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"International Corporate Tax Avoidance: A Review of the Channels, Magnitudes, and Blind Spots"

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Week 6

SCHEDULE FOR 2019 NYU TAX POLICY COLLOQUIUM

(All sessions meet from 4:00-5:50 pm in Vanderbilt 208, NYU Law School)

1. Tuesday, January 22 – Stefanie Stantcheva, Harvard Economics Department.
2. Tuesday, January 29 – Rebecca Kysar, Fordham Law School.
3. Tuesday, February 5 – David Kamin, NYU Law School.
4. Tuesday, February 12 – John Roemer, Yale University Economics and Political Science Departments.
5. Tuesday, February 19 – Susan Morse, University of Texas at Austin Law School.
6. Tuesday, February 26 – Ruud de Mooij, International Monetary Fund.
7. Tuesday, March 5 – Richard Reinhold, NYU School of Law.
8. Tuesday, March 12 – Tatiana Homonoff, NYU Wagner School.
9. Tuesday, March 26 – Jeffery Hoopes, UNC Kenan-Flagler Business School.
10. Tuesday, April 2 – Omri Marian, University of California at Irvine School of Law.
11. Tuesday, April 9 – Steven Bank, UCLA Law School.
12. Tuesday, April 16 – Dayanand Manoli, University of Texas at Austin Department of Economics.
13. Tuesday, April 23 – Sara Sternberg Greene, Duke Law School.
14. Tuesday, April 30 – Wei Cui, University of British Columbia Law School.

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INTERNATIONAL CORPORATE TAX AVOIDANCE: A REVIEW OF THE CHANNELS, MAGNITUDES, AND BLIND SPOTS

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Abstract. This paper reviews the rapidly growing empirical literature on international tax avoidance by multinational corporations. It surveys evidence on the main channels of corporate tax avoidance including transfer mispricing, international debt shifting, treaty shopping, tax deferral, and corporate inversions. Moreover, it performs a meta-analysis of the extensive literature that estimates the overall size of profit shifting. We find that the literature suggests that, on average, a 1 percentage-point lower corporate tax rate will expand before-tax income by 1%—an effect that is larger than reported as the consensus estimate in previous surveys and tends to be increasing over time. The literature on tax avoidance still has several unresolved puzzles and blind spots that require further research.

Keywords. Corporate taxation; International tax avoidance; Meta-analysis; Multinationals; Profit shifting

1. Introduction

Tax avoidance by multinational corporations (MNCs) has been on top of the international tax policy agenda since the global financial crisis. The tight fiscal constraints in the aftermath of the crisis amplified long-standing concerns in many countries that large MNCs pay very low effective tax rates. Moreover, the revelation of aggressive avoidance schemes in Luxleaks and more recently the Paradise papers have reinforced the public disquiet about the unfairness of the low effective taxation of some MNCs. These concerns have led to major new international initiatives to curb international tax avoidance—most notably the G20/OECD initiative on base erosion and profit shifting. Their aim is to develop approaches that limit the opportunities for MNCs to artificially shift profits and thus to enhance revenue mobilization (OECD, 2015).

This paper offers a survey of the empirical literature on international tax avoidance. The latter is defined as the international reallocation of profits by an MNC in response to tax differences between countries, with the aim to minimize the global tax bill. Hence, we ignore reallocation of real capital in response to tax. This survey goes beyond discussing studies assessing the overall magnitude of profit shifting and includes those on the importance of specific channels, especially the most commonly adopted ones such as transfer mispricing, strategic location of intellectual property (IP), international debt shifting, and treaty shopping. It also discusses tax avoidance that is unique to worldwide taxation systems, such as corporate inversions/headquarter location and tax deferral. Moreover, it summarizes empirical evidence

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on the effectiveness of a range of targeted anti-avoidance measures, which have been put in place to curb tax avoidance.

This paper extends earlier literature reviews by, for example, Dharmapala (2014), Hines (2014), and OECD (2015) in three important ways. First, we place a variety of empirical tax avoidance studies into a systematic framework of the current international tax architecture. Second, within this framework, we broaden the review's scope, as the number of studies on tax avoidance has been rapidly expanding in recent years. We survey empirical evidence on six main channels of international tax avoidance, four of which generate systematic differences in reported profits before taxation and can be characterized as tax-motivated profit shifting due to differences in the cross-border statutory corporate tax rates.

Finally, we perform a meta-analysis of studies estimating the effect size of total profit shifting to derive a consensus estimate of the tax sensitivity of MNC's reported profits to tax rates. The meta-analysis extends earlier work by Heckemeyer and Overesch (HO, 2017) by almost doubling the sample size of primary estimates,[1] reducing specification bias, and adopting an enhanced estimation method that corrects for within-study correlation of primary estimates. Our results suggest that a semielasticity of reported pretax profits with respect to international tax differentials of unity is a good reflection of the literature. This means that a 1 percentage-point larger tax rate differential reduces reported pretax profits of an affiliate by 1%. The estimate is larger than the consensus semielasticity of 0.8 in Heckemeyer and Overesch (2017). We further complement Heckemeyer and Overesch (2017) by providing new insights into the importance of controlling for the scale of real activities in estimating the consensus semielasticity estimate: excluding this control introduces upward bias in the consensus semielasticity by inflating it to around 1.4. Moreover, we find that the semielasticity has increased over time and that a value of around 1.5 applies to the most recent years. The insight is extremely important for the policy debate on profit shifting and for the calibration of models that account for tax avoidance. Using this estimate, we illustrate the revenue impact of tax avoidance for 81 countries.

The rest of this paper is organized as follows. Section 2 provides a broad overview of international tax avoidance, elaborating on the current international tax architecture, discussing empirical evidence on various avoidance channels, and elaborating on the impact of specific anti-avoidance measures. Section 3 reviews the literature on the overall size of profit shifting and provides a meta-analysis. It derives a consensus semielasticity and illustrates its implications for government revenue. Finally, Section 4 discusses a number of puzzles and blind spots in the literature. It points to research that would be needed to further advance our understanding of international corporate tax avoidance in the future.

2. International Tax Avoidance—The Issue

2.1 *Brief Overview of the International Tax Architecture*

The tax treatment of MNCs is determined by the international tax framework, which is a myriad of domestic legislations and a wide network of bilateral and multilateral tax treaties. The framework relies largely on *separate accounting,* which means that taxation of an MNC group is at the level of individual subsidiaries that operate in different countries. Each country has a right to tax the income assigned, based on its domestic law and tax treaty obligations.

2.1.1 *When Can a Country Tax MNCs?*

MNCs generate income in two main ways: selling products or services and investing their cash on hand. The former is typically known as active income, and the latter, passive. The taxing rights of a country over MNC income are based on the source of the income and the residence of the corporate taxpayer.

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Source refers to where investment and production take place and is largely determined by the physical presence of labor and/or capital. Certain thresholds must be met to define a permanent establishment (PE), which determines whether a source country can tax a foreign company or not. Residence refers to the place where the company receiving the income is deemed to have its primary location. Common tests for this are where the company is incorporated or effectively managed. Following international convention, source countries have primary taxing rights over the active business income of foreign PEs, while residence countries retain the right to tax passive income.

2.1.2 *How Does a Country Tax MNC Earnings?*

Two alternative systems determine the taxation of active business income of MNCs. Under a territorial system (used, e.g., in Europe and Japan), residence countries exempt foreign earnings of MNCs so that their active business income is only taxed in the source country. Under a worldwide system (used, e.g., in the BRICS and until recently the US), the residence country retains the right to tax active income from all source countries. Double taxation is typically avoided by the residence country granting a nonrefundable foreign tax credit against its own tax, so that the residence tax is limited to the excess of the residence country's effective tax rate over that in the source country.

In practice, the distinction between worldwide and territorial systems is not as clear-cut. Some provisions in existing systems, such as the deferral of dividend tax obligation until repatriation or the use of excess credits from high-tax countries to offset taxes on dividends from low-tax countries (cross-crediting), tend to soften the bite of worldwide taxation (Matheson *et al.*, 2014). Other measures, such as controlled foreign company (CFC) rules, extend domestic taxation rights for both worldwide and territorial systems by taxing foreign passive income immediately.

Withholding taxes (WHTs) also blur the clean allocation of passive income between source and residence countries. Many source countries impose WHTs on outbound income payments, such as interest, royalties and dividends. While residence countries typically provide some relief through foreign tax credits, unilateral endeavors to prevent double taxation are often imperfect and WHTs can "stick" on cross-border income flows. Double tax treaties (DTTs), by specifying maximum WHT rates that are often lower than the domestic WHT rates and sometimes down to zero, tend to limit source country's taxing right on cross-border passive income flows.[2] In this context, withholding taxation becomes a bilateral instrument to divide revenues between countries.

2.2 *Main Channels of International Tax Avoidance*

2.2.1 *Avoidance of Source Country Taxation*

Within the international tax framework, MNCs can use a wide array of techniques to shift profits between entities in the group to minimize their overall corporate tax liability. These techniques can be entirely legal, in which case they are referred to as tax avoidance—as opposed to tax evasion, which is illegal.[3] The precise channels of tax avoidance can vary, depending on the specific features of national tax systems and treaty networks. For instance, taxation in source countries can be minimized by[4] (i) transfer mispricing (stretching, violating, or exploiting weaknesses in the arm's length principle); (ii) strategic location of management of IP to low-tax countries to reduce taxes on associated income; (iii) debt shifting through intracompany loans (excessive borrowing in high-tax countries and lending to low-tax countries); (iv) treaty shopping (exploiting treaty networks to route income so as to avoid tax); (v) risk transfer (conducting operations in high-tax jurisdictions on a contractual basis to limit profits attributable there); (vi) avoiding PE status; and (vii) locating asset sales in low-tax jurisdictions (to avoid capital gains taxes).

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The rest of this section reviews existing empirical evidence on the main channels of international tax avoidance. The literature review confines to channels where available data allow identifying the behavioral effects of the international tax systems. Systematic evidence on other channels is largely absent.

