are high-tax affiliates. To address this possibility, Column (3) adds a full set of two-digit industry-year effects to absorb industry-specific shocks over time. The basic result is essentially unchanged.

Affiliates are classified as low-tax or high-tax based on the relationship between their local corporate tax rate and that faced by their parent firm. Thus, it is possible that, for example, one affiliate in Slovakia is low-tax in relation to its German parent, while another affiliate in Slovakia is high-tax in relation to its Irish parent. Nonetheless, it remains true that low-tax affiliates are disproportionately located in countries with low statutory corporate tax rates. Time-invariant country characteristics are already controlled for through affiliate fixed effects (which subsume country fixed effects, given that affiliates do not change their location). However, lower-tax countries may experience country-specific shocks that differ from those of the higher-tax countries in which high-tax affiliates tend to be located. One approach to controlling for these effects is to add a set of time-varying country controls.[20] Column (4) adds GDP per capita and population to the model, while Column (5) also adds the corporate tax rate. This leaves the qualitative results essentially unchanged.

Nonetheless, finding appropriate control variables for the universe of potential country-specific shocks in the economic, social and political dimensions is not feasible. Thus, we add a full set of country-year fixed effects which control for unobserved country-specific shocks to corporate profitability over time. The results are presented in Column (6) and confirm our previous findings: the coefficient estimate

[16] Note though that not all the European subsidiaries of our sample parents are included in the data since not all of them report the necessary separate unconsolidated accounting information.
[17] The statutory tax rate data for the EU-25 is taken from the European Commission (2006), while the rates for affiliates outside the EU are based on data of the tax consultancy firm KPMG (2006). Country data for GDP per capita and population are obtained from EUROSTAT. The host countries' average GDP per capita and population size are $ 21,662 and 35 million inhabitants, respectively.
[18] Note that this ignores any taxes on dividend repatriations imposed by parents' home countries, in cases where the home country uses worldwide taxation.
[19] Note that the basic results are robust to the use of Newey–West standard errors that are robust to serial correlation of unknown form.
[20] Another approach is to restrict attention to observations in countries that host both some high-tax and some low-tax affiliates in a given year. This leads to very similar results, as discussed below.

**Table 3**
Basic results, panel 1995–2005.

| Dependent variable: log pre-tax profit | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Log parent profits · low-tax subs | .0131*** | .0107*** | .0114*** | .0104** | .0080** | .0080* | .0397*** | .0326** |
| | (.0035) | (.0044) | (.0037) | (.0037) | (.0039) | (.0048) | (.0148) | (.0157) |
| Log parent profit | .0236*** | .0044 | −.0006 | −.0002 | .0005 | .0059 | −.0077 | −.0139 |
| | (.0100) | (.0105) | (.0109) | (.0109) | (.0110) | (.0109) | (.0135) | (.0145) |
| Log total assets | .8218*** | .7254*** | .7283*** | .7237*** | .7218*** | .7042*** | .7087*** | .6832*** |
| | (.0305) | (.0376) | (.0424) | (.0371) | (.0371) | (.0375) | (.0394) | (.0387) |
| Log GDP per capita | | | | .0834 | .1845 | | | |
| | | | | (.1936) | (.1973) | | | |
| Log population | | | | −2.9769** | −2.1006 | | | |
| | | | | (1.2318) | (1.2742) | | | |
| Corporate tax rate | | | | | −1.1309** | | | |
| | | | | | (.4891) | | | |
| Subsidiary effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year effects | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Industry-year effects | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Country-year effects | | | | | | ✓ | | |
| Country-pair-year effects | | | | | | | ✓ | ✓ |
| Observations | 18,408 | 18,408 | 18,026 | 18,026 | 18,026 | 18,026 | 18,026 | 17,068 |
| Number of firms | 4806 | 4806 | 4704 | 4704 | 4704 | 4704 | 4704 | 4584 |
| $R^2$ (within) | 0.1720 | 0.1784 | 0.2101 | 0.2107 | 0.2113 | 0.2309 | 0.2809 | 0.2766 |

Notes: Heteroscedasticity robust standard errors adjusted for firm clusters in parentheses. The observational units are multinational subsidiaries with a foreign parent firm. The dependent variable is the logarithm of the subsidiary's pre-tax profit. Log Parent Profit represents the logarithm of the parent firm's pre-shifting profit, constructed as described in Section 4. Low-tax Subs is a dummy variable that takes on the value 1 if the subsidiary faces a lower statutory corporate tax rate than does the parent firm. Log Total Assets is the logarithm of the subsidiary's total asset stock. Log GDP per capita represents the logarithm of GDP per capita in the subsidiary's host country, while Log Population represents the logarithm of the number of inhabitants. Corporate Tax Rate stands for the statutory corporate tax rate levied by the subsidiary's host country. Year Effects (Industry-Year Effects) indicate a full set of year fixed effects (industry-year fixed effects at the 2-digit NACE level). Country-Year Effects represent a full set of country-year fixed effects for the subsidiary country. Country-Pair-Year Effects represent country-pair-year fixed effects for the subsidiary and the parent country. All specifications include subsidiary fixed effects.

* Indicate significance at the 10% level.
** Indicate significance at the 5% level.
*** Indicate significance at the 1% level.

for the interaction term between parent earnings and the low-tax subsidiary dummy remains statistically significant with a positive sign.

