

Quantifying the OECD BEPS Indicators – An update to BEPS Action 11

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Summary:

- Profit shifting of multinational corporations is a pressing topic in the public debate, academic research and on the political agenda. Yet, measuring the extent of profit shifting and assessing the economic relevance of it is a major challenge. In 2015, the OECD has introduced six indicators to measure and evaluate BEPS activity over time and on different levels of aggregation. We transparently revive the three most convincing indicators and analyze their development over time.
- Our estimate of Indicator 1, which relies on macro-level data and intends to indirectly measure BEPS through the use of offshore tax havens, provides some indication of increasing BEPS but no solid evidence. The regression estimates of Indicator 4, relying on firm-level micro data, indicate that multinational firms have lower effective tax rates than domestic firms but that this difference diminishes over time, possibly due to effective BEPS countermeasures. However, our analysis of Indicator 5, which uses macro-level data and is concerned with profit shifting through intangibles, indicates a stable trend of BEPS.
- The OECD's intention to provide understandable and easy to replicate measures of BEPS, comes at the price that the indicators are highly dependent on the underlying assumptions and the availability of data and may be influenced by various other factors. Yet, transparent updates on the existence and extent of BEPS contribute to the ongoing public and academic debate on the necessity to reform the corporate income tax system.

1. Introduction

Profit shifting of multinational corporations is a pressing topic in the public debate, academic research and on the political agenda. The debate on legal tax avoidance is fueled by anecdotal evidence on extremely low effective tax rates (ETRs) by multinational enterprises (MNEs). Especially US companies with valuable intellectual property (IP), such as Google, Apple, and Amazon, are in the public focus for being tax ‘aggressive’.¹

The issue of ‘aggressive’ tax planning and cross-border income relocation is, of course, not new to policymakers. The release of the well-known Action Plan on Base Erosion and Profit Shifting (BEPS), in 2013, by the Organization for Economic Cooperation and Development (OECD), has lifted the issue to one of the top priorities in international politics. Since then many nations have implemented far-reaching reforms to prevent ‘aggressive’ income shifting and to strengthen anti-tax avoidance legislation. While some reforms are part of coordinated supranational action, e.g., the EU Anti-Tax Avoidance Directive, others are purely unilateral legislation to protect national tax revenues, e.g., the French digital services tax. Despite major reforms and a heightened public awareness against ‘aggressive’ tax planning, the conservation of corporate tax revenues is still a major concern of policymakers. Especially the ongoing digital transformation of the economy puts new pressure on the existing international tax system. Hence, the OECD has recently proposed a far-reaching two-pillar reform to adjust worldwide corporate taxation. Pillar One proposes a “Unified Approach” that is designed to allocate taxing rights to market jurisdictions. Pillar Two, the “Global Anti-Base Erosion” (GloBE) proposal, intends to counteract all remaining profit shifting risks by introducing a

¹ The effective tax rate of big tech companies is regularly discussed in the public media and Margarethe Vestager, European Commissioner for Competition, has become publicly known for her focus on illegal state aid cases and tax affair investigations. See, for example, <https://www.ft.com/content/79b56392-dde5-11e8-8f50-cbae5495d92b>; <https://www.theguardian.com/technology/2018/oct/08/facebook-uk-tax-bill-sales-margaret-hodge> and <https://www.bloomberg.com/news/articles/2019-09-16/apple-takes-on-eu-s-vestager-in-record-14-billion-tax-battle>.

coordinated global minimum tax and a deduction disallowance that should, in general, apply to all transactions.

The public and political debates indicate that tax avoidance of MNEs is a substantial issue. Yet, measuring the extent of profit shifting and assessing the economic relevance of it is a major challenge. In its 2015 published Final Report on “Measuring and Monitoring BEPS, Action 11”, the OECD has introduced six indicators to measure and evaluate BEPS activity over time and on different levels of aggregation (OECD 2015). In conjunction with the introduction, the OECD provided numbers for each indicator for the period from 2005 to 2012. Ever since these indicators have not been revised or quantitatively updated by the OECD.

We revive three of the indicators and analyze their development over time. We follow the conceptual evaluation of the indicators by Heckemeyer et al. (2018) and focus our analysis on the three most convincing indicators: Indicator 1 (Disconnect between financial and real economic activities), Indicator 4 (MNE vs. “comparable” non-MNE effective tax rate differentials) and Indicator 5 (Profit shifting through intangibles). Especially Indicator 4, which employs advanced statistical methods and counterfactuals, has been identified in previous work to represent the most promising approach (Heckemeyer et al. 2018). Overall, we provide numerical evidence on how BEPS activity has developed in recent years, assess the impact of policy changes, and connect our findings to contemporary international tax research.

This paper is organized as follows. Section 2 provides a brief overview of the empirical literature on what is known about international profit shifting. Section 3 highlights the underlying empirical methodology and describes the necessary data to estimate the specific OECD indicators. Section 4 discusses the results and Section 5 concludes.

2. Empirical Evidence on Base Erosion and Profit Shifting

During the last decade, numerous empirical studies have agreed on the existence of BEPS activity (Beer and Loeprick 2015; Dharmapala 2014; Hanlon and Heitzman 2010; Heckemeyer

and Overesch 2013; Riedel 2014). The authors of these studies use different empirical methods and datasets to provide convincing evidence of cross-border profit shifting. According to Hines and Rice (1994), later extended by Huizinga and Leaven (2008), the profit of an affiliate is the sum of regular income plus shifted income. The authors provide indirect evidence for income shifting activities by showing that the profitability of firms is tax-sensitive. Many scholars have followed their approach and estimated tax semi-elasticities. Thereby, a declining trend of tax rate sensitivity is observable. While this could indicate the effectiveness of anti-BEPS measures, it could also be merely driven by the application of superior empirical methods (Dharmapala 2014). Heckemeyer and Overesch (2013) conduct a meta-analysis to identify a consensus tax semi-elasticity and estimate that a 10-percentage point decline in the corporate income tax (CIT) rate differential is followed by an eight percent rise of reported profits before taxes.

