A new framework to assess the fiscal impact of a global minimum tax on FDI*

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Abstract

The OECD agreement in principle on a global minimum corporate income tax – Pillar Two of the Base Erosion and Profit Shifting project – is a major step in international tax regulation and coordination. Yet, its consequences for foreign direct investment (FDI) have received limited attention thus far. In the present paper, the authors detail the analytical framework developed to underpin the findings of the *World Investment Report 2022: International Tax Reforms and Sustainable Investment*. The paper introduces the notion of FDI-level effective tax rate (ETR). Unlike standard ETRs, FDI-level ETRs embed the profit shifting schemes of multinational enterprises (MNEs). They capture not only the taxes paid on income reported in the host country of the foreign investment but also those levied on income shifted to offshore financial centres (OFCs). The effect of Pillar Two on these two components of the tax base determines the increase in the overall tax rate faced by MNEs, which ultimately affects the investment decisions of MNEs. After empirically calibrating ETRs, profit shifting and FDI-level ETRs of more than 200 countries, the authors quantify the effect of Pillar Two on FDI-level ETRs. The results show that after the reform FDI-level ETRs are likely to increase by 2 to 3 percentage points in non-OFCs, which corresponds to an increase in the corporate income tax liability for MNEs between 14 and 20 per cent.

Keywords: effective tax rate, multinational enterprises, foreign direct investments, profit shifting, minimum tax, Pillar Two

JEL classification codes: F23, F42, H25, H26, H32

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1. Introduction

Pursued by the G20/OECD Inclusive Framework on Base Erosion and Profit Shifting (BEPS) to curb tax-motivated income shifting, the global reform of the taxation of large multinational enterprises (MNEs) has to date been endorsed by 141 jurisdictions. The agreement – in principle thus far – includes a minimum tax of 15 per cent for the largest MNEs (Pillar Two). Growing attention has been given to the consequences of a minimum tax, but ongoing discussions have generally focused on corporate income tax (CIT) revenues. Less is known about the effect of a minimum tax on the overall tax rate paid by MNEs on the income derived from foreign direct investment (FDI), which ultimately drives investment decisions.

The OECD's economic impact assessment (EIA) examines the effect of Pillar Two on the cost of investment for MNEs (Hanappi and Cabral, 2020; OECD, 2020). Yet, because the investment is conducted in the parent country, the analysis provides scant indication on the cost of FDI. Devereux et al. (2020) investigate the impact of Pillar Two on investment incentives and international tax avoidance. The authors develop a stylized three-country model to highlight the mechanisms at play; however, the framework remains theoretical and is not calibrated to actual data.

A new metric, the FDI-level effective tax rate (ETR), is presented to complement the standard definition of ETR and clarify the effect of Pillar Two on the CIT paid by MNEs on the income generated by their FDI. Standard (average) ETRs, defined as corporate income taxes paid by foreign affiliates divided by their pre-tax profits, reveal the taxes paid by foreign affiliates in a country on the profits reported in that country. They cannot reflect the taxes paid on the profits generated in the host country if some profits are shifted overseas for tax saving purposes.

However, compelling evidence indicates that MNEs artificially move profits across borders and internalize these profit shifting opportunities in their decision-making. Buettner et al. (2018) show that anti-profit shifting measures, e.g. thin capitalization rules, reinforce the sensitivity of FDI to tax rates (see also Grubert, 2003; Dharmapala, 2008). This finding suggests that profit shifting wanes tax rate differentials across countries and that standard ETRs need to be adjusted for profit shifting to understand FDI strategies. FDI-level ETRs combine information on both ETRs and profit shifting patterns. As such, they enrich standard ETRs and provide further insights into the investment decisions made by MNEs.

FDI-level ETRs are defined in a simple and transparent way. They depend on the ETR where production takes place and profits are made, i.e. in the host country, and on ETRs in place in offshore financial centres (OFCs), where some profits are shifted and recorded. The weights associated to these ETRs are determined by bilateral profit shifting shares, i.e. by the share of profits shifted from the host jurisdiction to each OFC.

A global minimum tax exerts two effects on FDI-level ETRs. First, it increases ETRs in host countries that have tax rates below the threshold (ETR channel). Second, it modifies the profit shifting practices of MNEs. The taxes paid on profits shifted to OFCs increase, with some of these profits "repatriated" to the host country where they were generated (profit shifting channel). The two effects can, to some extent, be isolated and quantified.

FDI-level ETRs are empirically calibrated to cover 208 distinct jurisdictions. We leverage a wide range of data to extend the scope of the analysis and check its robustness. In particular, we construct alternative matrices of bilateral profit shifting shares that include not only developed economies but also most developing economies. Obtaining an exhaustive sample of developed and developing economies is challenging but crucial from a policy perspective to better grasp the impact of a minimum tax rate worldwide.

The main results of this paper can be summarized as follows:

(i) The average gap between standard ETRs and FDI-level ETRs lies between 2 and 3 percentage points (pp). This means that profit shifting schemes enable MNEs to lower the tax rate paid on the income generated by their FDI by almost 15 per cent.

(ii) In our baseline (conservative) scenario, the implementation of a minimum tax rate of 15 per cent raises FDI-level ETRs faced by MNEs by 2 pp globally – a 14 per cent increase in their CIT liability relative to the pre-Pillar Two level. Under more aggressive assumptions, the impact of the reform on FDI-level ETRs could be up to 3 pp, or 20 per cent.

(iii) Looking through the lens of the FDI-level ETR at the objectives of the tax reform – countering profit shifting and limiting tax competition – it appears that Pillar Two acts mainly through the profit shifting channel. This is especially true for developing countries, which display relatively high ETRs and strong exposure to international tax planning.

The paper is structured as follows. In section 2, we present existing metrics of CIT rates, a key input to our analysis. Section 3 introduces a new indicator – the FDI-level ETR – and explains the extent to which it improves on existing metrics. Section 4 presents the impact of Pillar Two on FDI-level ETRs and section 5 discusses its repercussions on tax differentials. Section 6 calibrates the new framework to the data. Section 7 presents the results along with several sensitivity tests. The paper concludes with a summary of the findings in section 8.

2. Existing metrics of corporate income tax rates

2.1. Statutory tax rates (STRs) and effective tax rates (ETRs)

There are two broad classes of corporate income tax rates: STRs, which are established by law and ETRs indicating the tax rate at which profits are actually taxed. The choice of using one or the other tax rate depends on the research question (Bradbury et al., 2018). ETRs are best suited for studying the taxes paid on FDI for two related reasons. First, unlike STRs, they absorb credits, deductions, exemptions, and any other tax break that a government may have granted to lighten CIT on FDI. Second, ETRs more accurately reflect the very low taxation in OFCs and play a key role in the profit shifting practices of MNEs. While the average difference between STRs and ETRs is equal to 6 pp among non-OFCs, this gap rises to 11 pp in OFCs following access to greater availability of fiscal incentives and preferential tax treatment.[1]

2.2. Forward-looking ETRs and backward-looking ETRs

ETRs can be either forward- or backward-looking. Both seek to measure corporate tax liabilities but differ conceptually and analytically. Forward-looking ETRs are model-based, consider a hypothetical investment project, and include all taxes due over the investment's lifetime (Devereux and Griffith, 2002 and 2003). They are particularly suited for simulating alternative tax regimes. Backward-looking ETRs do not require predicting future scenarios (e.g. the evolution of interest and inflation rates). They reveal the taxes paid in a given year on the income reported in that particular year. They are computed directly from the data and calculated as the CIT paid over pre-tax profits. Recent improvements in the availability and reliability of data on MNE activities – notably through the country-by-country reporting initiative (BEPS Action 13) – have encouraged the use of backward-looking ETRs in the analysis of international corporate taxation (e.g. Garcia-Bernardo and Janský, 2022).

Previous analyses on the investment impact of Pillar Two have used both types of ETRs. The OECD's EIA employs forward-looking ETRs, whereas Devereux et al. (2020) make use of backward-looking ETRs. The latter approach lends itself more naturally to the study of the effect of Pillar Two on the taxes paid on FDI because backward-looking ETRs are more directly comparable with the GloBE ratio – the main trigger of the Pillar Two top-up tax (chapter III section A.2 in UNCTAD, 2022).

[1] Data from 2017. ETRs are retrieved from country-by-country reporting data, and STRs come from the Tax Foundation. See section 6 and figure 3 for more details.

Another key advantage of backward-looking ETRs resides in data availability. Backward-looking ETRs can be constructed for a large sample of countries (section 6.1), while forward-looking ETRs are only available for a limited subset of countries, mostly developed economies. For example, the Centre for Business Taxation of Oxford University provides updated and comparable forward-looking ETRs for a group of 43 countries, including only developed and emerging economies.[2]

3. A new metric: the FDI-level ETR

An extensive body of research shows that MNEs engage in large-scale tax avoidance and profit shifting. They move profits generated in high- to low-tax countries, and especially toward OFCs (Beer et al., 2020; Dharmapala, 2014; Riedel, 2018). Hence, the ETR an MNE ultimately pays on the income generated in some country is smaller than the ETR reported in this country. We introduce a more comprehensive notion of ETR which encompasses the entire income generated by FDI – including shifted income, the FDI-level ETR. The FDI dimension implies a shift in the analytical focus from the foreign affiliate's country of operations (host country) to the underlying value-creating FDI project itself.

Consider a generic FDI project i operated by a foreign affiliate of an MNE in a host country c. The standard ETR reported by the foreign affiliate in c is:

$$ETR_{ic} = \frac{CIT\ paid\ in\ host\ country\ c\ on\ the\ FDI\ income\ generated\ by\ i}{FDI\ income\ generated\ by\ i\ and\ reported\ in\ host\ country\ c}$$

The FDI-level ETR for the investment i in host country c is instead defined as:

$$ETR_{ic}^{FDI} = \frac{CIT\ on\ the\ FDI\ income\ generated\ by\ i\ in\ host\ country\ c}{FDI\ income\ generated\ by\ i\ in\ host\ country\ c}$$

Without profit shifting, FDI income generated in c is fully reported in c, and the two rates are equivalent. However, in the presence of profit shifting, a share of the income generated in c is shifted offshore and subject to lower taxation, so that $ETR_{ic}^{FDI} < ETR_{ic}$.