There may, however, still be a concern that the low-tax subsidiaries in our sample tend to be located in countries whose economies are systematically more strongly correlated with the host economy of the parent firm than are the host economies of the group's high-tax subsidiaries.[21] To allow for this possibility, Column (7) includes a full set of country-pair-year effects. These country-pair-year effects, which were not feasible in the specifications used in the prior literature, absorb shocks to the parent country over time and allow for a heterogeneous transmission of these shocks to the subsidiary economies. In essence, the country-pair-year effects represent the inclusion of a dummy variable for each combination of subsidiary location and parent home country in a given year — e.g. all affiliates located in Estonia with German parents in 1998 would have a common country-pair-year effect.[22] Again, the findings are qualitatively unchanged.

Quantitatively, Column (7) suggests that an increase in the pre-tax and pre-shifting profits at the parent level by 10% enhances the profit earned at the affiliate by 0.4%. Evaluated at the sample mean, this implies that an increase in the parent firm's pre-shifting profits by $22 million enhances the pre-tax profit reported at the subsidiary level (conditional on the subsidiary's assets) by around $30,000. This effect may seem small, but it represents only the amount of income-shifting to one specific low-tax affiliate. In part because our analysis does not consolidate the subsidiaries of a given multinational group located within the same host country, the parent firms in our sample own a considerable number of foreign subsidiaries. On average, a parent firm owns 23.11 subsidiaries in our European sample countries and 31.26 subsidiaries worldwide. As indicated in Table 2, 60% of the subsidiaries within Europe face a lower corporate tax rate than their parent firm, implying that a parent on average shifts profits to 13.9 subsidiaries. Evaluated at the sample mean, this implies that around $420,000 is shifted out of the parent country to affiliates within Europe, representing 2% of the pre-shifting profit shock of $22 million.

As previously noted, no financial data is available in AMADEUS for non-European affiliates. However, assuming that the income-shifting behavior that we estimate among EU-25 affiliates can be straightforwardly extrapolated to subsidiaries outside Europe, a parent would on average shift profits of $30,000 to 18.8 (low-tax) subsidiaries worldwide (based on the ratio of 31.26 global subsidiaries to 23.11 European subsidiaries).[23] This would imply that on average $564,000 is shifted out of the parent country to affiliates globally, representing 2.6% of the pre-shifting profit shock of $22 million.

This estimate is quantitatively somewhat smaller than those found in the previous literature, using corporate tax rate changes as a source of identification. Existing studies typically estimate the semi-elasticity of affiliate pre-tax profits to changes in the tax rate difference between the affiliate and other firms in the multinational group. The estimates range from semi-elasticities of around −0.5 to −1.7 (see e.g. Huizinga and Laeven, 2008). Estimates for profit shifting activities between headquarters and (low-tax) subsidiaries are around −0.5, i.e. at the lower end of this range (see Dischinger and Riedel, 2010). Replicating the approach of the previous literature using this sample also results in a semi-elasticity of around −0.5, which implies that on average around 3.3% of the parents' pre-shifting profits are transferred to low-tax

[21] A variant of this possibility is that the effect may differ across affiliates in Western and Eastern Europe, with the latter generally facing lower tax rates. However, the results are very similar and remain highly significant when observations for which either the affiliate or the parent is located in Eastern Europe (specifically, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland and Slovakia) are omitted.

[22] Of course, country-pair-year effects subsume the country-year effects used in Column (6). Note also that the time-varying country-level controls (such as GDP per capita) are no longer included in Columns (6) and (7), as they are subsumed by country-year effects and a fortiori by country-pair-year effects.

[23] The fraction of low-tax subsidiaries remains close to 60% if we account for all our parent firms' subsidiaries in the EU-25 and worldwide.

**Table 4**
Robustness tests, panel 1995−2005.

| Dependent variable | Log EBIT | Log fin. profits | Parent debt-to-asset-ratio | Log (pre-tax profit + K) | Log pre-tax profit | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Log par. profit · low-tax subs | .0141 | .0042* | | | .0436*** | .0507*** | .0376** | |
| | (.015) | (.0025) | | | (.0168) | (.0160) | (.0161) | |
| Log par. profit · fraction of low-tax subs | | | .0071** | | | | | |
| | | | (.0034) | | | | | |
| Log par. profit · lowest-tax subs | | | | | | | | .0433** |
| | | | | | | | | (.0208) |
| Log parent profit | . 0106 | −.0028 | .0058 | | −.0101 | −.0262* | −.0026 | .0138 |
| | (.0140) | (.0022) | (.0061) | | (.0162) | (.0158) | (.0142) | (.0121) |
| Log total assets | .6759*** | .0060* | .0140 | .0226*** | .6757*** | .7161*** | .6953*** | .7090 |
| | (.0381) | (.0031) | (.0119) | (.0043) | (.0508) | (.0471) | (.0459) | (.0397) |
| Log (par. profit + K) · low-tax subs | | | | .0177* | | | | |
| | | | | (.0093) | | | | |
| Log (par. profit + K) | | | | .0038 | | | | |
| | | | | (.0092) | | | | |
| Subsidiary effects | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Parent effects | | | ✓ | | | | | |
| Year effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Industry-year effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Country-pair-year effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 14,757 | 20,624 | 2225 | 26,737 | 11,864 | 13,231 | 14,759 | 18,026 |
| Number of firms | 4016 | 4716 | 678 | 5447 | 2882 | 3492 | 3990 | 4704 |
| $R^2$ (within) | 0.2777 | 0.0699 | 0.2099 | 0.0852 | 0.2956 | 0.2860 | 0.2532 | 0.2807 |