2.2.1.1 Transfer Mispricing

The valuation of intracompany transactions within an MNC affects the global allocation of the tax base between source and residence countries. Most countries use the *arm's length principle,* which stipulates that internal prices between related parties should resemble prices that would prevail between independent parties. Yet, there may be significant room for subjective interpretation. Conceptually, there may even be no "correct" arms-length price if there are no comparable third-party transactions. Given these weaknesses in the implementation of the arm's length principle, MNCs can charge a lower price for exports sold from high-tax to low-tax countries, or a higher price for inputs coming from low-tax countries, to reduce their global tax liability.[5]

The literature provides ample evidence for the presence of tax-motivated transfer mispricing. Earlier empirical studies show that at the aggregate level, differences in the statutory corporate tax rate between the USA and its trading partners substantially influence the balance and pattern of intrafirm trade in the USA (Clausing, 2001, 2006). Later studies provide more direct evidence, showing that the price wedge between the arm's length price for unrelated transactions and the transfer price for related-party transactions varies systematically with corporate tax rate differentials faced by MNCs in the USA (Clausing, 2003; Bernard *et al.*, 2006; Flaaen, 2016), Denmark (Cristea and Nguyen, 2016), France (Davies *et al.*, 2018), Germany (Hebous and Johannesen, 2015), and the United Kingdom (Liu *et al.*, 2017). The size of the effect, however, differs between studies, reflecting possible differences between countries, sectors and firms, as well as in the empirical sample and estimation methods. Overall, the estimated semielasticity (i.e., the percentage change in the transfer price in response to a 1 percentage point change in the tax rate) ranges between 0.5 and 6.

2.2.1.2 Strategic Location of IP

Another way to reduce the global tax of an MNC is by strategically moving valuable IPs to low-tax affiliates. Companies can conduct their research and development (R&D) activities in one country, but transfer the ownership of the patent that is subsequently created to another country where the resulting income streams will be taxed at a lower rate.[6] As there is often no comparable transactions of IPs between unrelated parties, determining the arm's length price for company's intangible transactions is usually very difficult, leaving room for tax-induced manipulation of transfer prices (see, e.g., Grubert, 2003; Desai *et al.*, 2006).

Empirical evidence concurs that the location of valuable IP is systematically distorted toward low-tax locations, by documenting a negative association between the level of corporate tax rate and the probability of patent application and the subsidiary's level of IPs in one country. Specifically, using a panel data set of multinational affiliates within the EU-25 between 1995 and 2005, Dischinger and Riedel (2011) find that a decrease in the average tax difference to all other affiliates by 1 percentage point raises the subsidiary's level of IP by 1.6%. Using data on corporate patent holdings of European MNCs, Karkinsky and Riedel (2012) find that a 1% point increase in the corporate tax rate reduces the probability of patent applications by around 3.5–3.8%. Tax responses of IP locations are found to be heterogeneous across European countries, with the amount of patents held most sensitive to tax in Luxembourg (with an estimated tax semielasticity of 3.9) and least sensitive in Germany (with an estimated tax semielasticity of 0.5) (Griffith *et al.*, 2014). Empirical evidence using data on European and US patent and trademark applications during 1996–2012 also suggests that there is substantial difference in the tax responses of IP locations between types of IP (Dudar and Voget, 2016), where the estimated tax semielasticity of trademarks is -6.2 and is significantly larger than that of patents (with an average tax semielasticity of -1.9).

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2.2.1.3 International Debt Shifting

A third way for an MNC to reduce its tax bill is through intracompany loans. Cross-country differences in rates of CIT create opportunities for lending from low-tax countries to affiliates in high-tax countries or by locating external borrowing in high-tax countries. This debt shifting reduces the group's tax bill without affecting the overall debt exposure of the group (and hence its bankruptcy risk).

Empirical studies confirm the presence of debt shifting, by showing that host-country taxes or international tax differentials have a positive and significant effect on internal debt of German MNCs (Weichenrieder, 1996; Ramb and Weichenrieder, 2005; Mintz and Weichenrieder, 2010; Buettner and Wamser, 2013; Schindler *et al.*, 2013), on intrafirm interest and debt ratio of US MNCs (Grubert, 1998; Altshuler and Grubert, 2003; Desai *et al.*, 2007), and on internal leverage of MNCs in Europe (Huizinga *et al.*, 2009). Synthesizing this literature in a meta-analysis, De Mooij (2011) finds that the tax elasticity of intracompany debt is 0.5, which corresponds to a tax impact on the internal debt-asset ratio of 0.12. Debt shifting is found to be more pervasive in developing countries, with the effect of taxes twice as large as in developed economies (Fuest *et al.*, 2011).

2.2.1.4 Tax Treaty Shopping

Considerable variation in the WHT rates in more than 3000 bilateral DTTs creates opportunities of treaty shopping. This enables MNCs to link different DTTs and divert cross-border payments through the country with the lowest WHT rate.

Empirical evidence for treaty shopping is first documented by Mintz and Weichenrieder (2010), who show that higher bilateral WHTs to (from) Germany increase the probability that outward (inward) FDI is diverted via a third country. The link between lower WHT rates and rerouting of FDI is further supported in Weyzig (2013), who shows that the reduced WHT rate on dividend payments in Dutch tax treaties is the key driver of FDI diversion through Dutch Special Purpose Entities. Revenue losses associated with treaty shopping can be substantial for source countries. Beer and Loeprick (2018) find that treaty shopping has reduced revenues in sub-Saharan Africa by around 8.5% among countries having signed a treaty with an investment hub. Balabushko *et al.* (2017) show that reduced WHTs under the Ukraine–Cyprus DTT imply revenue losses of around USA $77 million for Ukraine in 2015, or 1% of corporate income tax (CIT) revenue.

2.2.2 Avoidance of Residence Country Taxation

Worldwide systems can serve as a backstop for the avoidance of source taxes, since income will ultimately be subject to repatriation taxes in the residence country. However, residence taxation can also be avoided. One way is by the artificial use of tax deferral (delaying payment to the parent, sometimes indefinitely). Alternatively, the firm can avoid resident status through corporate inversion (changing residence to escape repatriation taxes or CFC rules) or by choosing the location of a new residence in a country that operates a territorial system.

2.2.2.1 Tax Deferral

As worldwide taxation imposes residence tax only upon repatriation of the profit, MNCs can avoid repatriation taxes by retaining foreign earnings abroad.[7] Several empirical papers find support for tax deferral, by showing that US MNCs increase their dividend payout in response to lower taxes on repatriation (Hines and Hubbard, 1990; Altshuler and Newlon, 1993; Grubert, 1998; Altshuler and Grubert, 2003). Recent studies, exploiting UK's and Japan's adoption of a territorial system in 2009 in a quasi-experimental setting, provide similar evidence that exemption of foreign earnings boosted dividend repatriation in the UK (Egger *et al.*, 2015) as well as in Japan (Hasegawa and Kiyota, 2017).

2.2.2.2 Corporate Inversions and HQ Location

MNCs in worldwide countries can also avoid repatriation taxes by changing the residence of the corporation or, stated differently, by "inverting" roles in the corporate group.[8] Corporate inversion by US

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parents is generally associated with substantial tax savings (Desai and Hines, 2002). Using a data set of 60 US MNCs that restructured between 1983 and 2015, CBO (2017) finds that the average saving in each company's global corporate taxes is around USA $45 million in the year after the inversion.

More broadly, corporate inversions are a special case of cross-border mergers and acquisitions (M&As) that are influenced by tax considerations. Using data on 278 cross-border M&As between 1997 and 2007, the taxation of foreign passive income in CFC legislations and worldwide taxation of foreign active income are found to be major drivers for cross-border M&As (Huizinga and Voget, 2009; Voget, 2011).

2.3 *How Effective Are Anti-Avoidance Regulations?*

During the last few decades, countries have adopted various anti-avoidance regulations to mitigate tax avoidance by MNCs. These include, for example, the adoption of transfer pricing regulations, thin capitalization rules, controlled foreign corporation (CFC) rules, or a general anti-avoidance rule (GAAR). These efforts have received considerable attention in light of the G20-OECD initiative on BEPS. For instance, countries participating under what is now called the inclusive framework on BEPS commit to four minimum standards (e.g., on treaty abuse) and adhere to the common approaches to adopt anti-avoidance legislation. The European Commission has also adopted an anti-tax-avoidance directive that requires its member states to implement a common set of rules to address tax avoidance. This section reviews the studies that analyze the effectiveness of these anti-avoidance rules.

Transfer pricing regulations offer guidance in the implementation of the arm's length principle. They often specify the methods that can be used to calculate transfer prices, determine documentation requirements, include various specific requirements in its application needed to support the transfer prices used, and set penalties if mispricing is detected or adequate documentation is not provided. Their effectiveness in curbing international tax avoidance is supported in two concurrent studies, which show that introduction and tightening of transfer pricing rules can diminish the tax sensitivity of corporate profits by 50% (Riedel *et al.*, 2015), though with much weaker effects for firms with lots of intangible assets or complex group structures (Beer and Loeprick, 2015). However, a later study shows that stricter regulations reduce reported profits of MNCs, possibly due to the combination of lower profit inflows into countries that are intermediate hubs for profit shifting and higher compliance costs of MNCs (Saunders-Scott, 2014).[9]

Thin capitalization rules deny interest deductibility above a certain threshold of either net interest payment (as a ratio of income) or net debt (as a ratio to equity). The precise conditions under these rules vary between countries and over time. Empirical evidence suggests that, on average, well-designed thin capitalization rules are effective in reducing debt shifting by multinationals, using data for MNCs in Germany (Overesch and Wamser, 2010; Buettner *et al.*, 2012) and the USA (Blouin *et al.*, 2014).

CFC rules stipulate that foreign subsidiaries' profits are subject to domestic taxation without deferral if certain conditions are met. CFC rules thus expand domestic taxation rights of territorial systems and limit the impact of deferral under worldwide systems. Initial studies have exploited the German MiDi data set and find that CFC legislation reduces passive assets by 77–82% for subsidiaries where the legislation was binding, that is, for whom the statutory tax rate in their host country falls below the safe-haven tax rate (Ruf and Weichenrieder, 2012). A recent study confirms this finding, by contrasting the financial earnings of subsidiaries in 200 countries just above and below the tax rate threshold; it reports a 20% difference in the level of reported profit due to binding CFCs (Clifford, 2017).