Three key assumptions are made at this stage. First, we assume that ETRs are homogeneous within countries, i.e. $ETR_{ic} = ETR_{c}$ for all i (assumption 1). This

[2] See also the OECD series (https://stats.oecd.org/Index.aspx?Data SetCode=CTS_ETR), Bazel et al. (2017) and Spengel et al. (2021). All three exclude the majority of developing economies – a severe limitation for global analysis.

assumption has historically been used in prior impact assessments (Devereux et al., 2020; Hanappi and Cabral, 2020; OECD, 2020). It remains the best approximation given the limited availability of disaggregated data. However, assumption 1 has implications for the impact assessment of Pillar Two. In our analysis, disregarding the within-country variance of ETRs leads to an understatement of the impact of the minimum tax on FDI (Auclair and Casella, 2022). Second, we assume that backward-looking ETRs are reliable proxies for GloBE ETRs, i.e. for the ratios triggering the activation of the top-up within the GloBE Pillar Two framework (assumption 2). This is an acceptable simplification at the aggregate level. Yet, it is worth noticing that specific treatments of categories of incentives in the GloBE Rules may produce a divergence between standard ETRs and GloBE ETRs for individual firms (chapter III.C in UNCTAD, 2022). Assumptions 1 and 2 make the top-up equal to the difference, if positive, between the 15 per cent minimum and the host country's average ETR. Finally, we assume that profits can only be shifted from non-OFCs to OFCs (assumption 3). This assumption is grounded on the profit shifting literature. Dowd et al. (2017) and Garcia-Bernardo and Janský (2022) show that most profits moved across borders for tax saving purposes are concentrated in OFCs, where ETRs are close to zero. Casella (2019), Damgaard et al. (2019) and UNCTAD (2015) also point out that 30 to 40 per cent of FDI transit through a limited number of very large investment hubs, hinting at the disproportionate role played by a limited set of OFCs in the tax optimization practices of MNEs.

Let ETR_h be the effective tax rate in the generic OFC h and γ_{ch} be the share of profits generated by foreign affiliates in c and shifted to h. The FDI-level ETR in host country c can be written as a linear combination between the ETR in c and ETRs in OFCs, where the weights are given by bilateral profit shifting shares:[3]

$$ETR_c^{FDI} = \left(1 - \sum_{h,h\neq c} \gamma_{ch}\right) ETR_c + \sum_{h,h\neq c} \gamma_{ch} ETR_h$$

[3] Profit shifting costs are considered negligible throughout this paper. It is in theory possible to establish micro-foundations and incorporate profit shifting costs à la Hines and Rice (1994). In such models, (non-deductible) costs incurred by firms when shifting profits from host country c to OFC h take the form: $(\gamma_{ch}^2)\pi_c/(2k)$, where π_c represents the profits generated in c. Hence, the share of profits shifted from c to h is equal to $k(t_c - t_h)$ (under reasonable assumptions) and profit shifting costs would enter equation (1). The additional term would be equal to $\sum_{h\neq c} \gamma_{ch}^2 /(2k)$. In the present paper, the calibration is more flexible and profit shifting shares will also depend on tax rate differentials (section 6 and annex). Further note that the additional term in (1) would be of small magnitude. Therefore, explicitly incorporating profit shifting costs à la Hines and Rice (1994) would only marginally change our findings.

An alternative expression for the FDI-level ETR in c is:

$$ETR_c^{FDI} = ETR_c - \sum_{h,h\neq c} \gamma_{ch}(ETR_c - ETR_h) \qquad (1)$$

The first term in (1) refers to the ETR in host country c. The second term represents profit shifting gains, i.e. the taxes "saved" by MNEs on the income generated by their FDI in host country c due to profit shifting. The difference between ETRs and FDI-level ETRs widens as profit shifting shares and ETR differentials between host countries and OFCs increase. The empirical calibration of ETRs and profit shifting is described in section 6.

4. An impact framework based on FDI-level ETRs

Taking ETRs and profit shifting as given, we now turn to the analysis of the impact of the global minimum tax on FDI. In doing so, we focus on FDI-level ETRs as the most comprehensive and realistic measure of the total tax liability faced by MNEs on their FDI income. As a starting point, we examine the impact of Pillar Two on FDI-level ETRs in the absence of profit shifting (section 4.1). Next, we re-incorporate profit shifting into the picture to highlight the (more indirect) impact of the reform through profit shifting (section 4.2). FDI-level ETRs increase not only because ETRs in host countries rise, but also because ETRs in OFCs increase and profit shifting activities of MNEs decline. Together, these two effects constitute the overall impact of the reform on the FDI-level ETR faced by large MNEs. We apply our framework to two distinct scenarios. We provide both a conservative estimate and an upper bound for the impact of Pillar Two on FDI-level ETRs, based on the profit shifting response adopted by MNEs to Pillar Two (section 4.3). To complete the formalization of the impact, we add the effect of a carve-out – a key feature of Pillar Two which excludes a share of profits tied to real activity from the top-up tax (section 4.4).

4.1. ETR channel

Consider the implementation of a minimum tax rate t^* applied to the foreign affiliates of large MNEs on a jurisdictional basis. We abstract, for the moment, from profit shifting and the carve-out. Assuming $\gamma_{ch} = 0$ for all h in (1), the FDI-level ETR is just equal to the ETR. The FDI-level ETR after Pillar Two is then given by:

$$ETR_c'^{FDI} = ETR_c' = max\,(ETR_c, t^*) \qquad (2)$$

Throughout the paper, the prime symbol ' denotes the underlying metrics post-Pillar Two. Changes in FDI-level ETRs of the foreign affiliates of large MNEs in c are then:

$$\Delta ETR^{FDI}_{lrg,c} = \Delta ETR_{lrg,c} = ETR'_c - ETR_c = \begin{cases} t^* - ETR_c & \text{if } ETR_c < t^* \\ 0 & \text{if } ETR_c \geq t^* \end{cases} \quad (3)$$

In other words, ETRs faced by large MNEs increase in countries where the average ETR is below the minimum. We refer to this effect as the ETR channel.

4.2. Incorporating profit shifting

From (1), taking the full difference in FDI-level ETRs between post- and pre-Pillar Two yields the expression:

$$\begin{aligned} \Delta ETR^{FDI}_{lrg,c} &= ETR'_c - ETR_c \\ &\quad + \sum_{h,h\neq c} \gamma_{ch}(ETR_c - ETR_h) - \sum_{h,h\neq c} \gamma'_{ch}(ETR'_c - ETR'_h) \end{aligned} \quad (4)$$

where γ'_{ch} denotes bilateral profit shifting shares of foreign affiliates of large MNEs after the reform, ETR'_c is defined by (2), and:

$$ETR'_h = max\,(ETR_h, t^*)$$

The first term in (4) reflects the ETR channel. With profit shifting, a supplementary term – a profit shifting channel – enters the equation. It captures the variation in the FDI-level ETR in c caused by the rise in taxes levied on profits reported in OFCs and by the reduction of profit shifting from c to OFCs.

An alternative expression for (4) is:

$$\begin{aligned} \Delta ETR^{FDI}_{lrg,c} &= \left(1 - \sum_{h,h\neq c} \gamma_{ch}\right)(ETR'_c - ETR_c) \\ &\quad + \sum_{h,h\neq c} (\gamma_{ch} - \gamma'_{ch})\,(ETR'_c - ETR_h) \\ &\quad + \sum_{h,h\neq c} \gamma'_{ch}\,(ETR'_h - ETR_h) \end{aligned} \quad (5)$$

Equation (5) represents the impact of Pillar Two on FDI-level ETRs as a sum of three components. The first component is the increase in CIT paid on non-shifted profits. The second component is the increase in taxes paid on profits that were previously shifted but are no longer shifted after Pillar Two. Finally, the third component is the

increase in taxes paid on profits that are still shifted after Pillar Two and subject to higher taxation in OFCs.

Equation (5) shows that the degree to which the reform raises FDI-level ETRs not only depends on initial ETRs but also hinges on assumptions on the evolution of profit shifting shares pre- and post-Pillar Two. This aspect is analyzed in the next section.

4.3. Profit shifting response to Pillar Two

Two intertwined dynamics contribute to the impact of Pillar Two on FDI-level ETRs through the profit shifting channel. On the one hand, profits remaining in OFCs are taxed at a higher rate. On the other hand, some profits that were shifted toward OFCs prior to Pillar Two are expected not to be shifted anymore. The remaining share of profits shifted to OFCs after Pillar Two rests on empirical and modelling considerations. In the evaluation made by Hanappi and Cabral (2020) and OECD (2020), profit shifting is fixed and constant, i.e. the second component in (5) is equal to 0. This assumption minimizes the profit shifting channel. This scenario can be useful to set a theoretical lower bound but is unlikely to occur in practice. Its occurrence would indeed imply that Pillar Two would be ineffective in tackling profit shifting, an outcome that is hardly realistic, nor desirable.

In this paper, we argue that profit shifting will decline after the reform. We consider two scenarios to assess the impact of Pillar Two on FDI-level ETRs: one that is likely to provide a conservative estimate of the increase in FDI-level ETRs ("baseline scenario") and another one that provides an upper bound ("upper bound scenario").

In the same manner as Devereux et al. (2020), the first scenario enables profit shifting to partially decrease, i.e. $\gamma_{ch} \geq \gamma'_{ch} \geq 0$. The reduction is proportional (linear) to the reduction of the difference in ETRs between host countries and OFCs. More precisely, in (5), we assume that the difference $\gamma'_{ch} - \gamma_{ch}$ between the bilateral profit shifting share before and after Pillar Two is a linear combination of the difference between the ETR in the host country before and after Pillar Two and the difference between the ETR in the OFC both before and after Pillar Two:

$$\gamma'_{ch} - \gamma_{ch} = \beta_1(ETR'_c - ETR_c) + \beta_2(ETR'_h - ETR_h) \qquad (6)$$

where β_1 and β_2 are estimated empirically (section 6.3), with expected signs $\beta_1 \geq 0$, $\beta_2 \leq 0$. The interpretation is straightforward. As a global minimum tax tends to raise ETRs in host countries and OFCs, or more precisely, the two ETR differences in (6) are either positive or zero, the change in profit shifting is driven by the increase in taxes in the host country relative to the increase in taxes in OFCs.

The upper bound scenario assumes that profit shifting of foreign affiliates of large MNEs disappears after the introduction of the reform (full reversal of profit shifting), i.e. $\gamma_{ch} \geq 0$ and $\gamma'_{ch} = 0$ for all h. This assumption maximizes the impact of the reform on FDI-level ETRs by setting to 0 the only negative term in (4), yielding the expression:

$$\Delta ETR^{FDI}_{lrg,c} = \left(1 - \sum_{h,h\neq c} \gamma_{ch}\right)(ETR'_c - ETR_c) + \sum_{h,h\neq c} \gamma_{ch}(ETR'_c - ETR_h)$$

The actual effect of the minimum tax on profit shifting is very likely to lie between the baseline and the upper bound, as confirmed by the recent literature supporting the significant non-linearity of profit shifting (Dowd et al., 2017; Garcia-Bernardo and Janský, 2022). In this respect, our baseline estimate is a conservative one.