Notes: Heteroscedasticity robust standard errors adjusted for firm clusters in parentheses. The observational units are multinational subsidiaries with a foreign parent firm. In Column (3), the observational unit is the multinational parent firm per year. The variable Log Parent Profit represents the logarithm of the parent firm's pre-shifting profit, constructed as described in Section 4 (using firms in the same country and the same 4-digit NACE industry for construction). Log (Par. Profit + K) represents the logarithm of the parent firm's pre-shifting profit plus a constant that corresponds to the first percentile of the distribution. Low-tax Subs is a dummy variable that takes on the value 1 if the subsidiary faces a lower statutory corporate tax rate than the parent firm. Log Total Assets is the logarithm of the subsidiary's total asset stock. Year Effects (Industry-Year Effects) indicate a full set of year fixed effects (industry-year fixed effects at the 2-digit NACE level). Country-Year Effects indicate a full set of country-year fixed effects for the subsidiary country. Country-Pair-Year Effects indicate country-pair-year fixed effects for the subsidiary and the parent country.

* Indicate significance at the 10% level.
** Indicate significance at the 5% level.
*** Indicate significance at the 1% level.

subsidiaries.[24] This exceeds our estimates of 2% of income being shifted within Europe and 2.6% worldwide.

As described in Section 4, the set of comparable firms used for the calculation of the parents' pre-tax and pre-shifting profit comprises both national and multinational corporations. Including multinationals in the calculation keeps the information set as large as possible. On the other hand, multinational corporations' pre-tax profitability might itself be distorted by profit shifting behavior.[25] As a sensitivity check, we thus construct the pre-tax and pre-shifting profit at the parent level using only the profitability of the subgroup of national firms in the same industry and country. Column (8) re-estimates Column (7) using the parent earnings measure calculated based on national firms only. This exercise results in coefficient estimates that are very similar to those in Column (7).[26]

### 5.2. The role of debt-shifting

The baseline specifications employ the affiliate's pre-tax profit as the dependent variable. Pretax profit includes both the operating and financial profit of the firm. Consequently, the estimated effect can be interpreted as capturing potential profit shifting activities through both transfer price distortions (which affect the affiliate's operating income) and through distortions to intra-firm debt (which affect the affiliate's financial income). To disentangle the transfer pricing and debt shifting channels, we run specifications in which we employ the affiliate's earnings before interest and taxation (EBIT), i.e. its operating profit, as the dependent variable. The strategic use of debt (in particular, the payment of interest by high-tax affiliates to low-tax affiliates) would be captured by pretax profit, but not by EBIT. On the other hand, EBIT would capture transfer pricing manipulation.

The results of the EBIT regression are presented in Column (1) of Table 4. The coefficient estimate for the interaction between the parent's pre-shifting profit and the low-tax subsidiary dummy is considerably smaller than in the baseline result and is statistically insignificant. This result is consistent with the profit shifting activity inferred from the baseline estimates occurring primarily through the use of inter-affiliate debt, rather than through transfer pricing. A direct test

[24] Replicating the approach of the previous literature involves adding the tax rate differential between the subsidiary and its parent firm to our regression model (which results in a semi-elasticity of around −0.5), consistent with the previous literature. Using this identification approach, the fraction of profit shifted from our sample parents to their low-tax subsidiaries can be approximated by multiplying the semi-elasticity estimate by the average tax rate differential (7.7% in our sample) between parents and low-tax affiliates (see Huizinga and Laeven (2008) for an analogous approach). Consequently, the estimate suggests that around 3.3% (=−0.5*7.7%) of the parents' pre-shifting profits are transferred to low-tax subsidiaries.

[25] Including multinational firms in the calculation of the shock variables may on the one hand lead to an overestimation of our effect, as e.g. positive profitability shocks in high-tax countries may be underestimated if multinational firms that are included in the calculation of $\bar{p}_i$ shift a fraction of the enhanced profits out of the country. On the other hand, the effect may be underestimated if the profitability of multinationals included in the calculation of $\bar{p}_i$ is affected by changes in profit shifting incentives (e.g. changes in anti-avoidance rules, such as transfer price documentation requirements). If incentives to shift profits from a high-tax parent country to a low-tax subsidiary are reduced, this for example enhances the estimated parent profitability $\bar{p}_i$ but simultaneously reduces the subsidiary's profitability and thus biases the effect downwards.

[26] Note that the sample size is smaller than in Column (6). This is due to the fact that several country-industry groups have fewer than 10 comparable firms if we account for national corporations only and are hence dropped from the analysis. Moreover, national firms in our data have a higher probability of making losses. Consequently, the constructed parent firms' pre-shifting profit estimates are more likely to be negative, causing them to be excluded from the estimation (see Section 4).

of the impact of parent earnings shocks on patterns of inter-affiliate debt unfortunately cannot be implemented, because AMADEUS does not separately report inter-affiliate and external debt or interest payments. However, some additional support for the importance of debt shifting in driving our results is reported in Columns (2) and (3) of Table 4.