3. A New Consensus on Tax-Motivated Profit Shifting

The research reviewed in the previous session examines channels of international tax avoidance separately. In contrast, following a simple conceptual framework developed by Hines and Rice (1994), and extended

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by Huizinga and Leaven (2008), a wide body of empirical work has examined the overall extent of tax-motivated profit reallocation by estimating the following regression:

$$\log(\pi_i) = \varepsilon(\tau_i - \bar{\tau}) + \gamma' X_i + u_i \quad (1)$$

where π is a measure of reported profit before taxation in country i, $(\tau_i - \bar{\tau})$ is a tax rate differential, X is a vector of control variables, and u is an idiosyncratic error term. The tax rate differential measures the difference in statutory CIT rate between location i and the average CIT rate among other affiliates of the same company group. The tax coefficient (ε) captures the responsiveness of reported profits to the tax rate differential and is expected to be negative in the presence of profit shifting.

Many recent studies estimate Equation (1) using firm-level data. However, some studies use more aggregate data to infer a relationship between taxable profits and tax rate differentials. Micro studies on profit shifting only capture avoidance behavior that affects the observed profits of an MNC. While transfer mispricing, international debt shifting, and strategic location of IPs directly affect reported profitability, other avoidance channels are not necessarily captured in studies using variants of Equation (1). For instance, avoidance of PE status implies that there is no profit reported in the first place, suggesting that microstudies that exploit firm-level data would neglect this channel.[10] Alternatively, avoidance of dividend taxes on repatriation would change after- but not before-tax profits, and would not be captured in either macro- or microstudies. Macro studies may capture a wider range of profit shifting channels related to statutory CIT rate differentials. Yet, by exploiting variation in the statutory CIT rates, all studies neglect avoidance of other corporate taxes, including those on interest, royalty and service fees, or on capital gains tax (treaty shopping and offshore indirect transfer of assets).

Empirical estimates of the semielasticity vary widely. Part of this dispersion is structural, as costs of profit shifting are likely to differ across MNCs of different operating scale or industry structure, and across countries with varying enforcement and administrative capacity. Given these differences, we expect variability in the estimates from different studies that rely on different samples even with the same regression specification. Part of the dispersion in the estimated semielasticity, however, is study-specific. For example, early studies often use cross-sectional data at the country level, and rarely control for real determinants of economic profitability. More recent studies use microlevel panel data and control for a wide range of nontax determinants of profits at both the macro and firm level.

This section uses metaregressions to synthesize existing empirical evidence on profit shifting and to disentangle the drivers behind reported estimates. Specifically, we first construct a comprehensive data set that includes 402 estimated semielasticities of reported profit with respect to a tax measure, associated standard errors, and a range of specification- and study-specific variables. We then use a metaregression to uncover the "consensus estimate," which represents the most likely value of the true semielasticity based on all evidence currently available.[11]

3.1 *Data and Descriptive Statistics*

We identify relevant studies in a comprehensive search of the EconLit database, economic journals, and working paper platforms, such as SSRN, using the keywords "income shifting," "profit shifting," and "tax avoidance."[12] We include studies that use a profit measure as the dependent variable and that either directly produce tax semielasticities or allow for their imputation. Our baseline sample has 402 semielasticities from 37 papers:[13] the earliest study Hines and Rice (1994) uses cross-sectional data in 1982; the latest Dowd *et al.* (2017) uses microlevel panel data up to the year 2012.

Table 1 summarizes features of the semielasticities in four subsamples of the main data set (column (1), differences described below). Column (2) shows the mean semielasticities. The average semielasticities of 1.59 in the baseline sample suggest that reported profit decreases by 1.59% in response to a 1 percentage

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Table 1. Estimated Semielasticity of Pretax Profits.

Sample (1)	Mean (2)	Weighted mean (3)	Median (4)	Observations (5)	Number of underlying studies (6)
Baseline	1.59	0.79	1.05	402	37
No conditional estimates	1.54	0.79	1.01	294	35
Heckemeyer and Overesch (2017) sample	1.47	0.79	1.00	208	26
Peer-reviewed, microdata sample	1.38	0.72	0.99	269	22

Notes: This table reports the summary statistics of the semielasticity estimates in four different samples in column (1). Weighted mean is computed as the average of semielasticity estimates weighted by the inverse squared standard error.

point increase in the statutory tax rate. Simple averages, however, ignore imprecisions in the primary estimates. Following HO, column (3) summarizes the weighted averages of estimated semielasticities by weighting each estimate with its inverse squared standard error, and shows a much smaller average response of 0.79 for the baseline sample.

Baseline Sample. Our baseline sample expands the HO sample in two important ways. First, it includes more studies of profit shifting. Second, it includes more estimates from the same studies included in HO.[14] Several papers investigate how profit shifting varies with some other explanatory variables (z), such as the presence of mandatory documentation requirements or the intangible intensity of the firm, typically in regressions of the form

$$\log(\pi_i) = \beta_1 \tau + \beta_2 z\tau + \gamma' X + \varepsilon \tag{2}$$

To avoid loss of information, we compute average conditional semielasticities as $\beta = (\beta_1 + \beta_2 \bar{z})$ when the regression includes interaction terms between the tax rate and some additional firm or country characteristics. We evaluate β at the mean value of z, $\bar{z}$. The associated standard errors are computed using the delta method.

Sample without Conditional Estimates. When dropping conditional semielasticities, which capture the effect of the tax rate interacted with some other explanatory variables from the baseline sample, we lose around one quarter of observations. The mean estimate is 1.54 and slightly smaller to the average in the baseline sample, while the weighted average and median are almost identical.

HO (2017) sample resembles the data used in their study, with similar mean and median values of the estimated semielasticity.[15] Minor differences occur because we use estimates based on updated or published versions of the primary studies.

Peer-reviewed microdata sample includes 269 semielasticity estimates from 22 peer-reviewed papers that exploit microlevel data. The mean, weighted average, and median semielasticity estimate in this sample are 1.38, 0.72, and 0.99, respectively.

Figure 1 illustrates the semielasticities of the baseline sample by the average sample year of the underlying study. On average, reported estimates have decreased over time (solid line). This may reflect a reduced tax response over time. Alternatively, the declining trend may also reflect the more extensive use of granular data (i.e., firm-level panel instead of country-level cross-sectional data) or improved empirical strategies. The dotted and dashed lines in Figure 1 illustrate this interpretation, differentiating time trends between macro- (dotted line) and micro-based studies (dashed line). We further explore the impact of these characteristics on the consensus estimate in the meta-analysis.

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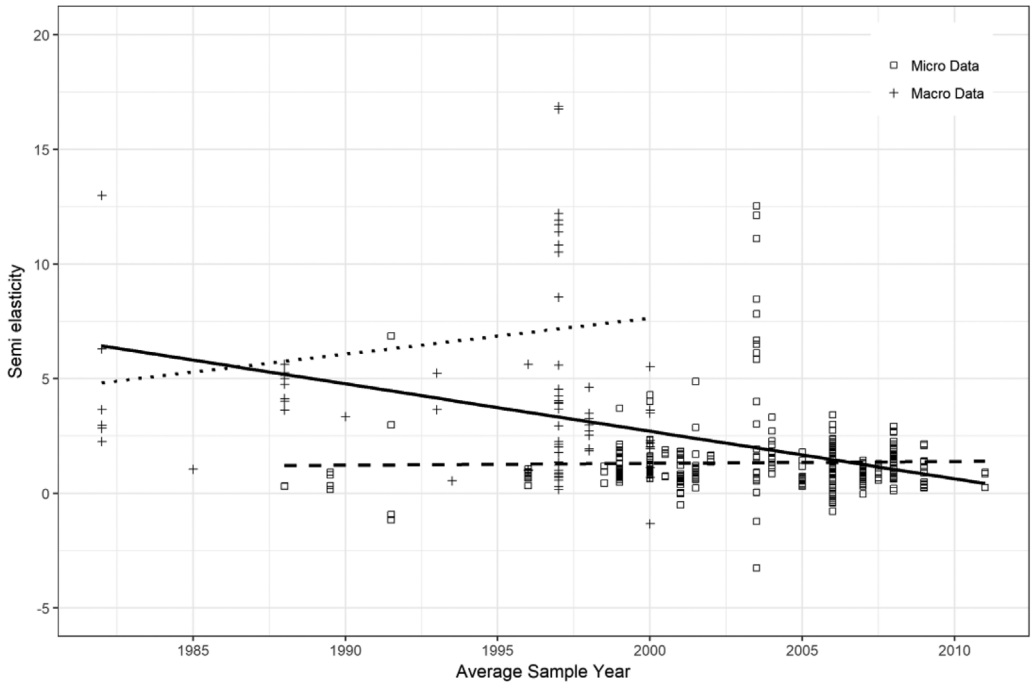

Figure 1. Semielasticity Estimates over Time.
Notes: The crosses show estimated semielasticities using macrodata; the squares show estimated semielasticities using microdata. The solid line is an aggregate time trend; the upper dotted line denotes the time trend in the macro-based estiamtes and the lower dashed line denotes the time trend in the micro-based estiamtes.

3.2 *Synthesis of Primary Estimates: Metaregression*

3.2.1 *Benchmark Specification*

Measured semielasticities differ due to structural differences in the underlying sample and differences in the estimation strategy. To disentangle these, we estimate a metaregression of the form:

$$\widehat{\varepsilon_{ij}} = \varepsilon + \beta' X_{ij} + \omega_{ij} \tag{3}$$

where $\widehat{\varepsilon_{ij}}$ is the ith semielasticity reported in study j, the vector X_{ij} comprises a set of dummy variables that take the value of 1 if estimate j in study i deviates from the benchmark specification, and ω_{ij} is an error term. The intercept ε thus captures the average semielasticity, while the coefficients on X_{ij} indicate deviations from this consensus estimate due to study- and estimate-specific attributes. Specifically, X_{ij} includes four groups of study or estimation characteristics:

3.2.2 *Estimation Techniques and Data Features*

Despite more use of micro data sets in recent studies, researchers continue to exploit macrodata due to its broader coverage in time and geography. Time series of aggregate data help revealing long-run tax

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elasticities, as it often takes time for MNCs to restructure their transaction or financing arrangement in response to tax changes. Aggregate data also have obvious drawbacks: profit shifting incentives at the affiliate level are unobservable, factor inputs cannot be matched with reported profitability, and unobservable factors at the firm-level cannot be controlled.[16]

Our preferred specification uses microdata and controls for firm- and country-specific fixed effects. The indicator *Aggregate Data* take the value of 1 for studies using country-level data; the indicators *No Firm FE* and *No Country FE* take the value of 1 if the study does not control for unobservable characteristics that differ across firms or countries, respectively.