4.4. Substance-based carve-out

A key feature of Pillar Two is the application of a substance-based carve-out tied to indicators of real activity. The carve-out reduces the tax base to which the Pillar Two top-up tax rate applies. This is intended to preserve the possibility for countries to compete for real and productive investment. It also leaves room for countries to engage in tax competition through their domestic tax system (chapter III section D in UNCTAD, 2022; Devereux et al., 2021). Here we focus on the formal expression of the impact of Pillar Two on FDI-level ETRs in the presence of a carve-out. The empirical calibration of the carve-out instead is presented in section 6.5.

We adjust (4) and (5) to account for the carve-out. More concretely, we re-formulate the definition of the variables after Pillar Two (ETR'_c, ETR'_h and γ'_{ch}) taking into account the carve-out.

Starting with ETR'_c and applying the definition of the carve-out, its expression becomes:

$$\begin{aligned} ETR'^{CO}_c &= \frac{1}{\pi^*_{lrg,c}}\left(\left(\pi^*_{lrg,c} - CO_c\right)ETR'_c + CO_c ETR_c\right) \\ &= (1 - CO^{SHARE}_c)ETR'_c + CO^{SHARE}_c ETR_c \end{aligned} \quad (7)$$

where $\pi^*_{lrg,c}$ denotes the profits reported by foreign affiliates of large MNEs in host country c, CO_c the reported profits excluded from the top-up tax thanks to the carve-out, and CO^{SHARE}_c their corresponding share.

We then argue that the two other variables post-Pillar Two, namely ETR'_h *and* γ'_{ch} are unaffected by the carve-out. First, the carve-out on shifted profits is 0, or close to 0, as their underlying economic substance is by nature negligible. Therefore,

$ETR'^{CO}_h = ETR'_h$. Second, we claim that the carve-out has no repercussion also on profit shifting patterns ($\gamma'^{CO}_{ch} = \gamma'_{ch}$). Generally speaking, this occurs if changes in profit shifting are neither accompanied by any change in real activities, nor in the carve-out available in each country – a reasonable and likely simplification.[4]

From the discussion above, it follows that the only term that changes in (5) after introducing a carve-out is ETR'_c. Re-arranging (5) and combining (5) with (7) gives a simple expression for the impact of Pillar Two on FDI-level ETRs in the presence of a carve-out:

$$\Delta ETR^{FDI,CO}_{lrg,c} = \Delta ETR^{FDI}_{lrg,c} - CO^{SHARE}_c (ETR'_c - ETR_c) \qquad (8)$$

Equation (8) shows that the carve-out mitigates the increase in FDI-level ETRs through the ETR channel: the higher the ETR channel and carve-out share, the greater the role played by the carve-out.

Finally, the minimum tax concerns merely large MNEs, i.e. MNEs with annual revenues above €750 million. Denoting by ω_c the (host-country-specific) coefficient indicating the share of activities conducted by foreign affiliates of large MNEs in activities carried out by all foreign affiliates, changes in FDI-level ETRs at the host country level – i.e. including all foreign affiliates – are given by:

$$\Delta ETR^{FDI,CO}_c = \omega_c \Delta ETR^{FDI,CO}_{lrg,c} \qquad (9)$$

An analogous transformation applies to (5) to obtain the country-level estimate for the impact of the reform in the absence of a carve-out. Unless stated otherwise, our results will be displayed at the country-wide level (i.e. in line with (9)) to facilitate the policy interpretation of the analytical findings.

[4] More descriptively, consider the case in which the pre-Pillar Two ETR in host country c is above the minimum. The carve-out applies neither to reported profits in the host country as there is no top-up, nor to profits shifted to OFCs as the substance requirement is not satisfied. The carve-out does not affect the change in ETR differentials between the host country and OFCs and, thus, has no influence on the profit shifting response to Pillar Two. Consider now the case where the pre-Pillar Two ETR in host country c is below the threshold. Without any carve-out, post-Pillar Two ETRs in host country c and OFCs are aligned and equal to the minimum. There is no incentive to shift profits anymore and γ'_{ch} is set equal to 0. The introduction of the carve-out does not affect these dynamics. If anything, it further weakens the rationale for profit shifting as the post-Pillar Two ETR in host country c, at some level below 15 per cent in virtue of the carve-out, would be lower than the ETR applied to shifted profits. Note that the considerations supporting the equality $\gamma'^{CO}_{ch} = \gamma'_{ch}$ hold irrespective of the scenario (baseline or upper bound).

5. Implications of Pillar Two for tax rate differentials

By setting a floor to the race to the bottom in CIT and mechanically compressing standard ETRs into a smaller range, the introduction of a minimum tax rate mitigates tax rate differentials between countries. Without profit shifting considerations, the reduction in tax rate differentials caused by the Pillar Two minimum (at 15 per cent) is particularly significant. Based on ETRs calculated from country-by-country reporting (CbCR) data (section 6), a third of developing countries – and about half of developed ones – will see their standard ETRs re-aligned (upward) to the minimum, reducing the gap between those countries and others that have ETRs above 15 per cent.

In the same vein, a frequently used argument is that the reduction of tax rate differentials would also improve efficiency in the capital allocation by making tax-related factors less relevant for the location choices made by MNEs (Englisch and Becker, 2019; OECD, 2020). The idea is that tax differentials distort the location of productive activities from an economically efficient allocation (Barrios et al., 2012; Davies et al., 2021).

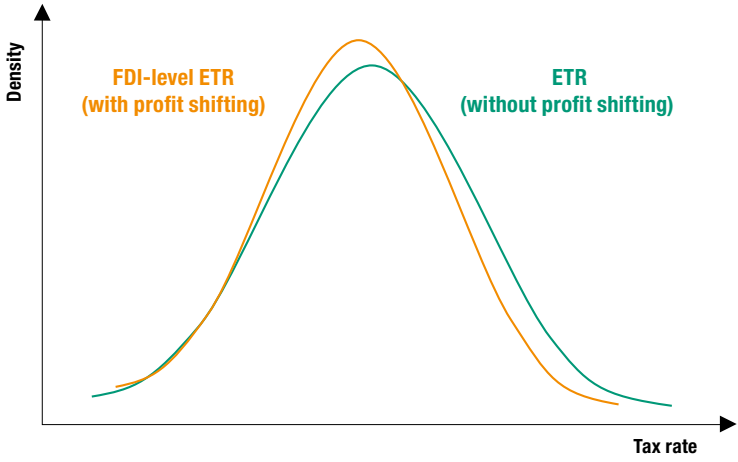
The typical discussion on the implications of Pillar Two for tax rate differentials, however, revolves around the standard notion of ETRs. Yet, standard ETRs do not account for profit shifting dynamics. Introducing profit shifting mitigates the role played by taxation in the location decisions of MNEs. Buettner et al. (2018) argue that the implementation of anti-profit shifting measures increases the sensitivity of FDI to tax rates (see also Dharmapala, 2008; Grubert, 2003).

In this respect, the FDI-level ETR, i.e. the new metric introduced in this paper, provides a more solid basis for an assessment of the impact of Pillar Two on tax rate differentials, addressing also the effects of profit shifting.

First, it confirms that profit shifting practices employed by MNEs reduce tax rate differentials. This occurs because the fiscal benefits provided by OFCs partially offset differences in tax rates across host countries (figure 1).

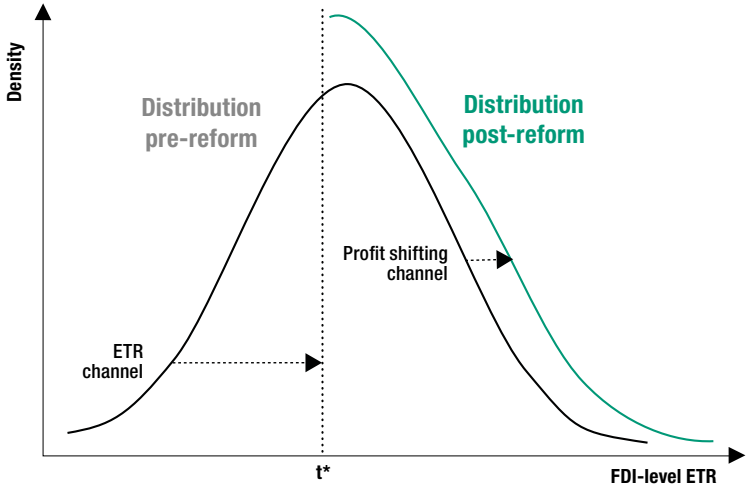
Second, it nuances the expected impact of Pillar Two on tax rate differentials (figure 2). As expected, ETRs on FDI in low-tax countries increase to 15 per cent, thereby compressing tax rate differentials in the left tail of the tax rate distribution. However, and perhaps less intuitively, the reduction of profit shifting caused by Pillar Two operates in the opposite direction. Countries with relatively high ETRs will see their FDI-level ETRs increase to a larger extent due to the decline of profit shifting, thus

Figure 1. Distribution of standard ETRs and FDI-level ETRs pre-Pillar Two



Source: Authors' elaboration.
Note: Distributions plotted for illustrative purposes.

Figure 2. Effect of a minimum tax rate t* on the distribution of FDI-level ETRs



Source: Authors' elaboration.
Note: Distributions plotted for illustrative purposes.

generating higher tax rate differentials in the right tail of the distribution.[5] The net effect will still be a reduction in FDI-level ETR differentials,[6] but will be smaller than expected based solely on the changes in host countries' ETRs. More accurately, the stronger the reduction in profit shifting by large MNEs following Pillar Two, the smaller the decrease in the tax rate differentials produced by the reform.

Hence, interestingly, profit shifting adds to the direct impact of Pillar Two on the level of FDI-level ETRs (equation (5)) but partially mitigates its impact on their differentials at the same time. It is worth emphasizing that since it is the FDI-level ETR and not the ETR that drives the investment decisions of MNEs, the effects of Pillar Two on tax-related competitive dynamics and economic efficiency should be assessed against changes in the former, and seen through this lens, they may be lower than expected.

6. Data and empirical calibration

6.1. Sample of countries

The analysis covers 208 economies, including 53 developed economies and 155 developing ones. This extensive coverage is a distinctive feature of this study and is crucial for a better understanding of the impact of Pillar Two worldwide.