Furthermore, several research projects try to pinpoint the specific channels that MNEs use to relocate income and avoid taxation (Clausing 2003; Lohse and Riedel 2013; Overesch 2016; Saunders-Scott 2015). Three shifting channels are considered most prominently in the literature. First, Clausing (2003) has highlighted that intra-firm transfer prices might be used by MNEs to minimize the overall tax burden. Second, it has been found that the capital structure of MNEs' affiliates is sensitive to tax rates. Intra-group loans are used to reduce the tax base in high-tax jurisdictions and to relocate income to low-tax jurisdictions (Buettner and Wamser 2013). The third profit shifting channel is increasingly relevant. It has been shown that MNEs relocate IP to low-tax jurisdictions, which allows them to deduct royalty payments in high-tax jurisdictions and lower their overall tax burden (Dischinger and Riedel 2011).

In addition to the mere existence of profit shifting and the driving channels, the extent of tax losses associated with profit shifting is of great interest to both academics and policy makers. Bilicka (2019) and Finke (2013) use a propensity score matching approach to estimate both the existence and extent of profit shifting for a specific country. Bilicka (2019) uses

proprietary tax return data of UK multinational and domestic firms to evaluate differences in tax payments. She shows that the ratio of taxes to total assets for MNEs is about half of that ratio for comparable domestic firms, which indicates systematic differences in tax payments. This result is translated to an approximate increase in corporate tax revenues of about 60 percent if the systematic differences between MNEs and domestic firms could be eliminated at the end of her sample period. Finke (2013) uses a similar approach to evaluate a sample of German firms. She shows that the profitability of German MNEs is about 1.5 percentage points below the profitability of comparable domestic firms. This result indicates that MNEs relocate part of their profits away from the high-tax jurisdiction Germany.

The debate on the extent of income relocation and its fiscal effects has recently gained momentum. Blouin and Robinson (2019) challenge the findings of most scholars that use national accounts data to estimate the extent of profit shifting and claim that due to double counting and misallocations of foreign income the estimates of BEPS may be overstated. Latest estimates on the global fiscal scope of BEPS range from 100 billion US dollar to more than 600 billion US dollar (Bradbury et al. 2018). In the most recent and frequently cited study on the global estimates on the extent of profit shifting, Tørsløv et al. (2018) argue that – *ceteris paribus* and disregarding all potential real changes in response to corporate tax reforms – the current level of profit shifting lowers the global tax revenue on average by 10 percent. Based on publicly available data, they show that the profitability of companies is higher in countries classified to be tax havens and that this higher profitability can be mostly attributed to foreign owned firms located in these countries (Tørsløv et al. 2018).

The final report on BEPS Action 11 adds to the academic and political discussion on profit shifting by stressing the need to develop measures to assess the extent of BEPS and the effectiveness of the proposed and implemented countermeasures against ‘aggressive’ profit shifting. The OECD suggests six indicators to shed light on the extent of profit shifting from different angles. Their main objective, to provide understandable and easy to replicate measures

of BEPS, comes at the price of too simplistic indicators that prevent a reliable tracing of profit shifting (Heckemeyer et al. 2018). Nevertheless, a broad range of estimates on the existence and extent of profit shifting is necessary to provide policymakers with a solid foundation for any decision making and evaluation of policy actions. Hence, we transparently replicate three of the proposed indicators (Indicator 1, Indicator 4 and Indicator 5) and extend the coverage of these indicators with data up to the most recent period available to us.

3. Methodology and Data

3.1. OECD Indicator 1 – Disconnect between financial and real economic activities

OECD Indicator 1 relies on macro-level data and intends to indirectly measure BEPS that takes place through the use of offshore tax havens. This is the strategy of MNEs to channel funds to affiliates in low-tax countries for tax purposes. In order to measure the movement of funds, the OECD focuses on foreign direct investments (FDI). FDI measures the amount of cross-border investments of related affiliates and includes not only investments related to BEPS but also to real economic activity. As FDI patterns can generally be expected to be proportional to the economic size of the involved countries, significantly high concentrations of FDI to GDP may signal BEPS. Following these considerations, Indicator 1 is based on the ratio of FDI stock in a country owned by foreign investors to the GDP of that country in a given year. Based on the magnitude of this ratio in a pre-determined base year, countries are assigned to two different groups – high-ratio countries and low-ratio countries – and remain in this group in all years. For each group, the sum of the ratio of FDI stock to GDP is determined and the indicator expands as follows:

$$Indicator\ 1_t = \frac{\sum_{i=1}^I \frac{FDI_{i,t}}{GDP_{i,t}}}{\sum_{j=1}^J \frac{FDI_{j,t}}{GDP_{j,t}}}$$

where subscript i refers to countries in the high-ratio group and subscript j to countries in the low-ratio group.

The OECD distinguishes between two different measures of FDI. The net FDI of a country is calculated as the inward FDI stock in that country owned by foreign investors from OECD countries less the outward FDI stock from domestic investors that is held in OECD countries. Hence, this measure shall identify those countries that are the ultimate destination of foreign investments for the purpose of BEPS. The OECD determines a threshold of 50 percent of the net FDI to GDP ratio for assigning countries into the two groups.

The second measure of FDI relies on the gross inward FDI stock in a country owned by foreign investors from OECD countries. In addition to countries that are the ultimate destinations for FDI, this measure is intended to also capture conduit countries with a high proportion of FDI stock relative to GDP. The OECD defines a threshold of 200 percent of gross FDI to GDP for assigning countries into the two groups.