3.2.3 *Dependent Variable Characteristics*

The distribution of firm profitability is heavily skewed and may not fit with a linear regressions model. Previous work addresses this issue in two ways: (1) dropping observations with negative profits and using the natural logarithm of profits as a dependent variable, or (2) using a profitability ratio, such as return on sales or return on assets, as the dependent variable. However, limiting the sample to firms with positive profitability might induce bias as loss making entities are potentially among the most aggressive tax planners (see, e.g., Johannesen *et al.*, 2017).[17] While using a profitability ratio may alleviate this bias, it may capture real responses to the tax rate in the denominator, confounding tax-minimization responses with real ones.

Against this background, our preferred specification uses the logarithm of reported profit before taxation as dependent variable. The dummy variable *Ratio* takes the value of 1 for studies using profitability ratios instead of the logarithm. The expected effect of this indicator is ambiguous as it depends on the denominator's response to tax differentials. The dummy variable *EBIT* takes the value of 1 for studies using before financing profit as the dependent variable. As before-financing profits exclude tax avoidance through internal borrowing, we expect the coefficient of *EBIT* to be negative.

3.2.4 *Tax Variable Characteristics*

From a theoretical perspective, the tax rate variable should capture the net tax savings associated with a relocation of one dollar across the corporate group. Microlevel data often allow computing statutory tax rate differentials that are likely good approximations to this theoretical concept. Absent detailed ownership information, researchers typically use the host country's statutory tax rate. Several studies, particularly from the USA, use backward looking average effective tax rates. These rates are outcomes of past profit shifting behavior and raise reverse causality concerns.

Absent special tax regimes and tax holidays, statutory corporate tax rates are precisely the rates applying to the *marginal* unit of profits and thus capture the true incentive for profit shifting (Devereux, 2007). Our preferred specification uses a statutory tax rate differential. The dummy *SingleRate* takes the value of 1 for studies using a single tax rate. The indicator *Effective* takes the value of 1 for studies relying on effective tax rates instead of statutory corporate tax rates. We expect the indicator *SingleRate* to have a negative sign due to attenuation bias. Given the positive reverse causality of reported profit on effective tax rates, we expect a positive sign on the indicator *Effective*.

3.2.5 *Controlling for Real Activity and Leverage*

Part of the variation in reported profits is due to changes in economic profits, which depend on the scale of real activities. A regression neglecting differences in real investments omits an important determinant of reported profitability and may yield omitted-variable bias.

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Our benchmark study controls for real production inputs, but not for debt, as internal financing decisions are one channel of profit shifting. Accordingly, the indicator *NoReal* takes the value of 1 for studies that do not control for either assets, the number of employees, or payroll, and is expected to have a positive sign. The indicator *Debt* takes the value of 1 for studies that hold financing decisions constant (by including leverage decisions as an explanatory variable). We expect the coefficient on *Debt* to be negative as it excludes an important channel of profit shifting through debt shifting.

3.2.6 *Other Sample Characteristics*

We include the average sample year of the underlying study (*Z-MIDYEAR)* to investigate whether the observable extent of profit shifting has changed over time.[18] The expected sign of this variable is ambiguous: while growing importance of intangible assets and increasingly sophisticated tax planning strategies may indicate a larger tax sensitivity of the global tax base, strengthened anti-avoidance measures may add to the costs of profit shifting to the MNC, thus dampening the tax sensitivity of the global tax base.

3.3 *Efficient Estimation*

Researchers typically account for the varying precision of primary estimates by estimating metaregressions with weighted least squares (WLS). By using the squared inverse of the reported standard error as a weight, this estimation strategy gives more weight to more accurately measured observations and should thus increase estimation efficiency over ordinary least square (OLS).

However, the efficiency gains of WLS depend on the correct specification of the error structure. Notably, WLS rules out correlation of primary estimates at the study level, which seems to be a restrictive assumption in our context. For instance, studies focusing on intangible intensive firms likely find larger semielasticities than studies focusing on publicly owned manufacturing firms. Such differences would imply correlation of estimates at the study level and render WLS a less efficient estimation strategy.

We allow for correlation of primary estimates at the study level to increase the efficiency of our estimates. More specifically, we assume that the unobservable error component of semielasticity j in study i is given by

$$\omega_{ij} = u_i + v_{ij} \tag{4}$$

where u_i is study-specific and v_{ij} is estimate-specific. The study- and estimate-specific error components are independently distributed with mean zero and variances σ^2 and ${\sigma_{ij}}^2$.This formulation allows sample characteristics, such as the underlying industry composition or strength of country-specific anti-abuse measures, to drive the tax sensitivity of reported profits.

We implement the estimations in a two-stage approach. In the first stage, we use OLS on study-specific average values of all dependent and independent variables[19] to obtain the residuals $\omega_i = u_i + 1/K_i \sum_j v_{ij}$, where K_i is the number of point estimates provided in study i. Note that primary studies derive estimates conditional on study-specific characteristics. Reported standard errors thus directly provide information on the estimate-specific component $\sigma^2_{ij} = \mathrm{Var}(\widehat{\varepsilon_{ij}}|X, u_i)$. We infer the second component using

$$\widehat{\sigma^2} = \frac{1}{N-V} \sum_i \omega_i^2 - \frac{1}{N} \sum_i \frac{1}{K_i^2} \sum_j \sigma_{ij}^2 \tag{5}$$

where V is the number of control variables included in the regression. In the second step, we combine these estimates to construct the covariance matrix for a feasible generalized least squares (GLS) estimation.

A critical advantage of the GLS is that the weight given to any observation depends on the total number of estimates in a study: each observation tends to receive less weight if the underlying study

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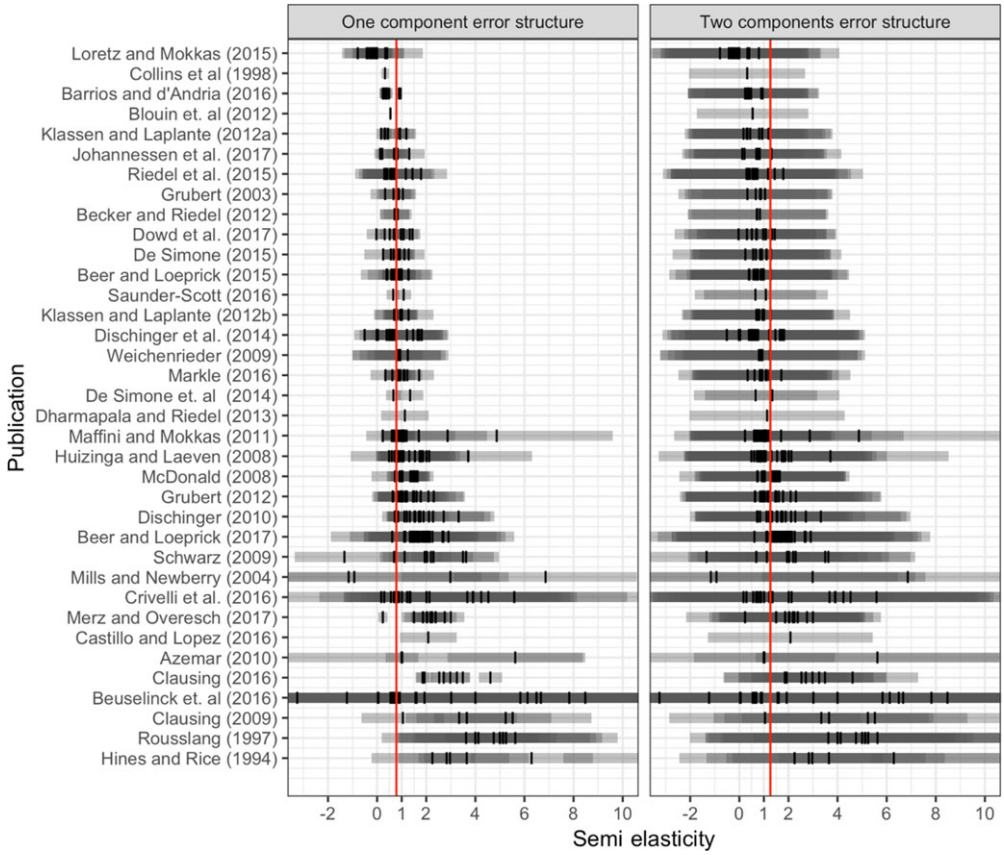

Figure 2. Unconditional Semielasticity Estimates. [Colour figure can be viewed at wileyonlinelibrary.com]
Notes: The short vertical black lines represent point estimates, and the (overlapping) clouds indicate associated confidence bands. The long red vertical lines denote the unconditional mean of all semielasticity estimates in our sample using WLS (mean of 0.8 indicated in the left panel) and GLS (mean of 1.2 indicated in the right panel) estimation.

provides many estimates; it receives more weight if the underlying study provides only a few estimates. This makes intuitive sense with intrastudy correlation where the estimates' information about the true parameter is subject to diminishing marginal returns. In contrast, WLS weighs observations solely based on the reported standard error, neglecting the underlying information source.

Figure 2 contrasts WLS (left panel) and GLS (right panel) estimates of the unconditional mean (red vertical line) in the baseline sample. Small vertical black lines depict point estimates; gray clouds around these point estimates illustrate associated 95% confidence bands. The left panel uses the standard errors that are reported in primary studies to illustrate these confidence bands, thus ignoring correlation at the study level. Many confidence intervals do not encompass the mean value in the left panel, suggesting that reported semielasticities and associated standard errors are from different distribution.[20] In contrast, the right panel presents confidence bands that account for variation at the study level, and shows considerable more overlap.[21]

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Table 2. Baseline Results.