Of these 208 economies, 39 are classified as OFCs following the classification established by Tørsløv et al. (2021).[7] OFCs are generally defined as jurisdictions where corporate income tax rates are low and where financial secrecy provides additional opportunities for tax avoidance. Following Tørsløv et al. (2021), we separate Belgium, Cyprus, Ireland, Luxembourg, Malta, the Netherlands and Switzerland from the rest. The remaining 32 OFCs are pooled together and form a composite OFC. The list is highly consistent with other classifications (e.g. Dyreng and Lindsey, 2009; Hines and Rice, 1994), and is also substantially aligned with

[5] This statement holds under the hypothesis that high-tax countries are more exposed to outward profit shifting, Evidence of this can be found in section 6.

[6] This statement holds under reasonable assumptions. For example, profit shifting must not be too large. In an extreme configuration in which all profits are initially shifted to OFCs and profit shifting significantly declines after the reform, FDI-level ETR differentials might increase overall. Nevertheless, this case remains purely theoretical and is unlikely to occur in practice.

[7] The list includes: Andorra, Anguilla, Antigua and Barbuda, Aruba, the Bahamas, Bahrain, Barbados, Belgium, Belize, Bermuda, British Virgin Islands, Cayman Islands, Curacao, Cyprus, Grenada, Guernsey, Gibraltar, Hong Kong (China), Ireland, Isle of Man, Jersey, Lebanon, Liechtenstein, Luxembourg, Macao (China), Malta, Marshall Islands, Mauritius, Monaco, the Netherlands, Panama, Puerto Rico, Seychelles, Singapore, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Switzerland and Turks and Caicos. Bonaire and Sint Maarten, included in Tørsløv et al. (2021), are excluded here due to data shortcomings.

the one used in previous UNCTAD studies (Bolwijn et al., 2018; Casella, 2019; UNCTAD, 2015).[8]

6.2. Pre-Pillar Two effective tax rates: ETR_c and ETR_h

Baseline ETRs

As previously mentioned in section 2, our preferred metrics of corporate income tax rates are backward-looking ETRs. However, the construction of an empirically consistent measure of backward-looking ETRs is challenging. Until the introduction of CbCR, the United States Bureau of Economic Analysis (BEA) data on outward activities of MNEs headquartered in the United States was the main source for calculating backward-looking ETRs of foreign affiliates. The dataset reports income taxes paid by, and net income accrued to, foreign affiliates of MNEs in nearly 70 countries, including several developing economies. The ratio between the two variables provides in principle a consistent ETR measure after some corrections for double counting of equity income (Blouin and Robinson, 2020).[9] Tørsløv et al. (2021) use national accounts, which are also available for many countries but include all firms operating within a country, i.e. both domestic firms and MNEs. Data from the BEA and Tørsløv et al. (2021) pool together profit- and loss-making firms, leading to an overestimation of the ETRs that firms have to contend with. Firm-level data have also been used to derive ETRs (e.g. Markle and Shackelford, 2012), but their application in developing economies – notably in Africa and in Latin America and the Caribbean – is severely limited by poor data availability.

In this context, the publication of CbCR data as part of BEPS Action 13 has been an important breakthrough. Large MNEs, i.e. those with annual revenues over €750 million, are required to prepare reports and give details about their activities in the countries where they operate. The information is then aggregated at the level of the headquarter-host country pair and made publicly available by the OECD. At the time of this analysis (December 2021), data were available for only 2016 and 2017. It is important to note that the reporting was not yet mandatory in 2016, but the 2017 data used in this report capture all the large MNEs from 38 countries that had signed the multilateral agreement for the automatic exchange of country-by-country reports.

[8] Notwithstanding the overall alignment between these different lists, our main motivation for using Tørsløv et al. (2021) is because of analytical consistency, as one matrix of bilateral profit shifting shares builds on Tørsløv et al. (2021) (section 6.3 and annex).

[9] Blouin and Robinson (2020) pointed out that one of the shortcomings of the BEA data is that foreign income is double counted due to equity income. Equity income must then be subtracted not to double count foreign income.

CbCR is thus very recent and as CbCR practice consolidates, it is expected to improve. Yet, experts (e.g. Garcia-Bernardo et al., 2021) concur that CbCR data are already both richer and more empirically consistent than alternative sources. These data cover the largest investors worldwide (almost 40 countries, corresponding to 90 per cent of outward FDI stock globally) and almost all recipient countries (about 200, compared with nearly 50 in Tørsløv et al. (2021) and 70 in the BEA dataset). In addition, loss- and profit-making companies are separated, and national companies can be excluded to focus the calculation on foreign affiliates. Furthermore, in the context of the analysis of Pillar Two, the CbCR perimeter is exactly aligned with the scope of the tax reform and only targets foreign affiliates of large MNEs. Finally, in the version used in this report, excluding stateless entities, CbCR data are less prone than the BEA data to double counting, although some residual double counting is possible for intracompany dividends.[10]

The baseline CbCR-based ETRs in this paper are provided by Garcia-Bernardo and Janský (2022) and cover 193 distinct jurisdictions. Missing values are imputed using the Tax Foundation data on STRs, after regressing CbCR-based ETRs on STRs (figure 3).

Alternative ETRs

For validation purposes, CbCR-based ETRs are triangulated with data from both national accounts and BEA. ETRs from national accounts are computed with the replication files of Tørsløv et al. (2021). As conceived, they encompass all firms operating in a country, i.e. domestic firms and MNEs. BEA-based ETRs are calculated using the BEA's data on the United States direct investment abroad. The three series of backward-looking ETRs are globally aligned, particularly CbCR and BEA data as expected (figure 4).

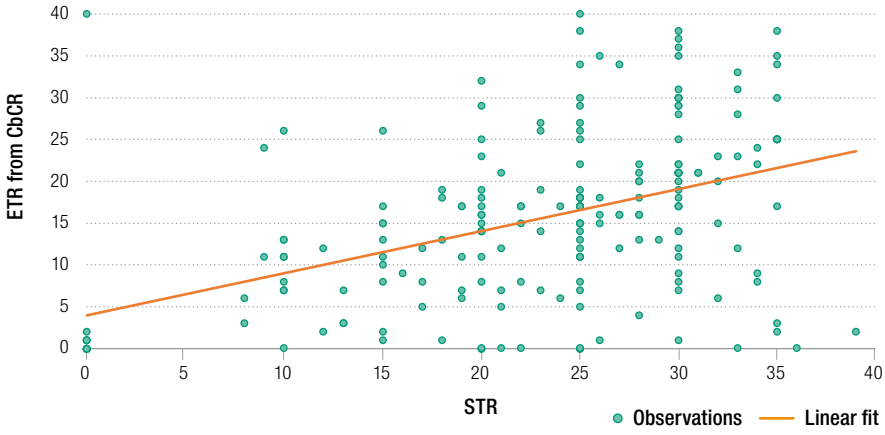
6.3. Pre-Pillar Two profit shifting shares: γ_{ch}

To calibrate pre-Pillar Two FDI-level ETRs (equation (1)), the share of profits shifted to each OFC needs to be computed for more than 200 host countries. In other words, we need to estimate a host country-OFC matrix of bilateral profit shifting shares. Quantifying profit shifting is another challenging task because it is not directly observed. Three main approaches have been adopted in the recent literature to gauge its magnitude, namely: (i) the misalignment approach; (ii) the approach taken by Tørsløv et al. (2021); and (iii) the tax semi-elasticity approach.

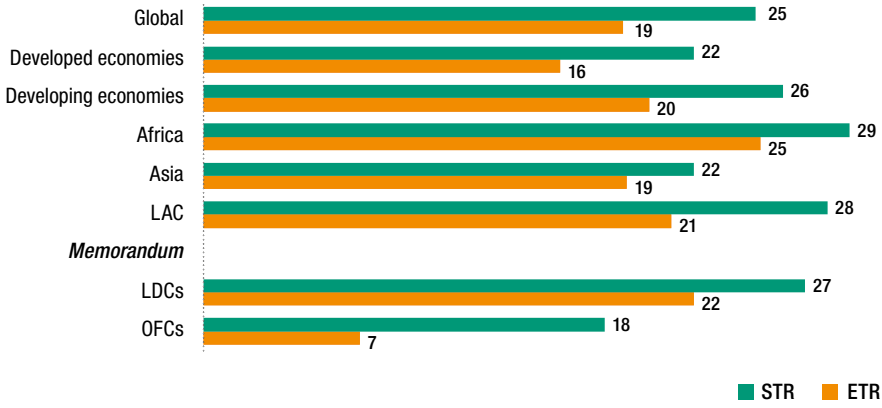
[10] In CbCR data, intra-company dividends are excluded from revenues but might still be double counted in profits, especially for the United States but more generally for developed economies. See discussions in Clausing (2020), Garcia-Bernardo et al. (2021) and Garcia-Bernardo and Janský (2022).

Figure 3. STRs and CbCR-based ETRs

(a) Country-level tax rates (Percentage)



(b) Average tax rates (Percentage)



Source: Authors' calculations.

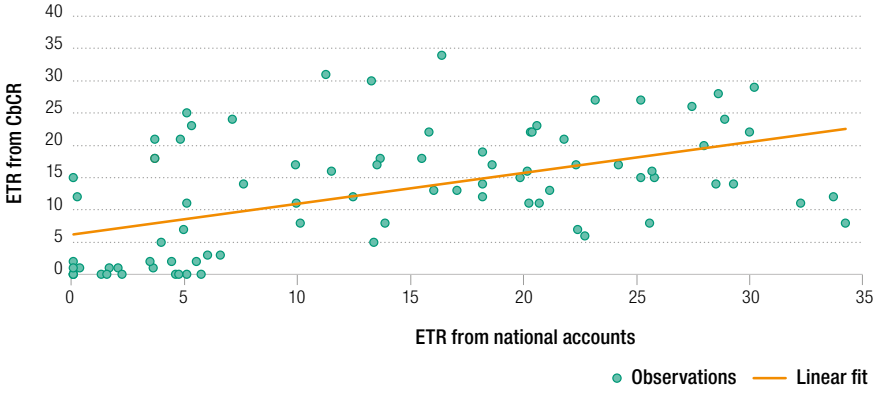
Note: Data from 2017. STR: Statutory tax rate from the Tax Foundation. ETR: effective tax rate from Garcia-Bernardo and Janský (2022).

Subfigure (a): ETRs on the y-axis and STRs on the x-axis. Correlation coefficient equals to *0.443*. $ETR_c^{CbCR} = 3.957 + 0.504 * STR_c$, $R^2 = 0.196$.