We replicate both measures using 2012 and 2018 as the base years for group allocation. Thereby, we use two different sets of data from the OECD Foreign Direct Investment Statistics. We firstly employ FDI position data of the 3rd edition of the Benchmark Definition of FDI (BMD3). The data includes inward and outward FDI positions from and to OECD countries for the time period from 2005 to 2013. Secondly, we use FDI position data of the 4th edition of the Benchmark Definition of FDI (BMD4) for the time periods from 2014 to 2018.² Additionally, we obtain GDP data in current US dollar for the years 2005 until 2018 from the World Bank.³ The dispersion of countries with available data is shown in Table 1.

Moreover, the BMD4 data allow us to observe FDI inflows and outflows of special purpose entities (SPEs). As defined by the OECD, SPEs are established in economies other than those in which the parent firm is resident and engage primarily in international transactions

² Since September 2014, the OECD has been collecting FDI statistics from member countries according to the updated benchmark definition BMD4. The methodology of the FDI statistics published between 1990 and end-2013 relates to the 3rd edition of the benchmark definition.

³ World Bank code: NY.GDP.MKTP.CD

but in few or no local operations. Therefore, FDI in SPEs might be considered especially BEPS-motivated.

3.2. OECD Indicator 4 – Assessing the ETR difference between MNEs and ‘comparable’ non-MNEs effective tax rates

Indicator 4 relies on firm-level micro data to evaluate cross-border profit shifting of MNEs and addresses the well-known drawbacks of highly aggregated macro data that is used to estimate the first OECD Indicator. In contrast to purely domestic firms, which operate only in one country, MNEs have incentives to relocate income to affiliates located in countries with a lower tax burden. The fourth OECD indicator exploits this difference between domestic and multinational corporations. Domestic firms serve as a counterfactual benchmark group to assess the extent of income shifting by comparable multinationals. The indicator uses financial data of multinational and domestic firms and compares the average effective tax rate (ETR) of both groups. The OECD expects that the ETR of MNEs is, on average, lower than that of comparable domestic firms (OECD 2015, p. 58).

The presumption of lower ETRs for MNEs is tested using the following regression framework:⁴

$$ETR_{f,c,i,t} = \beta_1 large_{f,c,i,t} \times year_t + \beta_2 large_{f,c,i,t} \times MNE_{f,c,i} \times year_t + \beta_3 X_{f,c,i,t} + \delta_i + \delta_{c,t}$$

where $ETR_{f,c,i,t}$ is the effective tax rate for firm f in country c , industry i and year t . The ETR is the ratio of tax payments to earnings before income and taxes (EBIT) in percent. $Large_{f,c,i,t}$ is a dummy variable that takes the value of 1 for firms with more than 250 employees and 0 otherwise. Multinational firms are identified using the dummy variable $MNE_{f,c,i}$. The group structure is based on the ORBIS ownership information at end of year 2016 and we restrict the sample to majority owned firms and headquarters. The group structure is assumed to be constant

⁴ Note that the regression framework deviates slightly from the regression stated in Annex 3. A1 in OECD (2015) to avoid the so-called dummy trap. We further directly interact the coefficient of interest (and its baseline effect) with a year dummy to obtain yearly estimates, as presented in Table 2.3. Indicator 4 in OECD (2015).

in our panel.⁵ We require a multinational group to have at least one cross-border relationship. β_2 , the estimated coefficient of the interaction between large and multinational firms, is the coefficient of interest and the estimated value of Indicator 4. We exclude the baseline effect of multinationals on the ETR to obtain a direct estimate of the OECD's verbally expressed difference between the ETR of large multinational and large domestic corporations. $Year_t$ is a dummy variable that is interacted with the coefficient of interest to provide yearly estimates. $X_{f,c,i,t}$ is a vector of firm-specific control variables. It includes the size of a firm, measured as the logarithm of total assets, the profitability ratio of a firm and an estimate for the degree of firms' innovation activities. We use the ratio of intangible to total assets as a proxy for firms' innovativeness in contrast to the number of patents that is used by the OECD. Furthermore, a dummy variable that indicates if a firm is the global ultimate owner controls for a firm's position in the group. δ_i are industry fixed effects at the two-digit NACE classification and $\delta_{c,t}$ are country-year fixed effects.

In line with the OECD, we use unconsolidated financial data from the well-known Bureau van Dijk ORBIS database to replicate the estimates of Indicator 4. Our panel starts in 2000 and has data up to 2016. Similar to other studies on profit shifting, we exclude observations with implausible financial data such as total assets below 0 and exclude all observations that have a negative effective tax rate or one above 100 percent (Beer and Loeprick 2015; Dischinger and Riedel 2011; Huizinga and Laeven 2008). Furthermore, we restrict the sample to firms with a profitability ratio, which is determined as EBIT to total assets, between 0 and 100 percent, i.e., we exclude loss-making firms and overly profitable corporations. Finally, we exclude all firms with less than three years of basic accounting data available in our panel (Beer and Loeprick 2015).

⁵ This assumption is commonly used in the literature on profit shifting. Many changes in the ownership structure result from data improvements by the data provider.

The OECD's regression approach to compare domestic and multinational corporations is an intuitive empirical methodology and the differences to alternative, more sophisticated, matching estimates are presumably of minor empirical importance (Angrist and Pischke 2008). Yet, the quality of the comparison between multinational and domestic corporations crucially depends on the matching quality, i.e., the similarity and comparability of the two groups is essential for any inferences. A well-established method of creating a control group that is as similar as possible to the treated group in a non-experimental setting is the so-called propensity score matching (Abadie and Imbens 2006; 2016; Rosenbaum and Rubin 1983; Rubin 1974). Bilicka (2019) and Finke (2013) apply propensity score matching for a sample of UK, respectively German, MNEs and domestic firms to evaluate BEPS. The matching process follows a two-step procedure. First, the likelihood of firms being domestic or multinational is estimated based on observable characteristics. Second, domestic and multinational firms are matched based on the estimated propensity scores. The method excludes firms that are very unlikely to serve as a comparable benchmark group.