Explanatory variable:	(1)	(2)	(3)	(4)	(5)
Constant	0.724***	1.205***	1.017***	0.974***	0.690***
	[0.127]	[0.244]	[0.286]	[0.128]	[0.098]
No Firm FE	0.121***	−0.159	−0.096	−0.211***	0.125
	[0.039]	[0.157]	[0.146]	[0.070]	[0.139]
No Country FE	0.456***	0.468***	0.359***	0.472***	0.097
	[0.036]	[0.025]	[0.125]	[0.020]	[0.190]
Aggregate Data	1.110**	1.674**	1.445**	1.082**	1.408***
	[0.515]	[0.637]	[0.632]	[0.513]	[0.330]
Aggregate Data* No Country FE	0.302***	0.296***	0.448***	0.354***	−1.274**
	[0.045]	[0.044]	[0.147]	[0.043]	[0.502]
Single Rate		−0.22	−0.23		
		[0.187]	[0.211]		
Effective		−0.536	−0.548		
		[0.671]	[0.677]		
Ratio		−0.341**	−0.344**	−0.374***	−0.251
		[0.152]	[0.142]	[0.069]	[0.161]
EBIT		−0.044	−0.045		
		[0.067]	[0.067]		
No Real Activity			0.469***	0.454***	0.045
			[0.104]	[0.116]	[0.372]
Debt			0.02		
			[0.113]		
No Market			0.349		
			[0.319]		
No Time FE			0.116		
			[0.114]		
Z-Midyear	0.035***	0.033***	0.036***	0.036***	0.014
	[0.008]	[0.008]	[0.009]	[0.008]	[0.019]
Group variance/Total variance	0.34	0.362	0.412	0.367	0
Observations	402	402	402	402	402
Estimation method	GLS	GLS	GLS	GLS	WLS

Notes: ***, **, * depict significance at the 1, 5, and 10 percent level, respectively. Fully robust standard errors are given in square brackets.

The simple graphical evidence suggests that a two-component error structure is more suitable to describe the unconditional mean in the baseline sample. Similarly, we find that an important share of the observed variation is at the study level in all conditional estimations of the mean (see regression results in the next section). Accordingly, we use GLS in all estimations to improve estimation precision over previous work.

3.4 *Main Findings*

Table 2 summarizes our regression results based on Equation (3) using the baseline sample. The dependent variable is the reported semielasticity of pretax profits, winsorized at top and bottom one percentile

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to remove the influence of outliers.[22] We account for heteroskedasticity and intrastudy correlation by presenting fully robust GLS standard errors (see, e.g., Arellano, 2003; Wooldridge, 2010). Moreover, we correct for the small number of clusters by inflating residuals[23] and reporting *p*-values based on *t*-distributions with *G*-1 degrees of freedom, where *G* is the number of the included studies (see Cameron *et al*., 2008).

Column (1) of Table 2 examines the joint impact of estimation techniques and data sources on measured semielasticities. The average semielasticity estimate is 0.72, when using microdata and including firm fixed effects. The coefficient on the indicator *No Firm FE* is positive and significant at the 1% level, suggesting that the assumption of no correlation between unobservable components at the firm level and the dependent variable might be violated in these models. Omitting country fixed effects increases the estimated semielasticity by an average of 0.46.

Among studies using aggregate data, estimated semielasticities are significantly larger and more sensitive to the inclusion of country-specific fixed effects. The coefficient on the *Aggregate Data* indicator of 1.11, which is significant at the 5% level, suggests that the data sources differ beyond the ability to control for unobservable factors at the firm level. With a magnitude of 2.29 (=0.72 + 0.46 + 1.11), the implied semielasticity for macrostudies is much larger than the effect identified in microstudies. Two explanations seem possible. On the one hand, macrodata potentially captures long-run responses and more channels. On the other hand, the larger effect may reflect bias, as aggregate data do not allow to match production factors with profitability measures at the firm level and precludes computation of relevant tax differentials. Country-specific fixed effects play a similar role for aggregate data as do firm-specific fixed effects for microdata. We acknowledge this difference by interacting the *No Country FE* indicator with the *Aggregate Data* indicator. Our findings suggest that estimated semielasticities increase by 0.76 (=0.46 + 0.3) if macro-based studies do not control for country-specific fixed effects; this effect is significantly larger than the increase for micro-based studies.

Column (2) of Table 2 adds dependent and tax variable characteristics, reporting an average semielasticity of 1.2. The firm fixed effect indicator is no longer significant, suggesting the additional controls subsume variations in the firm-level unobserved heterogeneity. The coefficient on *Single Rate* is −0.22 but not significant at conventional statistical levels. Similarly, the coefficient on the *Effective* indicator is negative and statistically insignificant. Studies using profitability ratios report significantly smaller semielasticities (−0.34) than studies using the logarithm of reported profit. Surprisingly, we do not find systematic differences between studies using EBIT and studies using profit before taxation as a dependent variable. Debt-shifting thus plays, on average, a minor role in our baseline sample.

We examine the importance of real production controls, leverage, and other covariates in column (3). The coefficient on the indicator *No Real Activity* is close to 0.5 and significant at the 1%, indicating an omitted variable bias in studies that neglect real responses to taxation. In contrast, debt ratios, macrocontrols, and time fixed effects do not seem to matter systematically in our baseline sample.

Following HO, we drop insignificant explanatory variables in column (4) to increase the estimation precision. The estimated constant of 0.98 is our preferred consensus semielasticity estimate. Studies yield smaller effects if they employ a profit ratio (instead of logarithm) or use a simple statutory tax rate (instead of a differential); they yield larger estimates if they do not control for unobservable country-specific effects, real activity, or use aggregate data.

We test the importance of the estimation approach by reestimating our preferred specification (column (4)) with WLS in column (5). As expected, many coefficients are no longer statistically different from zero, reflecting the reduced estimation efficiency of WLS. The estimated consensus semielasticity is now smaller at a value of 0.7. Surprisingly, the coefficient on the interaction between the aggregate data dummy indicator and the omission of fixed effects indicator is now negative and statistically significant at the 5% level.

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Throughout all columns using GLS estimations, the coefficient for the Z-Midyear variable is around 0.03 and significant at the 1% level, suggesting that the consensus semielasticity estimate increases with the sample year. For example, the consensus semielasticity is estimated to be 0.60 in 1990 and 1.5 in 2015. The positive coefficient of the sample year also suggests that the declining trend in the primary elasticity estimates in Figure 1 is driven by important characteristics of the primary studies other than time per se.

3.4.1 *Robustness Checks*

Table 3 checks the robustness of our findings by reestimating specification in column (3) of Table 2 with alternative samples. Column (1) examines the effect of outliers by using reported observations without winsorizing. Column (2) drops the top and bottom 5% of primary estimates. The results change slightly: with average values of 1.03 and 1 for the consensus estimate, respectively.

Column (3) excludes studies that are not published in peer-reviewed journals, and reports a slightly larger consensus estimate of 1.25. While most indicator variables have the expected signs, two differences emerge: first, the omission of country-specific fixed effects now impacts negatively on measured semielasticities. Second, we find a negative and significant coefficient on the indicator *EBIT*. Profit before interest and taxation decreases, on average, by 0.86 (=1.25 − 0.39)% in response to a 1 percentage point increase in the local statutory tax rate. The two estimates on the semielasticity of profits, before and after financial income, allow gauging the importance of debt shifting relative to other channels of profit shifting. Assuming interest payments account for 9% of pretax profit,[24] we expect a semielasticity of reported profit after financial income of 0.94 (=1.09*0.86) if financial channels are not used for profit shifting. The estimated response is 0.31 percentage points larger, suggesting internal debt shifting accounts for one-quarter (=0.3/1.25) of the total profit response.

3.4.2 *Comparison to HO*

Column (4) of Table 3 restricts the sample to estimates that were included in HO, and reports a consensus estimate of around 1. The measured sensitivity to international tax differentials exceeds HO's estimate by 25%, which could be due to (i) a different estimation strategy, (ii) a different baseline sample, or (iii) the inclusion of different control variables. We examine each one, in turn, in Table 4, thereby using the HO assumptions and then varying each of the three issues in turn. For (ii) and (iii), however, we also show GLS estimates.

Columns (1) and (2) of Table 4 examine the importance of different estimation strategies, by using the same sample and specification in HO (2017). Column (1) reports a consensus estimate of 0.797 using WLS, which is very similar to the value of 0.786 found by HO.[25] Column (2) reports the GLS consensus estimate, which increases to 0.997. The difference in estimates is not surprising, given that around 60% of the residual variation in primary estimates is due to differences between studies.

Columns (3) and (4) check the effect of using different samples. Column (3) estimates HO's preferred specification with WLS in our broader sample, and finds a much smaller consensus estimate of 0.499. Column (4) reports the GLS results under the same specification and sample, which increases the consensus estimate to roughly 0.816. Interestingly, the coefficient for the Z-midyear variable also becomes significant at the 1% level when using the larger sample, suggesting that the increasing trend of the consensus semielasticity estimate is only captured in the broader sample that includes more studies and primary estimates. The insight is important for the policy debate on profit shifting and for the calibration of economic models that account for tax avoidance.

Finally, columns (5) and (6) examine the importance of specification bias. In our baseline regressions, we control for characteristics of primary studies that explain measured effects in our sample, which

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Table 3. Robustness Checks.