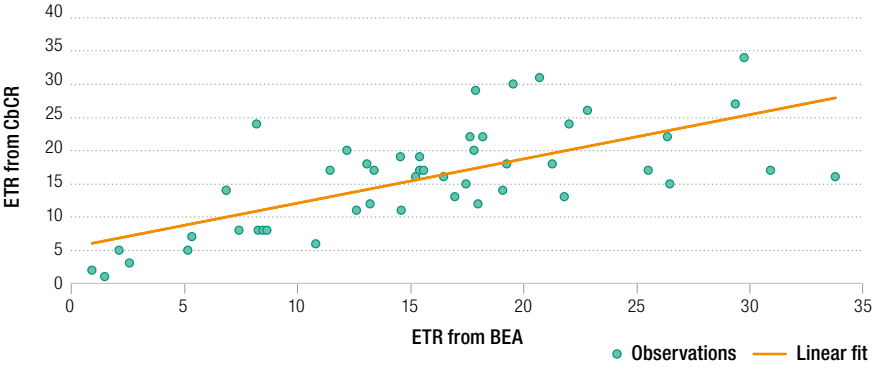
Subfigure (b): Simple average across countries. LAC: Latin America and the Caribbean. LDCs: least developed countries. OFCs: offshore financial centeres. OFCs are included only in the "OFCs" category.

Figure 4. ETRs across data sources

(a) CbCR data and national account data (Percentage)



(b) CbCR data and BEA data (Percentage)



Source: Authors' calculations.

Note: Data from 2017. ETR: Effective tax rate. BEA: Bureau of Economic Analysis.

Subfigure (a): ETRs from Garcia-Bernardo and Janský (2022) on the y-axis and ETRs based on Tørsløv et al. (2021) on the x-axis. ETRs before imputation of missing values. Correlation coefficient equals to *0.525*. $ETR_c^{CbCR} = 6.249 + 0.479 * ETR_c^{NA}$, $R^2 = 0.276$.

Subfigure (b): ETRs from Garcia-Bernardo and Janský (2022) on the y-axis and ETRs computed with BEA data on the x-axis. ETRs before imputation of missing values. Correlation coefficient equals to *0.682*. $ETR_c^{CbCR} = 5.498 + 0.665 * ETR_c^{BEA}$, $R^2 = 0.465$.

Baseline bilateral profit shifting shares

The baseline matrix of bilateral profit shifting shares is built with CbCR data and the misalignment method. Thanks to the extensive coverage of CbCR, profit shifting shares can be computed for many countries directly. The priority assigned to the misalignment method follows quite naturally from the choice of CbCR data as our main source of information on the activities and taxation of large MNEs.

The misalignment method leverages CbCR information on the location of profits and economic activities of (large) MNEs to derive profit shifting patterns (Garcia-Bernardo and Janský, 2022). Profit shifting creates a disconnect between the location of profits and the location of activities, as reported in CbCR data. The profit misalignment method re-aligns both distributions. It re-allocates the worldwide profits reported by MNEs to each jurisdiction in accordance with the scale of MNEs' activities in that jurisdiction.

Following Garcia-Bernardo and Janský (2022), we select three indicators of economic activity: L_c, the numbers of workers employed by MNEs in country c; W_c, the wages paid by MNEs in country c; and R_c, unrelated-party revenues of MNEs in country c. Let π_{lrg} be the worldwide profits generated by MNEs and $\pi_{lrg,c}$ be the profits generated by MNEs in country c. We also define π^*_{lrg} and $\pi^*_{lrg,c}$, the profits reported by MNEs worldwide and in country c, respectively. Notice that $\pi_{lrg} = \pi^*_{lrg}$ but, because of profit shifting, the equality does not necessarily hold at the country level. For any country c (including OFCs), defining s_c the share of profits generated by MNEs in c in total profits:

$$\begin{aligned}
\pi_{lrg,c} &= s_c \pi_{lrg} \\
&= s_c \sum_k \pi^*_{lrg,k} \\
&= \left(\phi_L \frac{L_c}{\sum_k L_k} + \phi_W \frac{W_c}{\sum_k W_k} + (1 - \phi_L - \phi_W) \frac{R_c}{\sum_k R_k} \right) \sum_k \pi^*_{lrg,k}
\end{aligned}$$

Following Garcia-Bernardo and Janský (2022), we set $\phi_L = \phi_W = 0.25$. Employees L_c and unrelated-party revenues R_c are observed in CbCR data. For their part, wages W_c are obtained after multiplying the number of employees L_c (from CbCR) with the average annual salary in country c in 2017 from the International Labour Organization.[11] Outward profit shifting from host country c is defined as the

[11] Missing salaries are predicted by a linear regression model with GDP and population as regressors: $ln(salary_c) = \alpha_0 + \alpha_1\, ln(GDP_c) + \alpha_2\, ln(population_c) + \xi_c$. $R^2 = 0.931$. GDP and population data are retrieved from the World Bank's Development Indicators (accessed 13 December 2021).

difference between profits generated in c and profits reported in c:

$$PS^{O}_{lrg,c} = \pi_{lrg,c} - \pi^{*}_{lrg,c}$$

where, symmetrically, negative values indicate inward profit shifting.

Let us assume that the profit shifting behaviour of MNEs is independent from their origin. For instance, the share of profits shifted from France to Ireland in the profits generated in France is the same for French, German or Italian MNEs operating in France. The share γ_c of the profits generated by foreign affiliates of MNEs in c that are shifted to OFCs is given by:

$$\gamma_c = \sum_{h,h\neq c} \gamma_{ch} = max\left(\frac{PS^{O}_{lrg,c}}{\pi_{lrg,c}}, 0\right)$$

We estimate that some $1,036 billion profits are shifted from non-OFCs toward OFCs, of which three quarters ($759 billion) originate from developed economies. Moreover, among these profits recorded in OFCs, about 25 per cent ($257 billion) are transferred by foreign affiliates, with the majority being instead shifted by domestic MNEs. Foreign affiliates operating in developing economies are estimated to artificially report about $108 billion in OFCs, corresponding to 42 per cent of all profits shifted by foreign affiliates worldwide. Yet, developing economies are relatively more exposed to international tax planning than developed economies, with the former transferring 18 per cent of their profits to OFCs, compared to 16 per cent for developed economies (figure 5). Profit shifting is most pronounced in the least developed economies, with one quarter of their profits being moved to OFCs.[12]

To complete the calibration of the bilateral profit shifting matrix, we allocate country-level outward profit shifting shares γ_c to OFCs based on their relative size as the destination of shifted profits. Denote μ_h the share of profits shifted to OFC h in total shifted profits:

$$\gamma_{ch} = \gamma_c \mu_h = \frac{PS^{IN}_{lrg,h}}{\sum_h PS^{IN}_{lrg,h}}$$

with $PS^{IN}_{lrg,h} = -PS^{O}_{lrg,h}$.

[12] These figures coincide with the conclusions reached by the Tax Justice Network et al. (2021) and Garcia-Bernardo and Janský (2022). Note that most of parent countries in CbCR data are developed economies. Therefore, it is not possible to infer profits shifted by MNEs headquartered in developing economies. This shortcoming, however, should not be a major problem as we expect most of large MNEs to be headquartered in developed countries.

Alternative bilateral profit shifting shares

We construct two supplementary matrices. One is based on Tørsløv et al. (2021) and the other relies on the tax semi-elasticity of reported profits estimated by Heckemeyer and Overesch (2017). Tørsløv et al. (2021) exploit the gap between the (reported) profitability of local and foreign firms in OFCs to assess inward profit shifting in OFCs. They then assign profit shifting in OFCs to non-OFCs using excessive flows in high-risk services (Hebous and Johannesen, 2021). Heckemeyer and Overesch (2017) find that, all other things being equal, profits reported in a given country decrease by 0.8 per cent if the tax rate in that particular country increases by 1 pp. The tax semi-elasticity of reported profits and tax rate differentials between host countries and OFCs together deliver a set of profit shifting shares (Devereux et al., 2020; Hanappi and Cabral, 2020; OECD, 2020). See the annex for technical details and a discussion of the two methods.

6.4. Bilateral profit shifting shares post-Pillar Two: γ'_{ch}

We adopt two scenarios to model bilateral profit shifting shares after Pillar Two (section 4.3). The upper bound scenario is straightforward. As profit shifting vanishes after the reform, we set $\gamma'_{ch} = 0$ for all $h \neq c$. The baseline scenario assumes that the reform partially reduces profit shifting and thus requires a careful empirical calibration of the linear coefficients β_1 and β_2 in (6).

Laffitte et al. (2021) incorporate corporate income taxation and profit shifting in a quantitative trade model and derive a gravity equation for bilateral profit shifting flows. Drawing on their contribution, we regress bilateral profit shifting shares on the ETR of the FDI host country, the ETR of the OFC, and a vector of gravity-type determinants. The latter embeds four bilateral variables all sourced from CEPII, namely: (i) bilateral distance (in km and logarithm); (ii) a contiguity dummy; (iii) a common language dummy; and (iv) a colonial history dummy. Gravity controls allow us to neutralize, to the extent possible, variations in bilateral profit shifting shares not attributable to ETRs in host countries and OFCs:[13]

$$\gamma_{ch} = \beta_0 + \beta_1 ETR_c + \beta_2 ETR_h + \beta_3 gravity_{ch} + \epsilon_{ch} \qquad (9)$$

We expect profit shifting to intensify as the ETR in host country c increases ($\beta_1 \geq 0$) and the ETR in OFC h decreases ($\beta_2 \leq 0$), in line with workhorse models of profit

[13] Three comments are in order. First, ETR_c and ETR_h are introduced separately (instead of $ETR_c - ETR_h$ directly) for reasons of flexibility. Second, we abstract from the possible non-linear effect of tax rates on bilateral profit shifting shares. Third, for the sake of simplicity, we also ignore the existence of interactions between OFCs and then proceed as if profit shifting between c and h is unrelated to the characteristics of other OFCs.

shifting (Hines and Rice, 1994). Notice that for any given host country-OFC pair, taking the difference of equation (10) between the period before and after Pillar Two yields equation (6), which is then used to formally define our baseline scenario of partial (linear) reduction in profit shifting. In this respect, our empirical strategy is fully consistent with our initial modeling assumptions.[14]

Results in table 1 confirm our hypotheses. Non-OFCs with high ETRs are more exposed to profit shifting, and OFCs with low ETRs tend to attract more profits. $\widehat{\beta_1}$ and $\widehat{\beta_2}$ have expected signs and are statistically significant at the 1 per cent level. Evidence also validates that distance matters for profit shifting. Altogether, ETRs and gravity factors explain around 30 per cent of the variance in bilateral profit shifting shares.