We extend the OECD's fourth indicator by applying a propensity score matching approach to estimate the average treatment effect (ATE). We borrow from Bilicka (2019) and Finke (2013) and match MNEs to domestic firms based on the logarithm of total assets, the logarithm of firm's productivity, the debt to equity ratio and the ratio of intangible to total assets within year, industry and country.

3.3. OECD Indicator 5 – Profit shifting through intangibles

OECD Indicator 5 relies again on macro-data rather than firm-level data and is concerned with profit shifting through intangibles. Profit shifting through intangibles is commonly defined as the strategy of transferring IP from high-tax to low-tax countries for tax purposes after it has been developed in high-tax countries. Using this structure, group firms in high-tax countries pay (potentially high amounts of) royalties for the use of the IP to the group firm in the low-tax country. The indicator shall indirectly capture the extent of BEPS through IP transfer.

Following the logic of transferring IP to low-taxed countries for tax purposes, IP receiving countries should have a higher ratio of royalty receipts to research and development (R&D) spending compared to those countries where the IP was developed. For this reason, in the first step, the ratio of royalty receipts relative to R&D spending in a country is measured for each country. Next, countries are assigned into two groups based on their concentration in a given year. Countries with a ratio above 50 percent are assigned to the group of high-ratio countries while the other countries form the group of low-ratio countries. By dividing the average ratio of the high-ratio group with the average ratio of the low-ratio group, indicator 5 is formed for year t :

$$Indicator\ 5_t = \frac{\frac{\sum_{i=1}^I Royalty\ receipts_{i,t}}{\sum_{i=1}^I R\&D\ spending_{i,t}}}{\frac{\sum_{j=1}^J Royalty\ receipts_{j,t}}{\sum_{j=1}^J R\&D\ spending_{j,t}}}$$

where the subscript i refers to members of the high-ratio group and subscript j to members of the low-ratio group in year t .

In its 2015 report, the OECD uses the year 2011 as the base year to identify the composition of the high-ratio and low-ratio group, which is held constant in the other years. The threshold of 50 percent has been chosen somewhat arbitrarily. We replicate the indicator using 2011 and 2017 as the base year.⁶ We also replicate the indicator by recalculating the two groups continuously on a yearly basis. Furthermore, we check the robustness of our results through different tests. We obtain country-level data on receipts for the use of IP as balance of payments in current US dollar for the years 2005 until 2018 from the World Bank.⁷ Moreover, we use data on the gross domestic expenditure on R&D from the UNESCO Institute for Statistics (UIS.Stat).⁸ The data availability is depicted in Table 2.

⁶ We take 2017 instead of 2018 as the base year for data availability reasons.

⁷ World Bank code: BX.GSR.ROYL.CD

⁸ Please note, the OECD names the World Development Indicators as its data source on R&D expenditures. However, we could only find data on R&D expenditures as a percentage of GDP. Using this data would have

4. Results

4.1. OECD Indicator 1

First, we replicate the OECD's estimation of Indicator 1, taking net FDI to GDP as measure and 2012 as the base year. For 2012, we have data on 202 countries, of which 14 are assigned to the high-ratio group. Unsurprisingly, members of the high-ratio group are countries with low or no CIT rate or preferential tax systems, e.g., the Bahamas, Cayman Islands or Ireland. The structure of the high-ratio group is depicted in Table 3 Panel A. Using the BMD3 data from 2005 to 2012, we can closely replicate the results of the OECD, which are shown in Table 4 Panel A and graphically plotted in Figure 1. In 2011, the indicator shows that the average ratio of net FDI to GDP of the high-ratio countries was about 43 times higher than the average ratio of low-ratio countries. However, we do not find the OECD's sharp increase in the indicator value in the year 2012, in which our estimate increases to 54.8 in contrast to 99.2 estimated by the OECD. Employing the BMD4 data from 2013 onwards, we see a drop in the indicator value to 23.9, which then steadily decreases to 11.7 in 2018 (Figure 2).

When taking 2018 as the base year for group allocation, we identify 13 countries in the high-ratio group, which is depicted in Table 3 Panel A. In 2005 and 2006, the average ratio of net FDI to GDP of the high-ratio group was only marginally higher. After this time, we find a steady increase to an indicator value of around 14, which remains stable until 2018 (Figure 2).

Second, we replicate the OECD's indicator using the gross FDI to GDP ratio. The OECD claims that by using gross FDI values, the indicator also captures those countries that function as conduits for BEPS. When using 2012 as the base year, ten out of 202 countries are assigned to the high-ratio group and, indeed, countries such as Ireland, the Netherlands and Luxembourg are part of the high-ratio group which may be seen as conduit countries for BEPS (Table 3 Panel

added even larger measurement error to our calculations. We verify our results using R&D spending data from the OECD, where we obtain similar results.

B). From 2005 to 2012, we are able to closely replicate the OECD's estimates. In 2005, the gross FDI to GDP ratio of the high-ratio countries is about 12 times higher than the ratio of the low-ratio countries and doubles to 24 until 2012. In the following years, the indicator value remains at a level of about 23 (Table 4 Panel B). Figure 3 shows that in 2018, the amount of gross FDI per euro of GDP in the high-ratio group of countries was, on average, 19 times higher than the average ratio for the remaining countries. When taking 2018 as the base year, eleven countries belong to the high-ratio group and Figure 4 shows that the indicator trend over time is steadily increasing and doubles between 2005 and 2018.

Overall, the indicator does not provide evidence of BEPS but gives some indication of it. Countries that are often expected to serve as conduits or final destinations for BEPS belong to the high-ratio group. Furthermore, over the entire time frame of investigation, those countries show a disproportionately high amount of gross or net FDI in relation to economic activity measured by GDP. When using gross FDI to GDP to estimate the indicator value, we find slight increase in BEPS over time. We explicitly point out that the found results have to be treated with caution since the underlying FDI to GDP ratio is influenced by numerous economic factors (Heckemeyer et al. 2018).