Dependent Variable: Semielasticity of Reported Profit (No Winsorizing)				
Explanatory Variable:	(1)	(2)	(3)	(4)
Constant	1.026***	0.995***	1.250***	1.012***
	[0.292]	[0.282]	[0.256]	[0.288]
No Firm FE	−0.102	−0.103	0.595	0.273
	[0.146]	[0.143]	[0.486]	[0.630]
No Country FE	0.361***	0.360***	−0.906*	0.298
	[0.124]	[0.124]	[0.479]	[0.684]
Aggregate Data	1.458**	1.461**	1.237*	0.931
	[0.638]	[0.611]	[0.699]	[0.758]
Single Rate	−0.231	−0.229	0.051	−0.434
	[0.214]	[0.212]	[0.198]	[0.353]
Effective	−0.549	−0.558	−0.569	0.657***
	[0.679]	[0.678]	[0.694]	[0.163]
Ratio	−0.350**	−0.322**	−1.161**	−0.093
	[0.145]	[0.139]	[0.453]	[0.469]
EBIT	−0.047	0.007	−0.387*	−0.282***
	[0.068]	[0.020]	[0.206]	[0.102]
No Real Activity	0.475***	0.426***	0.810***	0.734***
	[0.108]	[0.084]	[0.160]	[0.145]
Debt	0.022	0.032	−0.081	−0.248**
	[0.114]	[0.124]	[0.154]	[0.114]
No Market	0.348	0.356	1.034***	−0.105
	[0.322]	[0.317]	[0.353]	[0.078]
No Time FE	0.115	0.116	−0.169	−0.037
	[0.114]	[0.114]	[0.160]	[0.224]
Aggregate Data* No Country FE	0.447***	0.440***	1.060**	NA
	[0.146]	[0.145]	[0.478]	NA
Z-Midyear	0.036***	0.036***	0.029***	0.069**
	[0.009]	[0.009]	[0.003]	[0.031]
Group variance/Total variance	0.336	0.801	0.291	0.704
Observations	402	380	328	208

Notes: ***, **, * depict significance at the 1, 5, and 10 percent level, respectively. Fully robust standard errors are given in square brackets.

were not included in HO. Column (5) adds the indicators *Ratio* and *No Real Activity* in HO's preferred specification and uses the HO sample. The estimated constant remains very close to the HO estimate and the indicator variables do not explain variation in primary estimates. Column (6) repeats estimation with GLS. While the coefficient on *Ratio* remains insignificant, the indicator *No Real Activity* now systematically explains differences in primary estimates. The consensus estimate is, with a value of 0.96, slightly smaller than the GLS estimate presented in column (2) of Table 2 when neglecting these indicators.

In sum, the differences in estimation strategy, sample, and control variables cause differences between our findings and HO. The broader sample and the additional control for study-specific characteristics reduce estimated semielasticities, while the use of GLS seems to raise them. A major difference between these estimation methods is that reported standard errors are more important in determining the weights

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Table 4. Comparison to HO.

Dependent variable: Semielasticity of reported profit (no winsorizing)						
	Estimation strategy		Sample		Controls	
Differences in:	WLS (1)	GLS (2)	WLS (3)	GLS (4)	WLS (5)	GLS (6)
Constant	0.797***	0.997***	0.499***	0.816***	0.759***	0.963***
	[0.116]	[0.248]	[0.119]	[0.161]	[0.118]	[0.294]
EBIT	0.061	−0.263**	0.117	−0.012	0.115	−0.267**
	[0.132]	[0.116]	[0.079]	[0.058]	[0.166]	[0.100]
Debt	−0.346	−0.302**	−0.343*	−0.031	−0.348	−0.259**
	[0.402]	[0.126]	[0.190]	[0.195]	[0.386]	[0.115]
After Tax	0.488	0.312	0.792***	0.186	0.516	0.405
	[0.492]	[0.258]	[0.193]	[0.248]	[0.709]	[0.359]
Z-Midyear	0.014	0.055*	0.020***	0.034***	0.02	0.060*
	[0.029]	[0.033]	[0.007]	[0.008]	[0.027]	[0.033]
Aggregate Data	−0.055	1.459*	0.31	1.430***	0.037	1.300*
	[0.473]	[0.749]	[0.479]	[0.518]	[0.708]	[0.724]
Single Rate	−0.049	−0.414	0.266**	−0.204	−0.054	−0.396
	[0.150]	[0.356]	[0.101]	[0.146]	[0.160]	[0.366]
No Time	−0.117	−0.136	−0.014	0.02	−0.049	−0.08
	[0.433]	[0.253]	[0.106]	[0.089]	[0.411]	[0.237]
No Firm	0.091	0.583	0.301*	0.083	0.083	0.617
	[0.238]	[0.702]	[0.163]	[0.091]	[0.214]	[0.723]
No Country FE	0.119	0.244	−0.156	0.500***	0.042	0.091
	[0.340]	[0.671]	[0.206]	[0.119]	[0.428]	[0.706]
Ratio					0.022	−0.096
					[0.366]	[0.457]
No Real Activity					0.263	0.715***
					[0.325]	[0.127]
Group variance/Total variance	0	0.649	0	0.368	0	0.714
Observations	208	208	402	402	208	208

Notes: ***, **, * depict significance at the 1, 5, and 10 percent level, respectively. Fully robust standard errors are given in square brackets.

used in the WLS approach, while the common group variance allowed in the GLS approach dampens their importance. Notably, a positive correlation between standard errors and estimated semielasticities would explain why WLS yields smaller average semielasticities than GLS.

3.4.3 *Publication Bias*

In principle, estimated semielasticities and reported standard errors should be independently distributed. However, researchers, editors, and referees tend to prefer significant statistical results over insignificant results and previous work has indicated that selective reporting and publication of empirical findings is ubiquitous in the economics literature (see, e.g., Card and Krueger, 1995; Ashenfelter *et al.*, 1999; Doucouliagos and Stanley, 2013). Empirical work on profit shifting is likely no exception.

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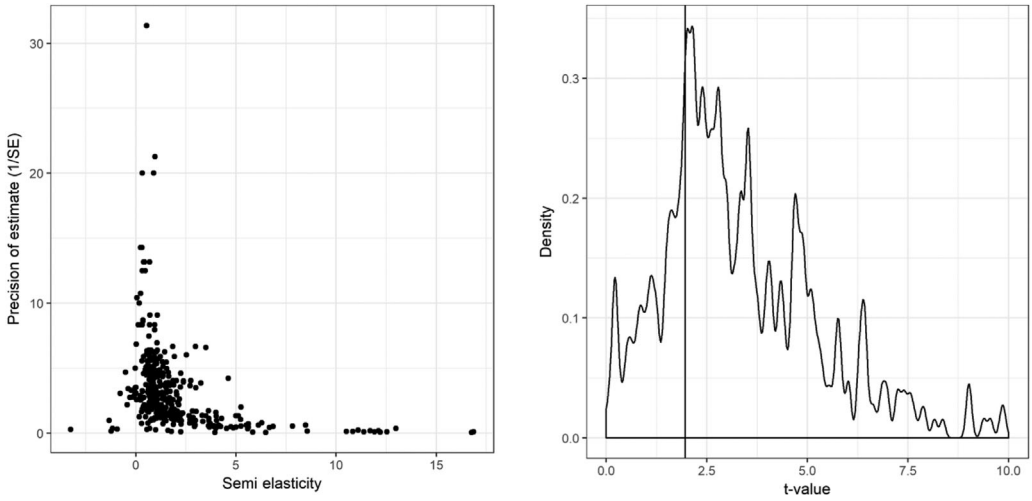

Figure 3. Graphical Evidence for Publication Bias.
Notes: Left panel plots semielasticities against inverse of standard errors. Right panel plots the density of associated *t*-values (semielasticity/standard error). The vertical line in the right panel depicts a *t*-value of 1.96.

Theoretical considerations imply that profit shifting induces a negative correlation between reported profit and the tax differential. However, data sources often have insufficient detail and local statutory tax rates change infrequently. As a result, the identified effect is sometimes imprecisely measured and random errors might even lead to estimated semielasticities that are positive. If researchers do not report such estimates, our metaregression suffers from sample selection and the mean estimate will be upward biased. Besides selective reporting, researchers potentially reestimate the same regression with slight perturbations (*p*-hacking) to provide statistically significant results. While this practice does not necessarily introduce bias in reported semielasticities, it does induce a correlation between standard errors and coefficient estimates, which impacts estimations using reported standard errors as weights.

Figure 3 presents two pieces of graphical evidence to explore the potential of publication bias in our sample. The left panel presents a funnel plot, where the inverse of reported standard errors is plotted against the reported semielasticity. Observations located at the top of the graph are accurately measured and should thus approximate the true mean. In contrast, observations at the bottom of the graph are imprecisely measured and on average expected to deviate to a larger degree from the mean. The plot clearly conveys asymmetry in the distribution of reported estimates, suggesting that the probability of ending up in our sample decreases substantially if the semielasticity carries the wrong sign. The right panel presents the density of *t*-values in our sample, where the vertical line depicts the critical value of 1.96. The spike right next to this line is consistent with *p*-hacking.

Column (1) of Table 5 examines the presence of publication bias by estimating the baseline specification with the reported standard error as an additional explanatory variable. The positive effect of the standard errors on reported semielasticities is significant at the 1% level and consistent with publication bias. The implied publication bias is not related to the average sample year (column (2)) or whether an estimate was taken from a published study or from an unpublished study (column (3)).

The constant in metaregressions that include the reported standard error has been interpreted as a selection-corrected estimate of the true effect (see, e.g., Doucouliagos and Stanley, 2009; Christensen and Miguel, 2016). While the precise relationship between the true parameter and the standard error depends on the selection rule that introduced publication bias in the first place, the relationship is in

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Table 5. Evidence on Publication Bias.

Dependent variable: Semielasticity estimates			
	(1)	(2)	(3)
Constant	0.483***	0.470***	0.531***
	[0.147]	[0.166]	[0.192]
SE	1.996***	2.041***	1.904***
	[0.381]	[0.427]	[0.401]
SE*Z-Midyear		0.042	
		[0.050]	
WP			−0.094
			[0.171]
SE*WP			1.008
			[0.717]
No Firm FE	−0.337**	−0.346**	−0.417**
	[0.131]	[0.148]	[0.185]
No Country FE	0.520***	0.527***	0.540***
	[0.031]	[0.036]	[0.038]
Aggregate Data	0.796*	0.952*	0.868**
	[0.418]	[0.485]	[0.417]
No Country FE*Aggregate Data	0.253***	0.255***	0.238***
	[0.055]	[0.060]	[0.057]
Ratio	−0.510***	−0.521***	−0.594***
	[0.130]	[0.147]	[0.183]
No Real Activity	0.249***	0.268***	0.309**
	[0.076]	[0.076]	[0.120]
Z-Midyear	0.026***	0.021**	0.024***
	[0.007]	[0.009]	[0.006]
Group variance/Total variance	0.295	0.301	0.304
Observations	402	402	402

Notes: ***, **, * depict significance at the 1, 5, and 10 percent level, respectively. Fully robust standard errors are given in square brackets.

general nonlinear (Andrews and Kasy, 2017), implying that the constants depicted in Table 5 are biased predictions of the true parameter. Accordingly, while we conclude that there is publication bias in the profit shifting literature, we do not interpret the constants in Table 5 as selection-corrected estimates of the true semielasticity.