Table 1. Determinants of bilateral profit shifting shares

Dependent variable	γ_{ch}
ETR_c	0.032***
	(0.007)
ETR_h	-0.097***
	(0.012)
$ln(distance_{ch})$	-0.004***
	(0.001)
$contiguity_{ch}$	0.001
	(0.006)
$common\ language_{ch}$	-0.002
	(0.002)
$colony_{ch}$	-0.012
	(0.020)
Observations	1 192
R^2	0.338

Source: Authors' estimations.

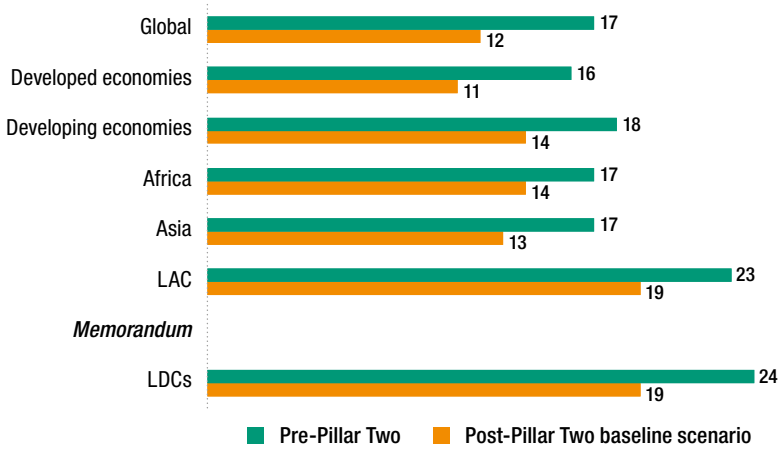
Note: Standard errors, in parentheses, are heteroskedasticity-robust. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. ETR: effective tax rate. Profit shifting shares γ_{ch} are calibrated with the profit misalignment method. ETRs are based on CbCRs (Garcia-Bernardo and Janský, 2022) and the list of offshore financial centres follows in Tørsløv et al. (2021).

Armed with $\widehat{\beta_1}$ and $\widehat{\beta_2}$, profit shifting shares post-Pillar Two are calculated using (6). For example, assume that the ETR in c increases by 2 pp and that the ETR in OFC h rises by 10 pp. According to (6) and our point estimates $\widehat{\beta_1} = 0.032$ and $\widehat{\beta_2} = -0.097$, the bilateral profit shifting share post-Pillar Two diminishes by 0.91 per cent.

[14] Importantly, regression results for (10) are also used to broaden the scope of the analysis and incorporate countries absent from CbCRs through imputations.

Figure 5 reports each group's profit shifting shares before and after Pillar Two, as estimated with the profit misalignment method. At the global level, we find that 17 per cent of FDI income generated in non-OFCs is artificially recorded in OFCs before Pillar Two. As Pillar Two is rolled out and narrows ETR differentials between non-OFCs and OFCs, MNEs adapt and reduce their profit shifting activities. The orange bars represent profit shifting shares after Pillar Two and are based on the regression results in table 1. Assuming a linear decline in profit shifting, we estimate a global profit shifting share of 12 per cent after Pillar Two, i.e. a 30 per cent decrease in the average profit shifting share.

Figure 5. Pre- and post-Pillar Two profit shifting shares (Percentage)



Source: Authors' calculations.

Note: Green bars represent pre-Pillar Two profit shifting shares. They also represent post-Pillar Two profit shifting shares, assuming no profit shifting response, as in Hanappi and Cabral (2020) and OECD (2020). Orange bars represent post-Pillar Two profit shifting shares, assuming partial reduction of profit shifting (baseline scenario). FDI-weighted averages. LAC: Latin America and the Caribbean. LDCs: least developed countries. Offshore financial centres are excluded since we assume no profit shifting out of offshore financial centers (assumption 3).

6.5. Additional parameters: carve-out shares (CO_c^{SHARE}) and relative contribution of large MNEs (ω_c)

Two sets of parameters are missing to complete the calibration exercise and calculate the impact of Pillar Two on FDI-level ETRs (equation (9)): the carve-out shares CO_c^{SHARE} and the relative contribution of large MNEs ω_c. Technically, the profits which can be spared from the application of the minimum tax rate (i.e.

carve-out) represent 5 per cent of tangible assets and payroll.[15] We make use of the OECD CbCR and the OECD Activity of Multinational Enterprises (AMNE) databases to approximate the share of profits excluded from Pillar Two. The carve-out share is based on the OECD AMNE database for the payroll calculation (using partner countries). The payroll component of the carve-out is calculated as 0.05 times personnel costs divided by gross operating surplus. The tangible asset calculation is based on the OECD CbCR data (by partner jurisdiction). The tangible carve-out is calculated as 0.05 times tangible assets divided by profit (loss) before income tax. The estimated total carve-out share is simply the sum of the two components. When aggregating, only partner countries with positive profits or gross operating surplus are used. We also drop the cases where the carve-out share is greater than one. Taking a simple average across countries gives a carve-out share of 40 per cent, with a median value at 31 per cent. We use this average for all host countries for convenience, i.e. $CO_c^{SHARE} = CO^{SHARE} = 0.4$ for all c.

Finally, Pillar Two only targets large MNEs. Therefore, calculating changes in FDI-level ETRs for all foreign affiliates requires knowing ω_c, i.e. the share of activities conducted by foreign affiliates of large MNEs among those carried out by foreign affiliates of all MNEs. The calibration of this parameter involves merging two complementary databases, namely: the BEA's data on the United States direct investment abroad and the United States' CbCRs.[16] The BEA's dataset provides details on the activities of MNEs headquartered in the United States overseas, while the United States' CbCRs exclusively cover those of large MNEs headquartered in the United States. The implicit assumption of using data on MNEs headquartered in the United States is that the relative size of foreign affiliates of large MNEs in a particular jurisdiction does not depend on the location of their headquarter. Denote $S_{lrgUS,c}$ the sales made by large MNEs headquartered in the United States in host country c and $S_{US,c}$ those of all MNEs headquartered in the United States in the same country c. ω_c is calculated as follows:

$$\omega_c = \frac{S_{lrgUS,c}}{S_{US,c}}$$

The ratio covers 82 host countries and includes the largest FDI recipients. Missing values are replaced with regional averages.

[15] A statement released by the OECD in October 2021 declares that "the GloBE rules will provide for a formulaic substance carve-out that will exclude an amount of income that is 5% of the carrying value of tangible assets and payroll. In a transition period of 10 years, the amount of income excluded will be 8% of the carrying value of tangible assets and 10% of payroll, declining annually by 0.2 percentage points for the first five years, and by 0.4 percentage points for tangible assets and by 0.8 percentage points for payroll for the last five years" (OECD, 2021, p. 4).

[16] The latter are available on the website of the Internal Revenue Service.

7. Results

We start by showing the gap between standard ETRs and FDI-level ETRs before Pillar Two (section 7.1). Then, we turn to the impact assessment of Pillar Two on FDI-level ETRs (sections 7.2, 7.3 and 7.4). We assume that all countries covered by the analysis implement Pillar Two and treat the scenario with partial reduction of profit shifting and substance-based carve-out as our reference. Moreover, we compare our estimates with those presented in the OECD's EIA (section 7.5). Lastly, we examine the effect of the reform on the dispersion of tax rates (section 7.6).

7.1. Initial ETRs and FDI-level ETRs

Table 2 displays ETRs and FDI-level ETRs before Pillar Two. Tax rates are weighted by FDI within each category. This correction provides a more faithful picture of taxes paid on FDI since foreign investments are not uniformly distributed across countries. The average ETR faced by foreign affiliates of MNEs in non-OFCs stands at 17 per cent, but ETRs differ markedly across groups. Developed economies exhibit lower ETRs (15 per cent), as compared to developing countries (23 per cent). At the other end of the spectrum, the average ETR in OFCs is the lowest and is equal to 5 per cent.

The difference between ETRs and FDI-level ETRs lies between 2 and 3 pp. Profit shifting activities are thus sizable. They reduce the tax rate paid on FDI income by more than 13 per cent. The gap is somewhat larger for developing economies (15 per cent) than for developed economies (13 per cent). It is most striking for the least developed countries (21 per cent) as they are relatively more affected by profit shifting (section 6.3).

Interestingly, Table 2 indicates that incorporating profit shifting dynamics is critical in assessing the impact of Pillar Two. The share of FDI subject to taxes below 15 per cent is indeed significantly higher once profit shifting is accounted for. For example, developing economies with an average ETR below 15 per cent represent 6 per cent of total FDI inward stock. If we were to look at corporate income taxes through the lens of FDI-level ETRs, the share of FDI taxed at less than 15 per cent reaches 26 per cent. From this perspective, the Pillar Two threshold of 15 per cent is more ambitious than it might appear at first sight. Given the high concentration of tax rates in the range between 15 and 21 per cent (21 per cent being the threshold originally discussed during the BEPS negotiations), even a slight shift in the minimum tax has a considerable impact on the positioning of countries relative to the Pillar Two threshold (see also UNCTAD, 2022).

Table 2. ETRs and FDI-level ETRs pre-Pillar Two

Group	**ETR** (percentage)	**FDI-level ETR** (percentage)	**Gap** (pp. percentage in brackets)
Global	17.3	15.0	2.3 (13.4)
Developed economies	15.0	13.1	1.9 (12.5)
Developing economies	23.0	19.6	3.4 (14.8)
Africa	25.6	22.2	3.4 (13.3)
Asia	22.3	19.6	2.7 (12.2)
LAC	23.4	18.6	4.8 (20.5)
Memorandum			
LDCs	25.4	20.1	5.3 (20.8)
OFCs	5.4	5.4	–

Source: Authors' estimations.
Note: FDI-weighted averages. ETR: effective tax rate. LAC: Latin America and the Caribbean. LDCs: least developed countries. OFCs: offshore financial centres. OFCs are included only in the "OFCs" category.

Table 3. Impact of Pillar Two on FDI-level ETRs (without carve-out)

Group	**Linear decline of profit shifting, baseline** (pp, percentage in brackets)	**Elimination of profit shifting, upper bound** (pp, percentage in brackets)
Global	2.4 (16.3)	3.0 (19.9)
Developed economies	2.7 (20.3)	3.0 (22.8)
Developing economies	1.9 (9.7)	3.0 (15.4)
Africa	2.1 (9.3)	3.4 (15.4)
Asia	1.6 (8.3)	2.4 (12.3)
LAC	2.3 (12.4)	4.2 (22.5)
Memorandum		
LDCs	3.0 (14.8)	5.4 (26.6)
OFCs	7.3 (133.5)	7.3 (133.5)

Source: Authors' calculations.
Note: FDI-weighted averages. Results for ΔETR^{FDI} expressed in percentage points (in percentage in brackets). ETR: effective tax rate. LAC: Latin America and the Caribbean. LDCs: least developed countries. OFCs: offshore financial centres. OFCs are included only in the "OFCs" category. No carve-out.