As robustness test, we replicate our analysis keeping only those countries for which we have data available over the whole period from 2005 to 2018 and find very similar results. Furthermore, we exploit FDI positions of SPEs in the time period from 2013 to 2018. Due to the variation in data availability, we do not find consistent results. Nevertheless, the prior identified countries in the high-ratio groups are again those countries with the highest ratios.

4.2. OECD Indicator 4

Our panel from 2000 to 2016 consists of more than 800,000 firms, thereof about 18 percent are multinational firms. Descriptive statistics are depicted in Table 5. In our baseline regression, depicted in Table 6, we estimate large MNEs to have a 0.96 percentage points lower ETR than comparable large domestic firms, which is significant at the one percent level. This estimate

decreases to about negative 1.5 if we only consider the period from 2000 until 2010 that corresponds to the OECD sample period. Yet, the OECD estimates that the ETR of large MNEs is, on average, three percentage points below the ETR of comparable large domestic corporations (OECD 2015, 58). We replicate the yearly estimates of the ETR differential in Table 7. In contrast to the OECD, we display all estimated coefficients. The interaction coefficient of large and multinational corporations is directly comparable to the estimates of Indicator 4 in the final report on BEPS Action 11. Our estimates are considerably below the annual estimates of the OECD. We plot the yearly coefficients and the confidence interval in Figure 5. The ETR differential is negative and statistically significant for nearly all years. The ETR differential follows for the second half of our sample period – that extends beyond the OECD’s period – an upward trend and converges towards zero.

We conduct several robustness tests. First, we restrict the sample to specific regions. In column 3 of Table 7, we only consider firms located in an OECD country, and in column 4, we only consider firms located in EU countries. The results do not change materially. Second, we change the outcome variable to tax payments over total assets to account for the critique on the chosen outcome variable in the OECD regression approach (Heckemeyer et al. 2018). The regression is depicted in Table 8. The relative tax payments to total assets are, on average, only significantly lower for large MNEs than for large domestic firms in the early sample period.

As an extension to the OECD’s regression framework, we implement a state of the art matching technique to determine two closely comparable groups of domestic and multinational corporations. We apply a propensity score matching technique and match MNEs to domestic firms based on the logarithm of total assets, the logarithm of firm’s productivity, the debt to equity ratio and the ratio of intangible to total assets within year, industry and country (Bilicka 2019; Finke 2013). Domestic and multinational firms are matched based on the likelihood of belonging to either group. All observable characteristics, which we use in the matching process, should be similar in the matched sample. Table 9 shows how the similarity of the two groups

improves in the matched sample. A solid sign of matching quality is a standardized difference between the samples of close to zero and a variance ratio of about one. On average, our matched sample approaches this standard for all observable matching characteristics within each country industry and year matching cluster. We then estimate the average treatment effect, i.e., the effect of being a multinational corporation, on the effective tax rates for each year in our sample. Table 10 depicts the yearly estimated treatment effect of being a multinational on the ETR. We have plotted the estimated average treatment effects in Figure 6. The estimated ETR differences range between negative 0.13 and negative 1.02 and they do not follow a specific trend in our sample period. In comparison to the regression estimates, the differentials are slightly smaller in the first half of our sample period. Moreover, in several years the estimates are statistically indistinguishable from zero. The estimated effective tax rate differentials depend – as the choice of control variables in the OECD regression approach – on the specific observable characteristics used for the propensity score matching. Hence, alternative controls or matching characteristics could lead to differences in the magnitude of the estimated ETR differentials. Yet, the qualitative insight, that multinational corporations tend to have lower effective tax rates than comparable domestic firms, holds with both approaches. However, it seems that this difference diminishes in recent years. This trend goes along with more political actions against BEPS and more public awareness about the social responsibility of corporations.

4.3. OECD Indicator 5

First, we replicate the OECD's estimation of royalty receipts to R&D spending and take 2011 as the base year for allocating countries into high-ratio and low-ratio groups. In 2011, data is available for 69 countries, of which eight countries are assigned to the high-ratio group. The structure of the high-ratio group is shown in Table 11. In fact, members of the high-ratio group are countries with low corporate income tax rates or preferential tax systems. For example, Ireland, the Netherlands and Luxembourg are part of this group.

In the year 2011, the high-ratio countries received EUR 1.53 of royalty for every EUR 1 invested in R&D while the low-ratio countries received only EUR 0.18. Thus, the ratio for the high-ratio countries is nearly nine times larger than that of the low-ratio countries, which leads to an Indicator 5 value of 8.7. Table 12 provides annual estimates of Indicator 5. Over the years, the indicator does not vary significantly. In 2005, the indicator takes a value of 7.7, which increases until 2010 to 9.1. After being stable for about three years, the indicator increases to 11.9 in 2015 but decreases again to 9.8 in the year 2017. Figure 7 plots the development of Indicator 5 graphically. In contrast to the estimates of the OECD, our Indicator 5 value is larger but we do not observe a strong increase over time. Our estimates confirm that some countries receive comparably very high shares of royalties to R&D spending, which can potentially be attributed to BEPS. In 2011, the eight countries in the high-ratio group received about 13.4 percent of the overall royalties of the 69 countries examined.

Second, we take the year 2017 as a base year to replicate the OECD's results. The group of high-ratio countries consists of nine countries, which are named in Table 11. Table 12 and Figure 8 depict the estimates. From 2005 to 2018, the indicator ranges between 3.5 and 5.7, taking its peak in 2017. Again, the indicator values seem to be stable over time and have about the same size as the OECD's estimates. The high-ratio countries received EUR 0.98 of royalties for every EUR 1 invested in R&D in 2017, while the low-ratio countries received only EUR 0.17.