In Column (2) of Table 4, we employ the logarithm of corporate financial profit as the dependent variable. Financial profit ($\pi fin$) is defined as pretax profit (the dependent variable in our baseline analysis) minus EBIT. To avoid losing negative observations, we add a constant $K$ to the variable which corresponds to approximately the first percentile of the sample distribution before taking the logarithm. The resulting specification is:

$$\log(\pi fin_{it} + K) = \alpha_0 + \alpha_1 \log a_{it} + \alpha_2 \log \tilde{\pi}_{it} + \alpha_3 (d_{it} \cdot \log \tilde{\pi}_{it}) + \alpha_4 x_{it} + \phi_i + \rho_t + \varepsilon_{it} \quad (10)$$

(where the other variables are defined as in Eq. (8)). The results from Eq. (10), reported in Column (2) of Table 4, suggest that the impact of profitability shocks at the parent firm on the financial income of low-tax affiliates is significantly larger than the corresponding impact on high-tax affiliates.[27]

To shed more light on the specific role of internal debt shifting, it is possible to examine the impact of profitability shocks at the parent firm on the parent's debt-to-total asset ratio. It might be expected that income-shifting via the internal debt channel would be larger when more of a parent's subsidiaries are located in low-tax countries (relative to the parent), especially if there are convex costs of income-shifting to any one subsidiary. The following specification is used to test this idea:

$$\frac{D_{pt}}{a_{pt}} = \alpha_0 + \alpha_1 \log a_{pt} + \alpha_2 \log \tilde{\pi}_{pt} + \alpha_3 \left(F_{pt} \cdot \log \tilde{\pi}_{pt}\right) + \alpha_4 x_{pt} + \phi_p + \rho_t + \varepsilon_{pt}. \quad (11)$$

Here, the dependent variable is the debt-to-asset ratio of parent $p$ in year $t$. Other variables are as defined in Eq. (8), except for $F_{pt}$, which is the fraction of parent $p$'s subsidiaries that are located in a country with a lower tax rate than the parent in year $t$. Note that in contrast to the other specifications used in this paper, Eq. (11) is estimated using data at the parent-year level, rather than the subsidiary-year level. The results reported in Column (3) of Table 4 show that the debt-to-total asset ratio of multinational parent firms increases more strongly in the wake of positive profit shocks if a high fraction of group subsidiaries is located in countries with a lower corporate tax rate than the parent. In particular, the coefficient estimate for the interaction between $F_{pt}$ and the parent's pre-shifting profit is positive and statistically significant.

As noted earlier, a direct test of the role of internal debt shifting is impossible because of the limitations of the dataset. However, there is substantial indirect evidence that the primary channel for the income-shifting behavior apparent in our baseline estimates is via inter-affiliate debt. This may appear surprising, in the light of the strong focus in the international tax literature on income-shifting via strategic transfer pricing. However, this pattern is likely to be driven by the design of our empirical approach. In particular, parents and subsidiary firms in our data belong (by construction) to different industries. Intra-firm trade across industries and thus strategic transfer pricing opportunities are likely to be limited, especially in responding to contemporaneous shocks to parent earnings. The strategic use of debt is likely to be a more credible channel for profit shifting across industries and in response to relatively short-term earnings shocks experienced by the parent.[28] It is important to note that our results do not imply that income-shifting via strategic transfer pricing would not be a significant phenomenon in a wider sample of firms that included subsidiaries operating within the same industries as their parents. More generally, our results do not imply that strategic transfer pricing is unimportant in reality; rather, our approach complements the existing focus on transfer pricing by highlighting an alternative income-shifting channel.

### 5.3. The role of sample restrictions

The baseline analysis restricts the sample to subsidiary-year observations in which the subsidiary's income is positive. The baseline sample is also restricted to subsidiary-year observations in which the subsidiary's parent experienced a positive earnings shock. These sample restrictions resemble those used widely in the previous literature, and focus attention on those firms for which income-shifting incentives are most relevant. However, when tax systems allow loss carryforwards and carrybacks, incentives for profit shifting may persist even when the affiliate's income is negative, and when the subsidiary's parent experienced a negative earnings shock.

Suppose that every country's tax system allows full loss offsets. Then, the MNE would find it advantageous to shift income to a loss-making low-tax affiliate (relative to a loss-making high-tax affiliate). For example, imagine a MNE consisting of a parent facing a 35% tax rate, a high-tax affiliate facing a 45% tax rate, and a low-tax affiliate facing a 10% tax rate. If both affiliates have negative income, shifting $1 from the parent to the low-tax affiliate will result in a reduction of $0.10 in the loss offset paid by the low-tax government, whereas shifting $1 from the parent to the high-tax affiliate will result in a reduction of $0.45 in the loss offset paid by the high-tax government. Thus, with full loss offsets, the incentive to shift income differentially to the low-tax affiliate will exist even when affiliates have negative income. On the other hand, if tax systems allow no loss offsets, then there will be no differential incentive to shift income to a loss-making low-tax affiliate, relative to a loss-making high-tax affiliate — both affiliates will in effect face a zero tax rate.

A negative parent earnings shock implies that the parent is predicted to make a loss in pretax and pre-shifting terms. If tax systems allow full loss offsets, then the incentive to shift income from the parent to a low-tax affiliate will persist even for a loss-making parent. On the other hand, if tax systems allow no loss offsets, then a loss-making parent in effect faces a zero tax rate, and so will typically have no incentive to shift income out. In reality, tax systems fall somewhere between these extremes. Thus, some incentive to shift income to low-tax affiliates may persist, but is likely to be attenuated because of the limitations on loss offsets in most tax systems. Similarly, the incentive to shift income to low-tax affiliates is likely to be attenuated for loss-making parents because of the limitations on loss offsets in most tax systems.