7.2. Impact of Pillar Two on FDI-level ETRs

Results without substance-based carve-out

The effect of Pillar Two on FDI-level ETRs without substance-based carve-out is outlined in table 3. Pillar Two is expected to increase the average FDI-level ETR faced by MNEs by 2 to 3 pp. Assuming that part of these profits is still transferred to OFCs after the reform (baseline scenario), the impact of Pillar Two on FDI-level ETRs in developing countries (1.9 pp) is two thirds that of developed economies (2.7 pp). In the alternative scenario (upper bound), the impact of the FDI-level ETRs reform is more homogenous (3.0 pp for developed economies and 3.1 pp for developing economies). Among developing economies, the subset composed of the least developed countries (LDCs) shows the largest rise in FDI-level ETRs, with 3.0 pp in the conservative scenario and 5.4 pp in the most aggressive scenario.

The different cross-regional impact patterns in the two scenarios stem from the exposure of countries to the profit shifting and ETR channels (section 4 and table 4). Countries that have lower ETRs and that are less prone to profit shifting tend to display a limited gap between the baseline and the upper bound, as the difference between scenarios entirely depends on the profit shifting behaviour of MNEs. This is fully exemplified by OFCs, which have very low ETRs and no outward profit shifting. To a lesser extent, this is also the case for developed economies. In contrast, developing countries, especially in Africa and in Latin America and the Caribbean, have relatively high ETRs and significant exposure to profit shifting, which explains the sizable difference between the baseline and the upper bound.

Globally, two thirds of the 3 pp increase in FDI-level ETRs can be attributed to the profit shifting channel (table 4). Yet, the effects vary greatly between developed and developing economies. In developed economies, the contribution to the overall impact is evenly shared between the two channels. However, the profit shifting channel is more prominent in developing economies, including LDCs, owing to the combination of higher pre-Pillar Two ETRs and greater exposure to profit shifting. The weight of the ETR channel is less than 10 per cent in developing economies, compared to almost 50 per cent in developed economies. Among developing economies, LDCs are somewhat distinct, with a stronger weight of the ETR channel. Conversely, in OFCs, the ETR channel drives the total effect of Pillar Two on FDI-level ETRs – an increase of 7 pp, corresponding to a growth rate of 133 per cent relative to the very low pre-Pillar Two level of 5 per cent.

Table 4 . Contribution of the ETR and profit shifting channels to the impact of Pillar Two on FDI-level ETRs (upper bound, without carve-out)

Group	ETR channel	Profit shifting channel	Weight of the profit shifting channel
	(pp)	(pp)	(percentage)
Global	1.1	1.9	64.5
Developed economies	1.4	1.6	53.4
Developing economies	0.3	2.7	90.8
Africa	0.7	2.8	80.8
Asia	0.1	2.3	94.4
LAC	0.2	4.0	96.2
Memorandum			
LDCs	1.1	4.2	78.8
OFCs	7.3	–	–

Source: Authors' calculations.

Note: FDI-weighted averages. Results for ΔETR^{FDI} expressed in percentage points (in percentage in brackets). ETR: effective tax rate. LAC: Latin America and the Caribbean. LDCs: least developed countries. OFCs: offshore financial centres. OFCs are included only in the "OFCs" category. Upper bound scenario: elimination of profit shifting. No carve-out.

Table 5. Impact of Pillar Two on FDI-level ETRs (with carve-out)

Group	Linear decline of profit shifting, baseline (pp, percentage in brackets)	Elimination of profit shifting, upper bound (pp, percentage in brackets)
Global	2.0 (13.5)	2.6 (17.1)
Developed economies	2.1 (16.1)	2.4 (18.3)
Developing economies	1.8 (9.2)	3.0 (15.1)
Africa	1.8 (8.1)	3.1 (14.2)
Asia	1.5 (7.9)	2.4 (12.0)
LAC	2.2 (12.1)	4.1 (22.1)
Memorandum		
LDCs	2.5 (12.5)	4.9 (24.1)
OFCs	4.4 (80.1)	4.4 (80.1)

Source: Authors' calculations.

Note: FDI-weighted averages. Results for $\Delta ETR^{FDI,CO}$ expressed in percentage points (in percentage in brackets). ETR: effective tax rate. LAC: Latin America and the Caribbean. LDCs: least developed countries. OFCs: offshore financial centres. OFCs are included only in the "OFCs" category. With carve-out.

Results with substance-based carve-out

Table 5 presents the results obtained with substance-based carve-out. As discussed in section 4.4, we consider that 40 per cent of profits reported in host countries are no longer subject to the minimum tax. The simulations reveal that substance-based carve-outs only mitigate the effect of Pillar Two on FDI-level ETRs to a certain extent and for host countries with a relatively low ETR before Pillar Two. This is because the substance-based carve-out leaves the profit shifting channel intact and acts merely through the ETR channel, as shown in (8). The case of developing countries perfectly illustrates this point. Substance-based carve-outs play a very minor role for these jurisdictions as barely 10 per cent of the impact of Pillar Two on FDI-level ETRs passes through the ETR channel (table 4). They reduce the impact of FDI-level ETRs to a larger extent for developed countries, where the ETR channel is more influential.

7.3. Summary of the findings

Combining results across different scenarios and assumptions on the carve-out (tables 3 and 5), the increase in FDI-level ETRs generated by Pillar Two is estimated to be between 2 and 3 pp globally. This implies growth relative to pre-Pillar Two levels of between 14 per cent (baseline scenario with carve-out, table 5, column 1) and 20 per cent (upper bound scenario without carve-out, table 3, column 2). In our preferred scenario (baseline scenario with carve-out), the increase is more pronounced for FDI in developed economies (16 per cent) than in developing economies (9 per cent). Note that the impact of Pillar Two on FDI-level ETRs for large MNEs alone (with annual revenues above €750 million) could be up to 17 per cent in the baseline scenario. It should also be noted that the baseline estimate reflects the average increase faced by FDI (an FDI-weighted average); this is smaller than the simple average change in FDI-level ETRs across countries, also estimated at 17 per cent.

7.4. Sensitivity analysis

To gauge the robustness of our findings, we replicate the simulations with alternative profit shifting matrices. The results for non-OFCs are laid out in table 6, in a setting with profit shifting elimination and no substance-based carve-out. This configuration is ideal for running sensitivity tests as it provides the highest impact. Therefore, if the results are aligned under such assumptions, the results obtained in different cases should be even closer. The first series of sensitivity checks lends credence to our estimates. Generally, the impact of Pillar Two on FDI-level ETRs is stable across profit shifting matrices. Table 6 suggests that our findings are not significantly driven by our modeling assumptions on profit shifting. This is important

as no consensus has been reached on the magnitude of profit shifting (Riedel, 2018), so focusing on one single calibration method might be problematic and potentially misleading.

Table 6. Impact of Pillar Two on FDI-level ETRs – robustness checks

Profit shifting matrix	Increase in FDI-level ETRs
	Global average, upper bound (pp, percentage in brackets)
Profit misalignment method (baseline)	3.0 (19.9)
Tørsløv et al. (2021) method	3.6 (25.0)
Semi-elasticity method	2.3 (14.8)

Source: Authors' calculations.
Note: ETRs used: from CbCR. FDI-weighted averages. Results for ΔETR^{FDI} expressed in percentage points (in percentage in brackets). Offshore financial centres excluded. Upper bound scenario: elimination of profit shifting. No carve-out.

Table 7 explores the sensitivity of the findings, with other sets of ETRs this time. The table further validates our findings. The average impact of Pillar Two on FDI-level ETRs hardly varies across ETR data sources. Note that, in line with our expectations, the impact is lowest when national account data are used. ETRs in OFCs are systematically larger when they are constructed with such data. The upward bias dampens the profit shifting channel and consequently the overall impact of Pillar Two on FDI-level ETRs.

Table 7. Impact of Pillar Two on FDI-level ETRs – robustness checks (ETRs)

Source of ETRs	Increase in FDI-level ETRs
	Global average, upper bound (pp, percentage in brackets)
CbCR (baseline)	3.0 (19.9)
National accounts	2.4 (14.9)
Bureau of Economic Analysis (BEA)	2.5 (15.8)

Source: Authors' calculations.
Note: Profit shifting calibration technique: profit misalignment. FDI-weighted averages. Results for ΔETR^{FDI} expressed in percentage points (in percentage in brackets). Offshore financial centres excluded. Upper bound scenario: elimination of profit shifting. No carve-out.

7.5. Comparison with the OECD Economic Impact Assessment

The OECD's EIA is to the best of our knowledge the main alternative estimate of the impact of Pillar Two on the taxes faced by MNEs (Hanappi and Cabral, 2020; OECD, 2020). Under the OECD's EIA, the effective average tax rate of MNEs would increase by 0.5 pp and the effective marginal tax rate of MNEs would rise by 1.9 pp (GDP-weighted average among non-OFC economies).

The approach followed by the OECD differs from ours in two respects. From a methodological perspective, the OECD's EIA uses forward-looking ETRs. We exploit backward-looking ETRs in our study for reasons explained in section 2. From a conceptual point of view, it is worth pointing out three main differences in the underlying assumptions:

(i) First, profit shifting remains constant in the OECD's EIA. The potential increase in investment costs resulting from a decline of international tax planning is therefore not incorporated. Our simulations allow for a reduction of profit shifting activities of large MNEs, which is one of the key objectives of Pillar Two.

(ii) Second, the OECD's EIA investigates the effect of Pillar Two on the taxes paid on the income of an investment carried out in the home country. The approach prioritizes a group-level perspective and informs on the investment impact of Pillar Two for the MNE group. In a sense, the present analysis is complementary as it addresses the effect of the tax reform on the foreign investments of an MNE.

(iii) Third, and related to (ii), the substance-based carve-out plays a role only through profit shifting in the OECD's EIA. This is because the tax increases only stem from the rise in taxes paid on shifted profits. In this paper, we argue that shifted profits, by their very nature, have no or negligible economic substance. The substance-based carve-out on shifted profits is thus assumed to be negligible.