Third, we refrain from pre-determined group allocation but re-estimate the allocation of the high-ratio and low-ratio group every year. As shown in Figure 7, the indicator values range between 5.7 and 10.7 without a clear pattern over the years. The greater dispersion may be explained by the yearly re-calculation of the sample for the indicator estimation. Nevertheless, the values do not exceed or fall below those of the samples with base years.

Finally, we confirm the robustness of our analysis using OECD data on R&D spending. The results are depicted in Table 13. Even though the R&D data are only available for, on

average, 37 countries, the results verify our previous findings. Furthermore, we replicate our analysis using only countries for which we have at least 10 years or 14 years of data available. Again, the values of the indicator do not change significantly. Lastly, we also obtain similar indicator results if we take the lag values of R&D spending for estimation. We do this to adjust for the possibility that between the time of receipts from royalty and the time of R&D spending a time gap exists.

Overall, the three described estimations as well as robustness checks indicate the existence of BEPS through the use of IP. Even though in recent years, various policy actions have been implemented to curb BEPS, the development of the indicator does not show any reduction. However, as Indicator 5 is an indirect measure of BEPS, no assertion can be made about the scale of BEPS. Furthermore, it is important to note that royalty payments may not only be linked to R&D spending but also to the use of trademarks, copyrights or franchises (Heckemeyer et al. 2018).

5. Conclusion

Profit shifting of multinational corporations is a pressing topic in the public debate, academic research and on the political agenda. We provide numerical evidence on how BEPS activity has developed in recent years, assess the impact of policy changes, and connect our findings to contemporary international tax research.

In its 2015 published Final Report on “Measuring and Monitoring BEPS, Action 11”, the OECD has introduced six indicators to measure and evaluate BEPS activity over time and on different levels of aggregation. We revive three of the indicators and analyze their development over time. We follow the conceptual evaluation of the indicators by Heckemeyer et al. (2018) and focus our analysis on the three most convincing indicators: Indicator 1 (Disconnect between financial and real economic activities), Indicator 4 (MNE vs. “comparable” non-MNE effective tax rate differentials) and Indicator 5 (Profit shifting through intangibles).

OECD Indicator 1 relies on macro-level data and intends to indirectly measure BEPS that takes place through the use of offshore tax havens. Overall, the indicator does not provide evidence of BEPS but gives some indication of it. Countries that are often expected to serve as conduits or final destinations for BEPS show a disproportionately high amount of gross or net FDI in relation to economic activity measured by GDP.

Indicator 4 relies on firm-level micro data to evaluate cross-border profit shifting of multinational corporations and addresses the well-known drawbacks of highly aggregated macro data, that is used to estimate the first OECD Indicator. We extend the OECD's fourth indicator by applying a propensity score matching approach to estimate the average treatment effect. The ETR differential is negative and statistically significant for nearly all years. The qualitative insight, that multinational corporations tend to have lower effective tax rates than comparable domestic firms, holds with both approaches, but this difference diminishes over time. This may indicate that the recently implemented measures to curb BEPS are effective.

OECD Indicator 5 relies again on macro-data rather than firm-level data and is concerned with profit shifting through intangibles. Overall, the estimates indicate the existence of BEPS through the use of IP. Moreover, the indicator seems to be constant over time and does not seem to react to recent policy actions to curb BEPS.

Our transparent replication of the three most promising OECD Indicators to measure the existence and extent of BEPS highlight that the empirical implications crucially hinge on the underlying assumptions of each indicator and the availability of high-quality data. We endorse the ongoing research to measure the existence and extent of BEPS and propose to tackle the issue from different angles. Only multidimensional estimation approaches allow to develop a holistic view of BEPS and to evaluate ongoing proposals to reform the corporate income tax system.

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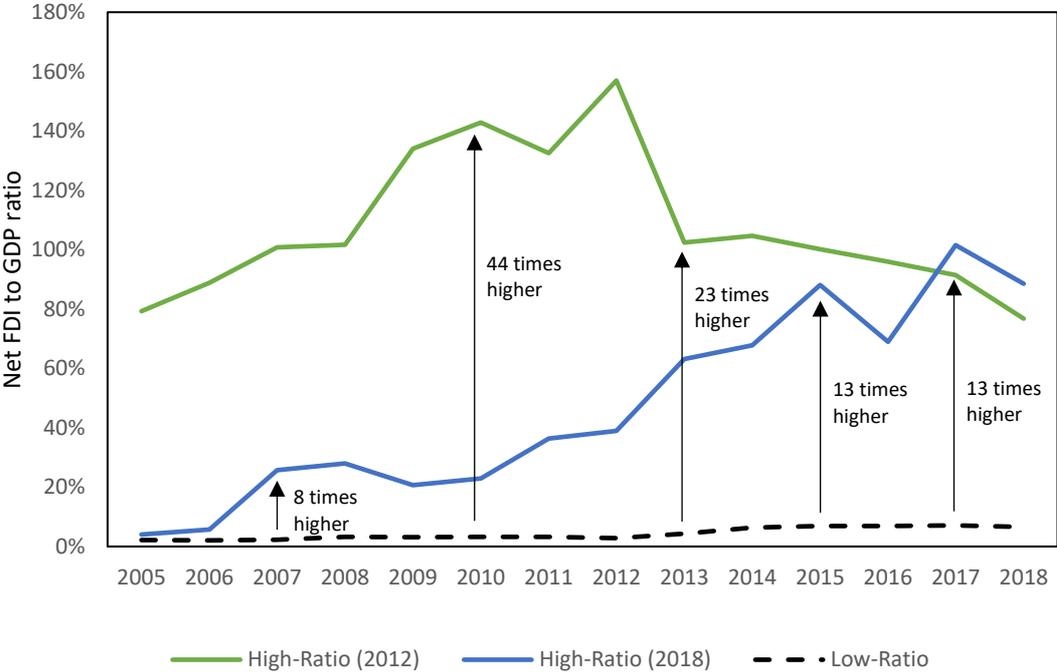
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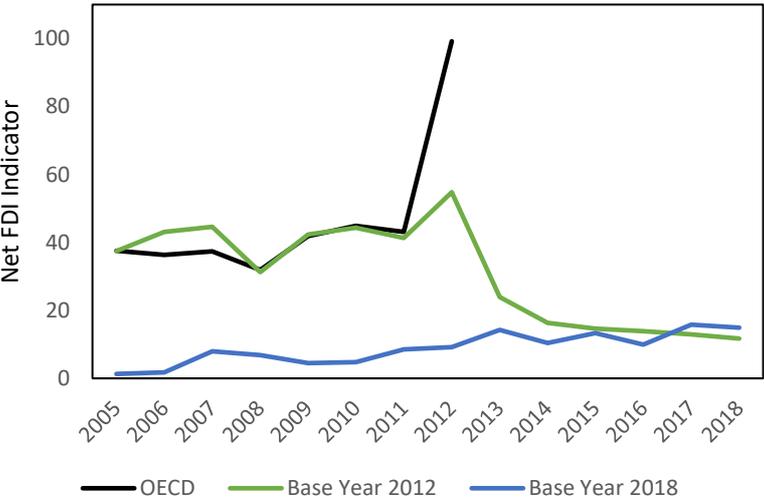
FIGURES