To address the concern that the baseline results may be sensitive to these sample restrictions, a robustness check adds observations with negative affiliate income and negative parent shocks to the sample. This uses a simple modification of Eq. (8). In particular, the dependent variable is $\log(\pi_{it}+K)$, where $K$ is a constant chosen such that $\pi_{it}+K>0$ for 99% of observations (including those with negative $\pi_{it}$). The

[27] Admittedly, this result is only of borderline statistical significance. However, restricting the sample to subsidiaries of larger multinational groups (i.e. those with an above average number of majority-owned affiliates, which may be expected to have more ability to shift income) results in a coefficient that is positive and significant at the 5% level.

[28] This inference is reinforced by examining differences in income shifting for firms with relatively high and relatively low degrees of R&D intensity. If transfer pricing were an important channel for the baseline income shifting result, then given the important role of intangible assets in transfer pricing, we would expect that income shifting would be concentrated among R&D-intensive firms. However, dividing the sample in this way (using average R&D expenditures relative to sales at the industry level) does not yield significant differences in income shifting between R&D-intensive firms and other firms.

**Table 5**
Additional robustness tests, panel 1995−2005.

| Dependent variable: log pre-tax profit | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | (1) | (2) | (3) | (4) High-tax shock | (5) Low-tax shock | (6) | (7) | (8) |
| Log parent profits · low-tax subs | .0342** | .0447*** | .0563*** | | | .0397*** | .0397*** | −.0010 |
| | (.0161) | (.0146) | (.0180) | | | (.0125) | (.0142) | (.0043) |
| Log parent profit | .0405 | −.0181 | −.0248 | | | −.0077 | −.0077 | −.0024 |
| | (.0323) | (.0137) | (.0172) | | | (.0168) | (.0135) | (.0108) |
| Log parent profit • financial depth | −.0617 | | | | | | | |
| | (.0413) | | | | | | | |
| Log group profit | | | | .0208** | .0099 | | | |
| | | | | (.0104) | (.0125) | | | |
| Log total assets | .6987*** | .7215**** | .6629*** | .7188*** | .6970** | .7087*** | .7087*** | .7060*** |
| | (.0323) | (.0442) | (.0530) | (.0377) | (.0507) | (.0495) | (.0495) | (.0476) |
| Subsidiary and year effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Industry-year effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Country-pair-year effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sample | All | FD>0.5 | FD>0.65 | All | All | All | All | All |
| Observations | 17,095 | 14,101 | 8758 | 16,318 | 13,036 | 18,026 | 18,026 | 16,601 |
| Number of firms | 4685 | 3.64 | 2236 | 4173 | 3343 | 4704 | 4704 | 4491 |
| $R^2$ (within) | 0.2832 | 0.2670 | 0.2538 | 0.3016 | 0.3147 | 0.2809 | 0.2809 | 0.2836 |

Notes: Heteroscedasticity robust standard errors adjusted for firm clusters in parentheses. The observational units are multinational subsidiaries with a foreign parent firm. The dependent variable is the logarithm of the subsidiary's pre-tax profit. The variable Log Parent Profit in specifications (1) to (3) represents the logarithm of the parent firm's pre-shifting profit, constructed as described in Section 4 (using firms in the same country and the same 4-digit NACE industry for construction). Analogously, Log Group Profit represents the logarithm of the sum of pre-shifting profits at all group affiliates with a higher (lower) corporate tax rate than the considered affiliate in Column 4 (Column 5). Low-tax Subs is a dummy variable that takes on the value 1 if the subsidiary faces a lower statutory corporate tax rate than the parent firm. Log Total Assets is the logarithm of the subsidiary's total asset stock. Financial depth (abbreviated "FD") is the ratio of financial system deposits to GDP, a proxy for financial development which is obtained from Beck et al. (2000, 2010). Year Effects (Industry-Year Effects) indicate a full set of year fixed effects (industry-year fixed effects at the 2-digit NACE level). Country-Year Effects indicate a full set of country-year fixed effects for the subsidiary country. Country-Pair-Year Effects indicate country-pair-year fixed effects for the subsidiary and the parent country.
* Indicate significance at the 10% level.
** Indicate significance at the 5% level.
*** Indicate significance at the 1% level.

shock variable is $\log(\tilde{\pi}_{it} + \tilde{K})$, where $\tilde{K}$ is a constant chosen such that $\tilde{\pi}_{it} + \tilde{K} > 0$ for 99% of observations (including those with negative $\tilde{\pi}_{it}$):

$$\log(\pi_{it} + K) = \alpha_0 + \alpha_1 \log a_{it} + \alpha_2 \log\left(\tilde{\pi}_{it} + \tilde{K}\right) + \alpha_3\left(d_{it} \cdot \log\left(\tilde{\pi}_{it} + \tilde{K}\right)\right) + \alpha_4 x_{it} + \phi_i + \rho_t + \varepsilon_{it}. \quad (13)$$

This modified specification is expected to lead to smaller profit shifting estimates for two reasons: firstly, income shifting incentives from loss-making parent firms are diminished and secondly, adding a constant to the variable before taking the log tends to mechanically reduce coefficient estimates.[29] The results presented in Column (4) of Table 4 confirm this presumption. The coefficient estimate for the interaction term between the parent earnings shock and the dummy for low-tax subsidiaries remains positive but is quantitatively smaller than in our baseline estimate. However, despite the attenuation of the estimated effect in the broader sample, the income-shifting estimate remains of borderline statistical significance. Thus, it does not appear that the results depend crucially on the sample restrictions, although as expected the estimated effect is stronger for the sample in which income-shifting incentives are likely to be more relevant.