These three conceptual differences are perhaps best visualized through equations. Combining equations (4) and (8) gives a comprehensive expression for changes in the FDI-level ETRs incurred by the foreign affiliates of large MNEs in the presence of a carve-out:

$$\begin{aligned}\Delta ETR_{lrg,c}^{FDI,CO} \quad = \quad & \left(1 - CO_c^{SHARE}\right)\left(ETR_c' - ETR_c\right) \\ & + \sum_{h,h\neq c} \gamma_{ch}(ETR_c - ETR_h) - \sum_{h,h\neq c} \gamma_{ch}'(ETR_c' - ETR_h')\end{aligned} \tag{11}$$

Assumption (i) implies $\gamma'_{ch} = \gamma_{ch}$. The expression above becomes:

$$\Delta ETR^{FDI,CO}_{lrg,c} = \left(1 - CO^{SHARE}_{c}\right)(ETR'_c - ETR_c) + \sum_{h,h\neq c} \gamma_{ch}(ETR'_h - ETR_h) - \sum_{h,h\neq c} \gamma_{ch}(ETR'_c - ETR_c) \quad (11.i)$$

Assumption (i) maximizes the negative term in (11) and (11.i) ≤ (11). Furthermore, the application of assumption (ii) to our framework implies that $ETR^{I}_{c} = ETR_c$, i.e. rules out the ETR channel. Expression (11.i) then becomes:

$$\Delta ETR^{FDI,CO}_{lrg,c} = \sum_{h,h\neq c} \gamma_{ch}(ETR'_h - ETR_h) \quad (11.ii)$$

Lastly, a substance-based carve-out applied to shifted profits, i.e. assumption (iii), further mitigates the impact of Pillar Two on FDI-level ETRs:

$$\Delta ETR^{FDI,CO}_{lrg,c} = \sum_{h,h\neq c} \left(1 - CO^{SHARE}_{h}\right) \gamma_{ch}(ETR'_h - ETR_h) \quad (11.iii)$$

Table 8 provides a quantification of the impact of the sequential application of assumptions (i), (ii) and (iii) to our framework. We use the baseline scenario with carve-out as a starting point (+2 pp) and provide estimates at the country-wide level (in line with (9)). To facilitate the comparison with the OECD's EIA, we first remove the countries not covered in the OECD analysis. The results show that sample selection is not determinant (+2.1 pp). Next, we assume that the profit shifting behaviour of the foreign affiliates of large MNEs is the same before and after Pillar Two (11.i). This hypothesis alone reduces the estimated impact of Pillar Two on FDI-level ETRs by 0.2 pp (+1.9 pp). The third iteration assumes that the impact of Pillar Two through the ETR channel is null. The impact of Pillar Two on FDI-level ETRs lowers by 0.6 pp in this case (+1.3 pp). Finally, we apply a carve-out of 40 per cent to shifted profits. The global impact of Pillar Two decreases by 0.5 pp (+0.8 pp). Overall, the expected increase in FDI-level ETRs at the global level goes from a baseline (conservative) estimate of +2.1 pp to +0.8 pp after incorporating the OECD's EIA assumptions (i), (ii) and (iii) into our framework. The final simulated impact at +0.8 pp is only slightly higher than the impact estimated by the OECD. Although the two approaches are very different and hardly comparable, it suggests that the difference between our estimate and the OECD's stems from underlying assumptions rather than fundamental differences in methodology.

Table 8. Simulation of the impact of Pillar Two on FDI-level ETRs under assumptions made in the OECD economic impact assessment (Percentage point)

Assumption	Increase in FDI-level ETRs
	Global average
Baseline (11)	2.0
Baseline (11) with reduced sample	2.1
—— + constant profit shifting (11.i)	1.9
—— + no ETR channel (11.ii)	1.3
—— + 40 per cent carve-out on shifted profits (11.iii)	0.8

Source: Authors' calculations.
Note: FDI-weighted averages. Results for $\Delta ETR^{FDI,CO}$ expressed in percentage points. Offshore financial centres excluded. PS: profit shifting. ETR: effective tax rate. With carve-out.

7.6. Tax rate differentials

Before concluding, we examine the evolution of tax differentials for large MNEs, assuming profit shifting elimination and no carve-out for ease of exposition (table 9). Without profit shifting considerations, the reduction in (standard) ETR differentials across countries generated by Pillar Two is particularly sizable. The post-Pillar Two distribution of the average ETR is "truncated" at the minimum tax rate (section 5), resulting in a 30 per cent decrease in the standard deviation of ETRs. In contrast, differentials in FDI-level ETRs decrease to a lesser degree because of the profit shifting channel extensively discussed in section 5. The decline is more moderate at 15 per cent, i.e. it represents half of the reduction observed for standard ETRs. The baseline scenario with partial reduction of profit shifting shows a stronger decrease in FDI-level ETRs differentials but is still smaller than for standard ETRs.

Table 9. Standard deviation of ETRs and FDI-level ETRs across host countries (Percentage)

Tax rate	Standard deviation pre-Pillar Two	Standard deviation post-Pillar Two	Change in standard deviation post-Pillar Two
ETR	11.8	8.3	29.7
FDI-level ETR	9.6	8.3	14.7

Source: Authors' calculations.
Note: Assuming elimination of profit shifting, no carve-out, and including only large MNEs. All countries included.

8. Conclusion

This paper assesses the effect of BEPS Pillar Two on the taxes paid by MNEs on FDI income. To this end, we introduce a new metric that refines and complements standard measures on ETRs. Standard ETRs provide insights into the taxes paid by firms in a country on the income reported in this country. The new indicator, FDI-level ETR, reflects the taxes paid by firms on the income generated in that country. It thus captures the tax avoidance schemes of MNEs and sheds more light into MNEs' investment decisions.

Pillar Two triggers two effects on FDI-level ETRs. First, ETRs in host countries will increase if they are lower than 15 per cent (ETR channel). Second, the tax rate that applies to profits artificially reported in OFCs will increase, and profit shifting is likely to decrease (profit shifting channel). Both channels can be quantified within our framework.

Next, we bring the model to the data. We collect and exploit rich data to construct ETRs, profit shifting matrices, and FDI-level ETRs for 208 countries. We expand the profit shifting literature by building more extensive matrices. While existing studies either calibrate bilateral profit shifting for a subset of advanced countries or calibrate profit shifting shares at the country level, we estimate bilateral profit shifting for almost all countries. This not only enriches our understanding of profit shifting patterns but also allows us to predict the effect of Pillar Two on FDI-level ETRs for various types of countries.

The findings are three-fold. First, profit shifting activities allow MNEs to reduce the taxes paid on FDI income in non-OFCs by about 15 per cent. Second, among non-OFC countries, on average a global minimum tax of 15 per cent raises FDI-level ETRs faced by MNEs by 14 per cent in our benchmark (and conservative) exercise. The increase in FDI-level ETRs reaches 20 per cent under more aggressive assumptions. Third, the effect induced by Pillar Two on FDI-level ETRs mostly passes through the profit shifting channel. The latter is more pronounced in developing countries, where ETRs are higher and outward profit shifting is fiercer in the first place.

The policy implications of these findings are important. They include strategic investment policy considerations as the competitive positions of individual countries for FDI attraction are altered, and tax competition is reshaped fundamentally. They also extend the practical implications for the use and effectiveness of common investment promotion tools, such as fiscal incentives, special economic zones, and other preferential schemes. Discussion of these implications is beyond the scope of this paper and is covered in UNCTAD (2022).

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Annex

Profit shifting matrix based on Tørsløv et al. (2021)

To the best of our knowledge, the only available source of profit shifting data at the bilateral level is Tørsløv et al. (2021). The material provided by the authors contains not only bilateral profit shifting flows for around 45 non-OFCs but also the data exploited to construct these flows. All figures and tables from Tørsløv et al. (2021) can thus be reproduced with the files uploaded on www.missingprofits.world. We build on this work and extract the data for 2017.

To calibrate γ_{ch}, we proceed as follows. Due to data limitations, we assume that the share of profits generated in c and shifted to h is the same irrespective of the size and nationality of MNEs. Denote $PS^{O}_{all,ch}$ outward profit shifting of foreign affiliates from c to h, PS^{O}_{ch} outward profit shifting of MNEs from c to h, $\pi_{all,c}$ profits generated by foreign affiliates in c, and π_{c} profits generated by MNEs in c. Formally:

$$\gamma_{ch} = \frac{PS^{O}_{all,ch}}{\pi_{all,c}} = \frac{PS^{O}_{ch}}{\pi_{c}}$$

Furthermore:

$$\pi_{c} = \pi^{*}_{c} + \sum_{h \neq c} PS^{O}_{ch}$$

where π^{*}_{c} represents the profits reported by MNEs in c. Denote ψ_{c} the share of profits reported by MNEs in c (π^{*}_{c}) among all profits reported by enterprises operating in c (Π^{*}_{c}).

Hence:

$$\gamma_{ch} = \frac{PS^{O}_{ch}}{\psi_{c}\Pi^{*}_{c} + \sum_{h \neq c} PS^{O}_{ch}}$$

The database compiled by Tørsløv et al. (2021) includes information on the profits shifted from c to h (PS^{O}_{ch}) and on the total profits disclosed in country c (Π^{*}_{c}). For ψ_{c}, we leverage data from the OECD's AMNE database. The latter reports the sales made by all active firms in c and those made exclusively by MNEs in c. If the share of sales mirrors the share of profit, combining data from Tørsløv et al. (2021) and OECD AMNE enables us to pin down γ_{ch} for a set of countries present in both data sources. A caveat is that the two databases are mostly composed of OECD economies. To insert more developing economies and thereby extend the scope of our analysis, we predict missing bilateral profit shifting shares using equation (10).

Profit shifting matrix based on Heckemeyer and Overesch (2017)

The tax semi-elasticity approach hinges on the meta-study of Heckemeyer and Overesch (2017) and is used in Devereux et al. (2020) and Hanappi and Cabral (2020), among others.

Heckemeyer and Overesch (2017) find that the tax semi-elasticity of (pre-tax) reported profits is equal to 0.8. In other words, reported profits in country c decrease by 0.8 per cent if the tax rate in c increases by 1 pp. Country-level profit shifting shares γ_c are thus calibrated as follows:

$$\gamma_c = max\left(0.8 \times \left(ETR_c - \overline{ETR_h}\right), 0\right)$$

where $\overline{ETR_h}$ is the average ETR in OFCs. Country-level profit shifting shares are then transformed into bilateral profit shifting shares using data on FDI from non-OFC countries in OFCs:

$$\gamma_{ch} = \gamma_c \frac{FDI_{ch}}{\sum_{h,h \neq c} FDI_{ch}}$$

FDI data come from the International Monetary Fund (IMF) Coordinated Direct Investment Survey (CDIS) database (accessed 31 December 2021), which incorporates 127 countries. Ratios $\frac{FDI_{ch}}{\sum_{h,h \neq c} FDI_{ch}}$ for non-OFCs missing from the IMF CDIS database are replaced with global averages. It is worth noting that this calibration procedure does not require an econometric model.