Figure 1: Indicator 1 – Net FDI to GDP by groups



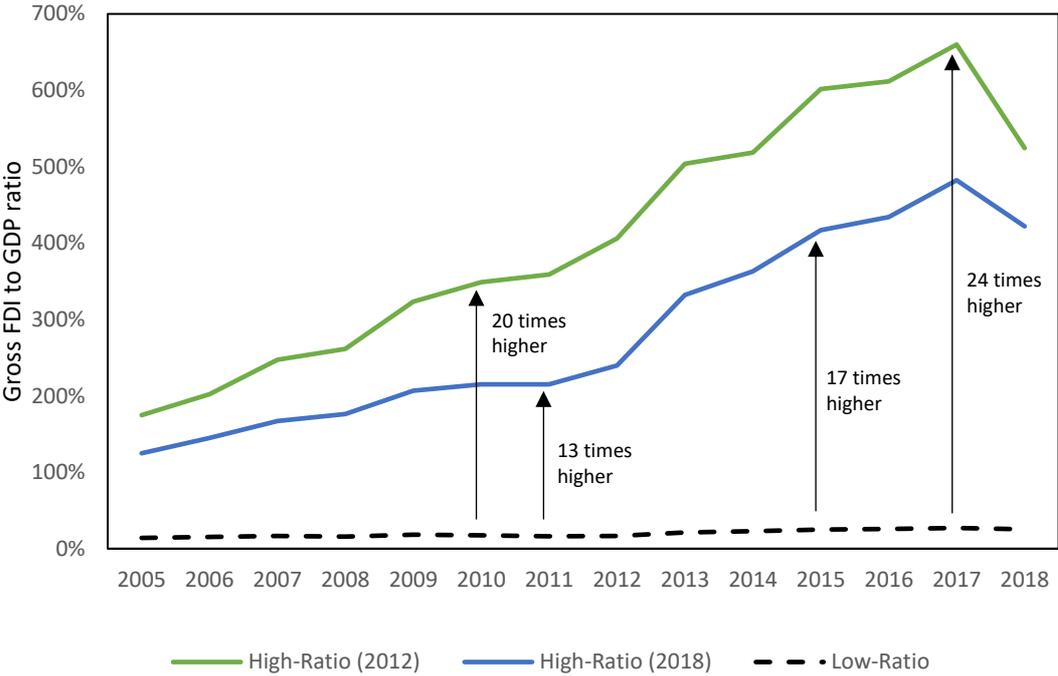
Notes: The green line depicts the trend of the average net FDI to GDP ratio for the group of countries that have a ratio above 0.5 in 2012. The blue line depicts the trend of the average net FDI to GDP ratio for the group of countries that have a ratio above 0.5 in 2018. The black dotted line displays the average ratio of the remaining (low-ratio) countries.

Figure 2: Indicator 1 – Net FDI Indicator trend



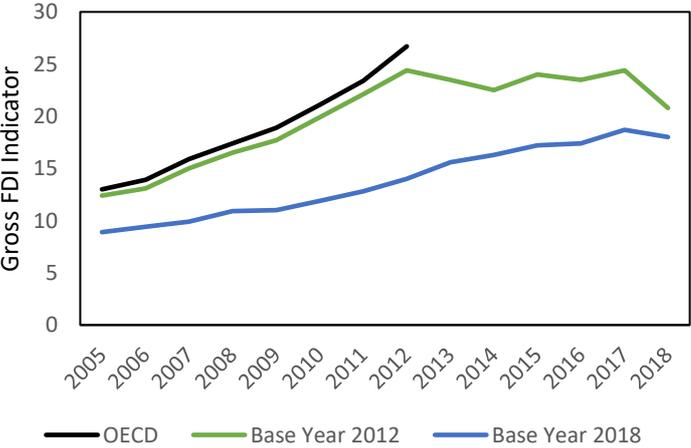
Notes: The green line shows the trend of Indicator 1 using net FDI to GDP as measure and 2012 as base year. The blue line uses 2018 as base year for group allocation. The black line shows the indicator’s trend estimated by the OECD in 2015.