### 5.4. Additional robustness checks

The baseline results described in Section 5.1 are also robust to a variety of additional checks. For instance, our analysis relies on financial profit information (i.e. book income), and we do not observe corporate income reported for tax purposes. Although financial and tax accounts are in general more closely linked in Europe than in other countries like the US (see e.g. Freedman, 2008), book income and tax income may differ. Book–tax differences may be caused by differences in the accounting rules governing the reporting of income for book and tax purposes, as well as by tax planning activities (e.g. Desai and Dharmapala, 2006; 2009). To the extent that book and tax income diverge, the main implication for our analysis is that the parent may shift tax income (but not book income) to low-tax affiliates. This would tend to bias the profit shifting estimate downwards. To confound our results, the parent would have to be assumed to shift book income (but not tax income) to low-tax affiliates. We empirically assess this possibility by using data on book–tax alignment.

Burgstahler et al. (2006, Table 3, p. 999) construct a dichotomous variable measuring the degree of book–tax alignment for a number of European countries. We use this variable to classify our sample countries according to their book–tax alignment. Column (5) of Table 4 reruns our baseline specification in Column (7) of Table 3, dropping observations where either the subsidiary itself or its parent is located in a country with a low degree of book–tax alignment.[30] The results are similar to our baseline estimates, with the coefficient being somewhat larger in magnitude. This is very much as would be expected, given that the shifting of taxable income is likely to be underestimated in countries with low book–tax alignment.

As previously discussed, the approach developed by Bertrand et al. (2002) was intended to measure tunneling activities. However, it is unlikely that the effect we find can be explained by tunneling. The affiliates in our sample are held by their parents with at least a 90% ownership stake. The results, moreover, are robust to restricting the sample purely to those affiliates that are 100% owned by the parent. As long as 100% of the cash-flow rights associated with stock in the subsidiary are held by the parent, the parent's controlling shareholder (if one exists) has no incentive to tunnel income from the affiliate to

[29] Running the specification in Eq. (13) on the baseline sample (excluding affiliates with negative income or negative parent shocks) leads to results that are similar to the baseline findings.

[30] These countries are Denmark, Great Britain and the Netherlands. Unfortunately, there is no longitudinal measure of book-tax alignment for our sample countries. Note, however, that any changes in the accounting rules or practices that would affect book-tax differences in either the parent's home country or the affiliate's country would be absorbed by the country-pair-year fixed effects.

the parent firm (or vice versa). The only scenario in which tunneling might potentially confound the results is when affiliates issue dual-class stock, with the parent owning 100% of the voting stock but significantly less of the cash-flow rights, and where the parent owns a larger share of the cash-flow rights at low-tax affiliates than at high-tax affiliates.

Unfortunately, AMADEUS does not report information about dual-class stock. However, Faccio and Lang (2002) trace the ownership patterns of a large set of European corporations, and find that divergence between cash-flow rights and voting rights is of importance in relatively few of their sample countries. Among our sample countries, dual-class stock is most common in Sweden, Finland, Italy and Ireland (Faccio and Lang, 2002, Table 6, pp. 386–387). Hence, we drop subsidiaries with parents in these countries from the sample in a robustness check reported in Column (6) of Table 4. The results are very similar to our baseline results.

One major advantage of our identification strategy is that it allows us to control for country-pair-year fixed effects and hence avoids results which are driven by unobserved heterogeneity in the firms' time-varying host and home country characteristics. As a further robustness check, we restrict our sample to firms in country-years where we observe *both* subsidiaries that are high-tax affiliates within their group (i.e. face a higher corporate tax rate than their parent) *and* subsidiaries that are low-tax affiliates within their group (i.e. face a lower corporate tax rate than their parent). The results are presented in Column (7) of Table 4; they resemble our baseline findings, both qualitatively and quantitatively.

The baseline analysis focuses on whether an affiliate faces a higher or lower tax rate than does its parent. However, in the absence of other restrictions, multinational groups have an incentive to transfer income to the affiliate with the *lowest* corporate tax rate within the group. To assess this possibility, we define a dummy variable indicating those subsidiaries within our sample that have the lowest corporate tax rate within their corporate group. We then reran our baseline analysis, interacting the parent's earnings shock with this minimum tax indicator. As shown in Column (8) of Table 4, the coefficient estimate for the interaction term is positive and statistically significant and is quantitatively larger than our baseline estimate.

A potential alternative explanation for the propagation of parents' shocks to their affiliates is the operation of internal capital markets within multinational entities.[31] In particular, it might be the case that low-tax affiliates happen to be located in countries where it is more difficult or costly to obtain financing locally. Any time-invariant financing constraints are already captured by affiliate fixed effects, and any changes in countries' financial markets over time by the country-year or country-pair-year fixed effects. The concern, however, is that the low-tax affiliate indicator is capturing the effect of weakness in the host country's financial system, rather than tax status. To address this possibility, we use a measure of the strength of the financial system in the affiliate's host country. Following previous papers, we use the ratio of financial system deposits to GDP (often referred to as "financial depth") as a proxy for financial development which is obtained from an updated version of the dataset described in Beck et al. (2000, 2010).