3.5 *Simulation of Revenue Effects*

This section illustrates the revenue impact of profit shifting using the consensus estimate.[26] Specifically, we draw on the theoretical model of Huizinga and Laeven (2008), which suggests that the observed tax base in country i (π_i) is the sum of true profits (B_i) and shifted income S_i:

$$\pi_i = B_i + S_i(\boldsymbol{B}, \varepsilon, \boldsymbol{\tau}), \quad \text{for all } i = 1, \ldots N \tag{6}$$

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Table 6. Estimated Revenue Losses.

Country	USA (1)	Big 15 (2)	Low-tax 15 (3)	Global (4)
CIT revenue (in billion. US$)	363	1563	49	1888
CIT rate (federal + state, %)	40	31	15	30
Reported CIT base	907	4983	318	6213
True CIT base	1095	50,784	263	6213
Corporate income shifted	198	102	−55	0
Revenue loss (in % of CIT revenue)	17.2	4.1	−19.8	2.6
Revenue loss (in % of GDP)	0.42	0.11	−0.43	0.07

Note: We calculate the variables as follows: CIT revenue is $\sum_i \boldsymbol{\tau}\boldsymbol{\pi}_i$, reported CIT base is $\sum_i \boldsymbol{\pi}_i$, preshifting CIT base is $\sum_i \boldsymbol{B}_i$, Income shifted is $\sum_i \boldsymbol{S}_i$, and tax revenue losses is $\frac{\sum_i \tau_i \boldsymbol{S}_i}{\sum_i \tau_i \boldsymbol{B}_i}$ and revenues.

Shifted income can be either positive or negative and is a function of the unobservable vector of true earnings before profit shifting ($\boldsymbol{B}$), the semielasticity of reported earnings (ε, negative), and the vector of tax rates in countries where the MNC operates ($\boldsymbol{\tau}$):

$$S_i = \left(\frac{B_i}{\varepsilon}\right) \frac{\sum_{k\neq i}^{n} \left(\frac{B_k}{1-\tau_k}\right)(\tau_k - \tau_i)}{\sum_{k=1}^{n} \left(\frac{B_k}{1-\tau_k}\right)}$$

For a given semielasticity, vector of tax rates, and observed tax bases, the true tax base vector $\boldsymbol{B} = f(\boldsymbol{\pi}, \varepsilon, \boldsymbol{\tau})$ can be imputed from Equation (6).

For the calculations, we obtain corporate tax rates for 2015 in 81 countries from the KPMG database. We obtain corporate tax bases of these countries by dividing corporate tax revenues for 2015, obtained from the IMF's government finance statistics, by statutory tax rates.[27] We then calculate for each country the tax base without profit shifting, the amount of profits shifted in or out of the country, and the associated revenue effect. In the calculations, we impute the semielasticity to be 1.5 for the year 2015, using the preferred semielasticity of 0.98 (Table 2, column (4)) and the Z-Midyear coefficient of 0.036.

Table 6 summarizes the simulation results for four country groups: the USA, the 15 largest countries in the sample, the 15 countries with the lowest corporate tax rates, and the average among all 81 countries. Column (1) of Table 6 suggests that reported corporate tax revenue in the USA is roughly US $360 billion in 2015. The combined federal and state tax rate of 40% implies an underlying reported tax base of US $900 billion. The high statutory corporate tax rate relative to the rest of the world implies a net outward profit shifting from the USA of US $198 billion, implying a true tax base of roughly US $1095 billion. Hence, profit shifting activities eroded the USA tax base by about 17%, or 0.4% of USA GDP.[28] This number is comparable to the 14.4% reported by Zucman (2014), but somewhat smaller than Clausing (2016) who estimates a revenue loss between 19% and 30% of corporate tax revenue. In comparison, Torslov *et al.* (2018) estimate it at 8% of tax revenue from MNCs.

Columns (2) and (3) present the average effect for the largest 15 economies (Big 15), including the USA, and the 15 countries with the lowest statutory tax rate (Low-tax 15). Compared to the USA, the revenue consequences of profit shifting are much smaller for Big 15: corporate tax revenue declines in these countries by an average of 4%, or by 0.11% of GDP. The reason is that several large countries have CIT rates below the world average. The 15 countries with the lowest statutory CIT rate gain from inward profit shifting, with corporate tax revenues increasing by almost 20%, or by 0.43% of their GDP.

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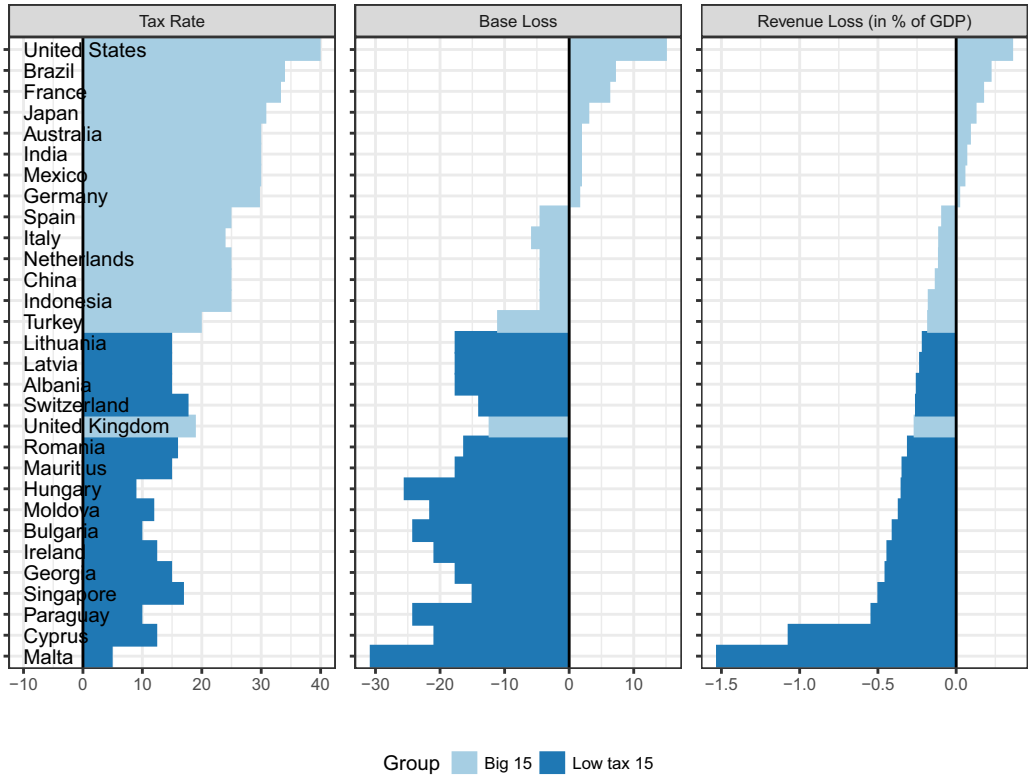

Figure 4. Country-Specific Estimates of Fiscal Impact. [Colour figure can be viewed at wileyonlinelibrary.com]

Notes: This figure illustrates simulation results, depicting the level of tax rates (left panel), relative changes in the tax base due to profit shifting (middle panel), and revenue losses due to profit shifting (right panel). Negative base and revenue losses are gains.

Column (4) further shows the global net revenue effect of profit shifting, that is, the balance of the gains in some countries and the losses in other countries. While the total of shifted income is equal to zero (by definition), the shifting from high-tax to low-tax countries reduces the total of corporate tax revenue by 2.6% of corporate tax revenues, or 0.07% of global GDP. These numbers are somewhat smaller than those reported by Crivelli *et al.* (2016), OECD (2015), and UNCTAD (2013).

Figure 4 presents country-specific results for a selection of simulated variables. The graph shows that seven large economies actually gain from profit shifting because their rate is lower than those prevailing elsewhere.

4. Discussions and Conclusion

The existing literature on international tax avoidance has significantly advanced over recent years, but there remain several blind spots and puzzles that future research should address.

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First, we reviewed granular evidence on tax-motivated behavioral responses of MNCs in areas such as transfer mispricing, strategic location of intangibles, intracompany debt shifting, treaty shopping, corporate inversion, and tax deferral. However, there is much less evidence on some of the other channels of profit shifting. For example, MNCs can structure their businesses to artificially avoid the creation of PEs, thus escaping source country taxation at the outset. Alternatively, they can exploit mismatches in national tax rules, when different countries classify the same entity, transaction, or financial instrument differently.[29] Another pressing issue for especially developing countries relates to the taxation of offshore indirect transfers of assets, where MNCs avoid taxes on significant capital gains in source countries. Understandably, the lack of systematic analysis on these alternative channels of profit shifting is due to both their highly technical and complex nature and the lack of suitable data. More and deeper analysis in this area is needed to advance our understanding on the anatomy of international tax avoidance.

Second, there is little evidence on the interaction between alternative modes of profit shifting. Empirical work tends to focus on specific channels in isolation, so it is difficult to infer information about substitution between alternative channels. A notable exception is Saunders-Scott (2015), who provides insight into whether transfer mispricing and debt shifting are substitutes or complements. The study examines changes in the reported EBIT following a tightening of thin-capitalization rules for multinational affiliates, using the ORBIS database. The findings suggest that MNCs use transfer mispricing and intracompany debt shifting as substitutes (see also Nicolay *et al.*, 2017). More research is needed in this direction in order to shed light on how successful targeted anti-abuse rules are in restricting the overall extent of international tax avoidance by MNCs.

Third, there is limited insight into the systematic variation in tax avoidance across countries, sectors, firms, and time. Indeed, the relative costs of various shifting methods are likely to differ in all these dimensions. Therefore, conclusions of certain studies are hard to generalize to all MNCs or all countries. Recently, some studies have started to focus on specific sectors or extended the scope to developing countries. For example, using tax records of USA MNCs, Dowd *et al.* (2017) find significant nonlinear effect of tax differential that points to more shifting into tax havens. Also, the metaregressions in this study shed some light on the changes in profit shifting behavior across time and regions. The literature is too scattered, however, to draw firm conclusions on important sources of heterogeneity.

Fourth, there is little attention in the literature on the interaction between profit shifting and the reallocation of real activities by MNCs. Existing research has focused largely on quantifying either the scale of profit shifting or the impact of taxes on the location of FDI. Yet, profit shifting may interact with investment and thus have complex and unexpected welfare implications, with important policy implications. For instance, some have argued that profit shifting can mitigate distortions from existing tax systems on real capital (Desai *et al.*, 2006; Hong and Smart, 2010). Anti-avoidance measures might then reduce welfare to the extent that they magnify distortions in real capital allocation.