Column (1) of Table 5 reestimates our baseline regression in Column (7) of Table 3, including the interaction between financial system deposits over GDP and the parent firm's pre-shifting profit as an additional control variable (note that financial depth per se is subsumed by the country-pair-year effects). The coefficient estimates for the financial depth interaction are statistically insignificant. Most importantly, however, the estimation results confirm our previous findings – earnings shocks at the parent firm exert a significantly larger positive effect on the pre-tax profits of affiliates in low-tax countries relative to high-tax locations, even when controlling for the possibility of a differential effect with respect to financial depth. The basic result in Column (7) of Table 3 is also robust to excluding affiliates in countries with weakly developed financial markets from the sample (see Columns (2) and (3) of Table 5).[32]

Our baseline specification relies only on profit shocks to the parent firm. However, the intuition underlying our empirical strategy extends beyond this, and potentially applies to profit shocks at any other group affiliate. Unfortunately, it is not possible to compute group-wide profit shocks, as the AMADEUS database only reports accounting information for European affiliates, even though many of the multinational entities in the sample own affiliates outside Europe (AMADEUS records the existence of non-European affiliates, but not any detailed information about them). Exploiting the available information, we construct two pre-shifting profit variables pertaining to affiliate *i*: first, the sum of the pre-shifting pre-tax profits at all group affiliates within the EU-25 that face a higher corporate tax rate than affiliate *i* (including the parent if it satisfies this criterion) and second, the sum of the pre-shifting pre-tax profits at all group affiliates within the EU-25 that face a lower corporate tax rate than affiliate *i* (including the parent if it satisfies this criterion).[33] In Column (4) (Column (5)) of Table 5, we regress the subsidiary's pre-tax profit on the former (latter) variable.

We find that profit shocks to affiliates with a higher corporate tax rate than affiliate *i* have a positive and statistically significant impact on subsidiary *i*'s profits, while profit shocks to affiliates with a lower corporate tax rate have an effect that is smaller and statistically indistinguishable from zero. This is consistent with the baseline results, although the statistical significance is somewhat weaker. These findings should be interpreted with some caution. The lack of data for non-European affiliates introduces measurement error in the shock variables, biasing our coefficient estimates towards zero under the assumption that this error is random. It may also cause other systematic biases if non-European affiliates have systematically different characteristics than European subsidiaries. However, the fact that these results are in the expected direction is at least somewhat reassuring.

Moreover, while our baseline regressions account for correlations in the error term at the firm level, we also assessed the robustness of our results to specifications where standard errors are clustered at the country-year level and the country-pair level respectively. This exercise does not affect the significance of our results, as shown in Columns (6) and (7) of Table 5 where we reestimate Column (7) of Table 3 with standard errors clustered at the country-year and country-pair level, respectively.

Furthermore, our analysis relies on the assumption that profitability shocks are not systematically correlated across different countries and industries within Europe in ways that could confound the results. A placebo test to assess the validity of this assumption is to randomly reassign parent-subsidiary connections in our data and rerun our analysis in the reassigned data. If our identification strategy is valid, we would expect that this placebo test leads to insignificant results. This is confirmed in Column (8) of Table 5.

As AMADEUS does not report accounting information for non-European affiliates, our analysis does not account for profit shifting to

[31] Dropping financial sector firms, which might be thought to play a greater role in internal capital markets, leads to results similar to the baseline findings.

[32] Column (2) excludes affiliates in host countries with a ratio of financial system deposits to GDP smaller than 0.5 (Estonia, Finland, Hungary, Latvia, Lithuania, Poland, Sweden). Column (3) also excludes affiliates in host countries with a ratio of financial system deposits to GDP smaller than 0.65 (which corresponds to the mean of our sample countries). The additional excluded countries are the Czech Republic, Denmark, France, Greece, Italy, and the Slovak Republic. Note also that the sample size for the regressions including the financial depth variable is slightly smaller than in the baseline regression as the information on financial system deposits over GDP is missing for some sample years.

[33] To ensure that our results are not driven by changes in the composition of firms that are used for the calculation of the shock variables, the construction uses only those firms for which we observe information on the pre-shifting profits for the whole sample period.

zero-tax non-European havens.[34] Applying the tax haven definition in Dharmapala and Hines (2009)[35] and using the information in AMADEUS on the location of non-European affiliates, 58% of the affiliates in our sample belong to multinational entities that include at least one affiliate in a non-European tax haven. For these affiliates' multinational groups, income shifting to non-European havens may serve as a substitute for income shifting to low-tax European countries. This would imply that low-tax European affiliates in this subsample might be expected to experience a smaller effect of parent earnings shocks. On the other hand, it is possible that multinational entities with more profit-shifting opportunities are more likely to establish affiliates in non-European havens.[36] Then, it is possible that low-tax European affiliates in this subsample may experience a larger effect of parent earnings shocks. In either case, however, the measured effect in our analysis would seem to be understated relative to the effect that would be obtained with accounting data on non-European haven affiliates.

The available evidence suggests the latter interpretation — i.e. that multinational entities with more profit-shifting opportunities are more likely to establish affiliates in non-European havens. The effect of parent earnings shocks on the income of low-tax affiliates (relative to the effect on high-tax affiliates) is larger and statistically significant in the subsample of affiliates belonging to multinational entities that include at least one affiliate in a non-European tax haven. This effect is smaller and not statistically significant in the subsample of affiliates belonging to multinational entities that include no affiliates in non-European tax havens. This suggests that the effect we find in the full sample is concentrated among the former subsample. However, this does not undermine the basic result, as there would presumably be even more income-shifting that would be observed among this subsample if data on non-European haven affiliates were observed.[37]

In addition, our sample includes a set of parent home countries that employ worldwide taxation systems under which subsidiary income is subject to taxation in the parent country. For multinational entities headquartered in such countries, profit shifting incentives may accordingly be diminished (see our discussion in Section 2). On the other hand, however, home country taxation of foreign profits is deferred until the foreign affiliate pays a dividend to the parent. This may result in strong profit shifting incentives, even in countries that employ worldwide taxation systems. Among the sample countries, Great Britain, Greece and Ireland used worldwide systems of taxation during our sample period (Markle, 2010). Excluding subsidiaries of parents from these countries leads to substantially similar results, as might be expected if income shifting does not differ dramatically between territorial and worldwide countries in the presence of deferral (the primary finding of Markle, 2010).[38]

Finally, our fixed effects approach does not directly account for potential changes in the subsidiary structure of the multinational group. If the MNE for example establishes a new subsidiary in a low-tax country in response to a positive profit shock at the parent firm, this variation is not captured in our analysis. Again, this suggests that our findings should be interpreted as a lower bound to the true effect.

## 6. Conclusion

Multinational profit shifting activities are perceived to be a major threat to the tax base of high-tax economies around the world. However, empirically testing for profit shifting behavior is inherently difficult as it requires a way to isolate tax motivations. Existing studies employ indirect identification approaches that analyze shifting behavior by estimating firm responses (adjustments in reported pre-tax profitability, intra-firm transfer prices or debt-equity structure) to changes in the corporate tax rate or the difference in tax rates between home and host countries. Identification is thus based on rather infrequent changes in statutory corporate tax rates, which are difficult to differentiate from contemporaneous changes in the home and/or host country's political, social or economic environment. Moreover, tax changes may affect other determinants of profitability such as management effort, potentially confounding the estimates of income-shifting.

Our paper develops a new identification approach based on the idea that in the presence of profit shifting, exogenous earnings shocks to a multinational parent firm would be expected to propagate differently to foreign subsidiaries in high-tax and low-tax countries. Specifically, if a multinational group engages in corporate profit shifting activities in order to reduce its corporate tax burden, it would be expected to transfer a fraction of the additional parent earnings to its low-tax subsidiaries only. This allows us to use the multinational's high-tax affiliates as a control group to absorb other (technological or financial) channels through which parent earnings may affect subsidiary profitability. As pre-shifting earnings change frequently and continuously, our identification strategy uses a rich source of variation, and also allows us to control for country-specific and country-pair-specific time effects of arbitrary form.

This identification approach is implemented using a large and comprehensive panel data set on European firms. We construct exogenous earnings shocks to multinational parent corporations by exploiting annual profitability information on a large set of comparable firms operating in the same four-digit industry and/or the same country as the parent. Our regression results indicate that these exogenous changes in parent earnings exert a significantly positive effect on the profitability of low-tax subsidiaries, relative to the effect on the profitability of high-tax subsidiaries. This result is robust to controlling for various sources of nontax heterogeneity across low-tax and high-tax affiliates.

The paper's primary contribution is thus to find support for the hypothesis of tax-motivated income-shifting, using a very different identification strategy than those used in the previous literature. This approach thus deepens and enriches the sources of evidence on this issue. For example, it enables us to rule out the possibility that profit shifting results are merely an artifact of country-pair-specific time effects. Quantitatively, the estimates suggest that at the margin around 2% of the (additional) parent profits are transferred to low-tax subsidiaries. This represents a substantial effect, although it is somewhat smaller than that found in the previous literature using changes in corporate tax rates as the source of identification. On the other hand, the fact that the estimates are not larger in magnitude also suggests that existing economic and legal frictions (such as transfer pricing regulations and thin-capitalization rules) constraining tax planning play an important role.

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[34] On the other hand, as there is no accounting data for high-tax non-European affiliates, it is theoretically possible that there is a very large positive impact of shocks to parent earnings on the income of high-tax non-European affiliates that would potentially weaken our result. Unfortunately, there is no way to completely rule out this possibility using this dataset. However, there is no reason to believe that the impact of parents' earnings shocks on high-tax non-European affiliates would be so dramatically different from the essentially zero effect on high-tax European affiliates.

[35] This is based on the list of tax havens in Hines and Rice (1994). Results are similar using an alternative list of tax havens constructed by the OECD and also reported in Dharmapala and Hines (2009).

[36] Desai et al. (2006) find that U.S. multinationals that are larger in size, have more opportunities for trade within the MNE, and higher R&D intensity are more likely to have tax haven affiliates.

[37] Note that the lowest tax rate in our sample is 10%, whereas many non-European havens have a zero tax rate. Thus, the incentives to shift income to such havens would presumably be stronger than the incentives to shift income to low-tax European countries in our sample.

[38] There is little longitudinal variation in the use of worldwide tax systems. Note, however, that any changes in parent country tax rates and rules would be absorbed by the country-pair-year fixed effects.

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