Only a handful of recent studies analyze the spillover effect of anti-avoidance rules on investment. For example, De Mooij and Liu (2018) exploit introductions and tightening of transfer pricing regulation in countries as a quasi-natural experiment and find that transfer pricing regulation has a negative and significant effect on MNC investment in fixed assets. Buettner *et al.* (2018) provide evidence that thin-capitalization rules have a negative effect on MNC investment for firms relying on excessive debt financing. Egger and Wamser (2015) explore whether limitations to foreign income exemptions affect investment using a regression continuity design. They find that the German CFC rule decreased foreign subsidiaries' real investments. The scarce evidence thus suggests that unilateral tightening of profit shifting through anti-avoidance rules may have negative effects on MNC investment. More evidence is needed, however, to inform the debate on effective policy design, including through international coordination.

There are also several puzzles in the literature that remain partially unresolved. One is the "large aggregate effects" versus "small micro effects." In particular, our metaregressions suggest that firm responses reflected in aggregated data are substantially larger than in microdata, thereby controlling for several study attributes that may confound the estimated semielasticities in primary studies. Our

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interpretation of this difference is between short-term and long-term responses, for example, due to adjustment costs and optimization frictions (i.e., fixed costs of tax planning). Indeed, microstudies typically exploit variation across time from which the contemporaneous effect is obtained, while macrostudies exploit cross-sectional variation that yield and estimate of the long-run effect. Moreover, macrostudies may cover a wider array of shifting channels than microstudies. Whether this is indeed the case should be explored more deeply.

Another puzzle is our finding regarding debt shifting. The literature directly exploring the extent of debt shifting finds a robust significant impact of corporate tax differences on intracompany debt. One would expect that this would be reflected in studies on the total size of profit shifting by showing a systematic difference between studies using profit indicators that include and exclude interest costs. While our metaregressions confirm this difference, deeper analysis is needed to explain this, which might include methodological issues such as omitted variable bias or attenuation bias.

Notes

1. We include 11 additional studies and 199 additional primary estimates.
2. Moreover, by stipulating that foreign withholding tax payments are creditable against the domestic tax liability, DTTs often imply that the WHT is irrelevant for the MNC's final tax obligation.
3. However, the dividing line is often unclear, and there are plenty of cases/disputes in differentiating tax evasion from tax avoidance.
4. Taxes in high-tax locations can also be avoided by changing the location of foreign direct investment (FDI). This paper, however, focuses only on tax avoidance through profit shifting, not through a change in the location of real capital (for a survey of taxation and FDI, see, e.g., De Mooij and Ederveen, 2008).
5. Transfer mispricing has also implications for national accounts statistics and the measurement of GDP growth, see, for example, Guvenen *et al.* (2017).
6. Relocation of such intangibles commonly takes place before they are fully developed (and the value is fully known to the tax authority) to avoid capital gains tax on the initial transfer.
7. Theory predicts that tax deferral might not be a relevant avoidance strategy. Analogous to the "new view" of dividend taxation, Hartman (1985) argues that dividend taxes are unavoidable costs for mature foreign subsidiaries, that is, at some point in time they must be paid. Hence, if the subsidiary's choice is to distribute dividends now or later and taxation remains constant, the tax rate should play no role. However, effects are expected if tax rates are anticipated to change.
8. Corporate inversions can take the form of a merger with a foreign entity, which then results in the former domestic parent becoming a subsidiary of the new foreign parent (even though the shareholders of the original domestic company may retain more than 50% of the shares in the new corporation).
9. Another explanation could be that stricter transfer pricing rules increase the effective marginal tax rate, and therefore dampen MNC investment (De Mooij and Liu, 2018).
10. Avoidance of PE would be captured though in macrostudies that use national accounts.
11. Throughout this section, we report the absolute value of this semielasticity (i.e., as a positive value, even though this reflects a negative effect of reported profit to the tax rate).
12. Our search took place in February 2018 and focused on both accounting and economic studies. The meta-analysis fully follows the journal's reporting guidelines as summarized in Stanley *et al.* (2013).
13. See the Appendix for detailed descriptions of the baseline sample.
14. One exception is that we do not include 12 estimates presented by Loretz and Mokkas (2015), which by regressing after-tax profitability on domestic tax rate introduces mechanical negative correlation between the two variables.
15. HO found an arithmetic mean and median of 1.52 and 1.02, respectively, in a set of 203 observations from 27 studies.

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16. Another drawback of the BEA data set, a major information source for macro studies, is that reported earnings include dividend income. This raises concerns about double counting (Clausing, 2016)
17. On the other hand, tax law asymmetries (such as loss-offset) imply that loss making entities are subject to a different tax treatment and tax avoidance incentives might differ as a result (Dharmapala, 2014).
18. The *Z-MIDYEAR* variable is standardized, reflecting deviation from the average sample year of all studies in the baseline sample.
19. Typically referred to as "between" estimation in a panel data context.
20. Otherwise, we would expect that around 95% of these confidence bands do cover the red line.
21. In other words, we use Equation (5) to estimate $\widehat{\sigma^2}$ in the right panel, where the clouds cover roughly two times $\sqrt{\widehat{\sigma^2} + {\sigma_{ij}}^2}$ in each direction. In contrast, we simply set $\widehat{\sigma^2} = 0$ in the left panel.
22. We check the sensitivity of our results to winsorization in Table 3, and show that it has hardly any impact on the consensus semielasticity estimate.
23. We use the factor $(\frac{G}{G-1})^{0.5}$.
24. For instance, the average ratio of pre-tax *EBIT* to profit based on consolidated financial statements for the largest 1000 nonfinancial companies measured by total assets in 2011 in ORBIS is 1.09.
25. The coefficient estimates on the indicators are not directly comparable, as we defined our baseline differently. However, none of the coefficient estimates is statistically significant at conventional levels.
26. These calculations should be interpreted with caution, since they are based on a highly stylized model and do not account for heterogeneity across countries and firms. Thus, it is meant only as an illustration of what the average semielasticity obtained in the previous subsection means in terms of the allocation of tax bases and, consequently, corporate tax revenue.
27. Note that this approach introduces two counterbalancing inaccuracies: first, by using total corporate revenues rather than the share of revenues from MNCs, we may overestimate the relevant tax base. Second, by ignoring the effect of accelerated depreciation, tax losses, and other provisions in determining the actual tax liability of corporations, the statutory tax rate can be much higher than the effective average tax rate. By dividing total revenue by statutory rates, we thus underestimate the relevant tax base.
28. Following the US Tax Cuts and Jobs Act (TCJA), global profit shifting patterns are likely to change substantially (see, e.g., Beer *et al.*, 2018).
29. A notable exception is Hardeck and Wittenstein (2017), who use the Luxembourg Leaks database and show that hybrid arrangements by MNCs are related to substantial and continuous reduction in the effective tax rate of MNCs. The empirical evidence provides support for the considerable tax benefits of hybrid arrangements outline in theoretical research by Johannesen (2014).

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Appendix: Descriptive Overview of Included Studies

Study	Total estimates	Conditional estimates	Mean	Median	Min	Max
Azemar (2010)	3	2	2.54	1.02	0.99	5.62
Barrios and d'Andria (2016)	8	0	0.49	0.37	0.23	0.95
Becker and Riedel (2012)	3	0	0.76	0.73	0.71	0.84
Beer and Loeprick (2015)	19	18	0.85	0.90	0.39	1.28
Beer and Loeprick (2017)	31	31	1.77	1.69	0.61	2.91
Beuselinck *et al.* (2015)	25	7	3.60	1.60	−3.25	12.54
Blouin *et al.* (2012)	1	0	0.54	0.54	0.54	0.54
Murciego and Laborda (2016)	1	0	2.08	2.08	2.08	2.08
Clausing (2009)	5	0	3.76	3.65	1.05	5.52
Clausing (2016)	8	0	2.92	2.84	1.85	4.61
Collins *et al.* (1998)	1	1	0.32	0.32	0.32	0.32
Crivelli *et al.* (2016)	20	1	2.02	1.33	0.17	5.59
De Simone (2016)	9	9	0.83	0.91	0.25	1.29
De Simone *et al.* (2017)	2	0	1.00	1.00	0.66	1.34
Dharmapala and Riedel (2013)	1	0	1.13	1.13	1.13	1.13
Dischinger (2010)	16	4	1.60	1.54	0.72	3.32
Dischinger and Riedel (2011)	4	0	3.20	3.18	2.14	4.29
Dischinger *et al.* (2014)	28	4	0.91	0.68	−0.51	1.82
Dowd *et al.* (2017)	10	4	0.81	0.84	−0.03	1.44
Grubert (2003)	5	4	0.75	0.85	0.33	1.05
Grubert (2012)	18	6	1.31	1.20	0.63	2.31
Hines and Rice (1994)	6	0	5.16	3.31	2.25	12.99
Huizinga and Laeven (2008)	27	1	1.25	0.98	0.49	3.71
Johannesen *et al.* (2017)	8	0	0.69	0.75	0.12	1.31
Klassen and Laplante (2012a)	9	9	0.60	0.44	0.17	1.19
Klassen and Laplante (2012b)	8	8	0.91	0.88	0.69	1.28
Loretz and Mokkas (2015)	12	0	−0.07	−0.11	−0.79	0.80
Maffini and Mokkas (2011)	22	0	1.21	1.03	0.23	4.87
Markle (2016)	12	3	0.95	0.92	0.34	1.71
McDonald (2008)	20	14	1.26	1.36	0.73	1.65
Merz and Overesch (2017)	13	12	2.05	2.18	0.23	3.00
Mills and Newberry (2004)	4	0	1.94	1.03	−1.16	6.86
Riedel *et al.* (2015)	14	14	0.71	0.59	0.29	1.79
Rousslang (1997)	12	0	4.74	5.00	3.63	5.63
Saunder-Scott (2015)	2	0	0.87	0.87	0.66	1.08
Schwarz (2009)	9	0	1.78	2.03	−1.33	3.62
Weichenrieder (2009)	6	4	0.94	0.91	0.79	1.25

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