Figure 3: Indicator 1 – Gross FDI to GDP by groups



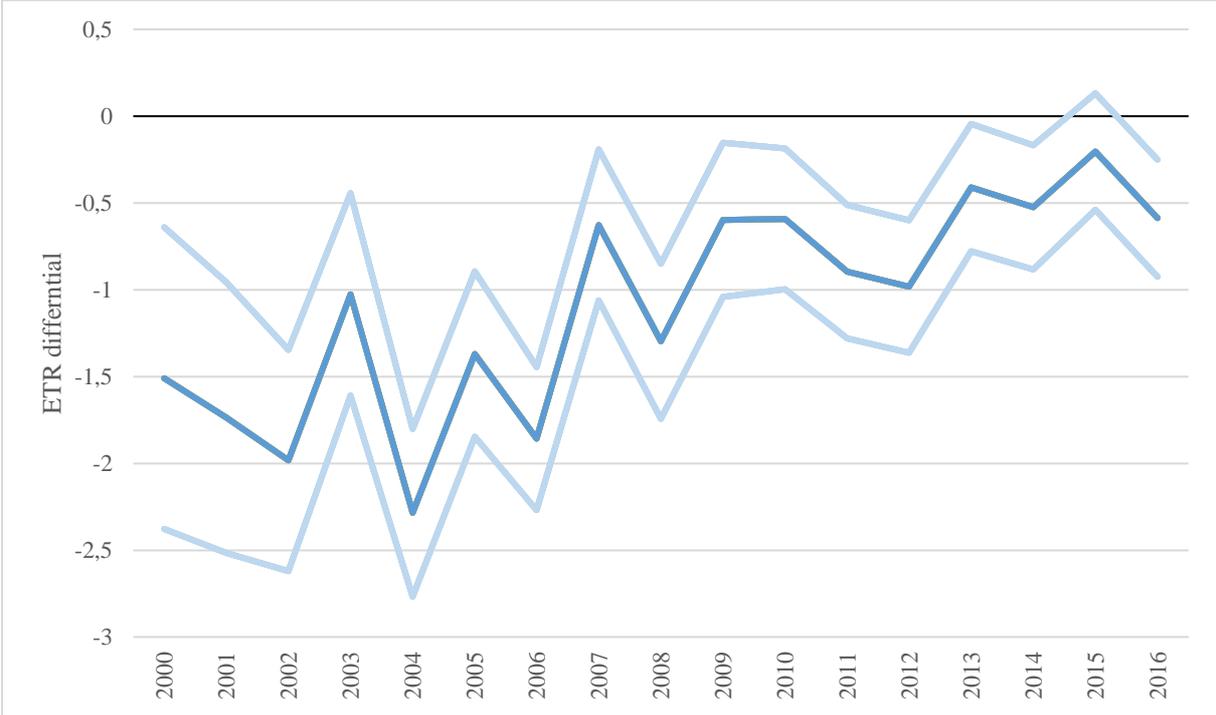
Notes: The green line depicts the trend of the average gross FDI to GDP ratio for the group of countries that have a ratio above 2.0 in 2012. The blue line depicts the trend of the average gross FDI to GDP ratio for the group of countries that have a ratio above 2.0 in 2018. The black dotted line displays the average ratio of the remaining (low-ratio) countries.

Figure 4: Indicator 1 - Gross FDI Indicator trend



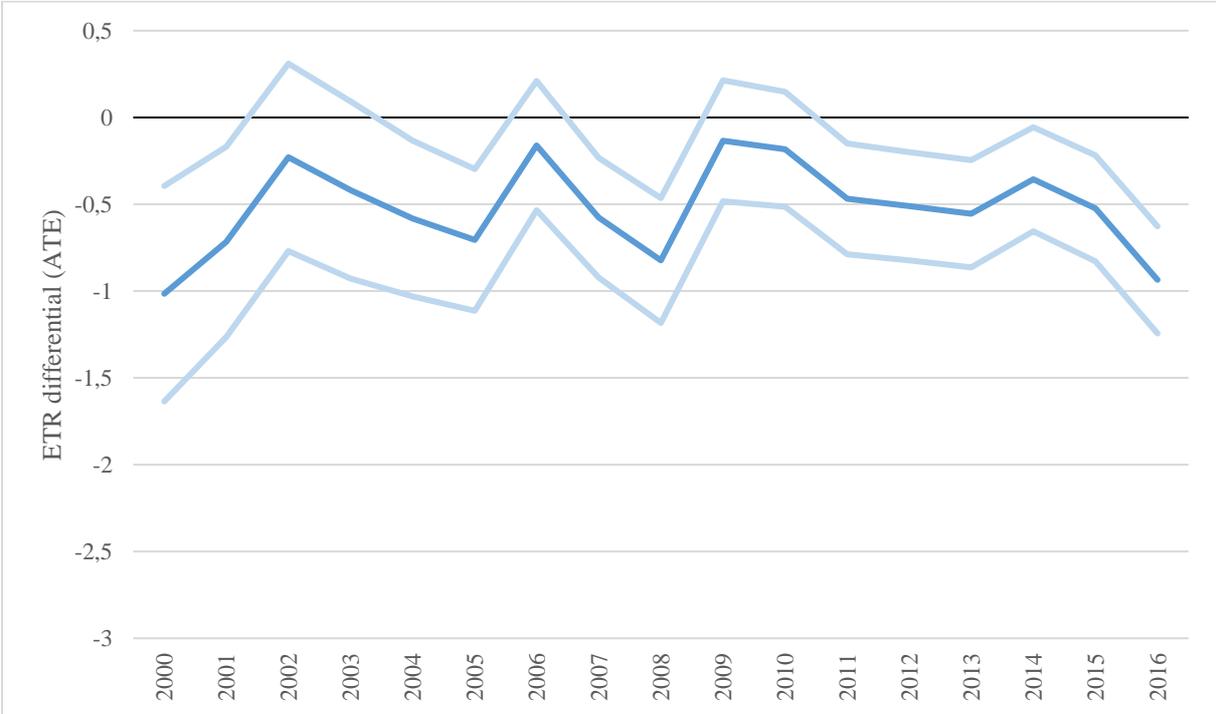
Notes: The green line shows the trend of Indicator 1 using net FDI to GDP as measure and 2012 as base year. The blue line uses 2018 as base year for group allocation. The black line shows the indicator’s trend estimated by the OECD in 2015.

Figure 5: Indicator 4 - Trends in international tax planning, 2000-2016



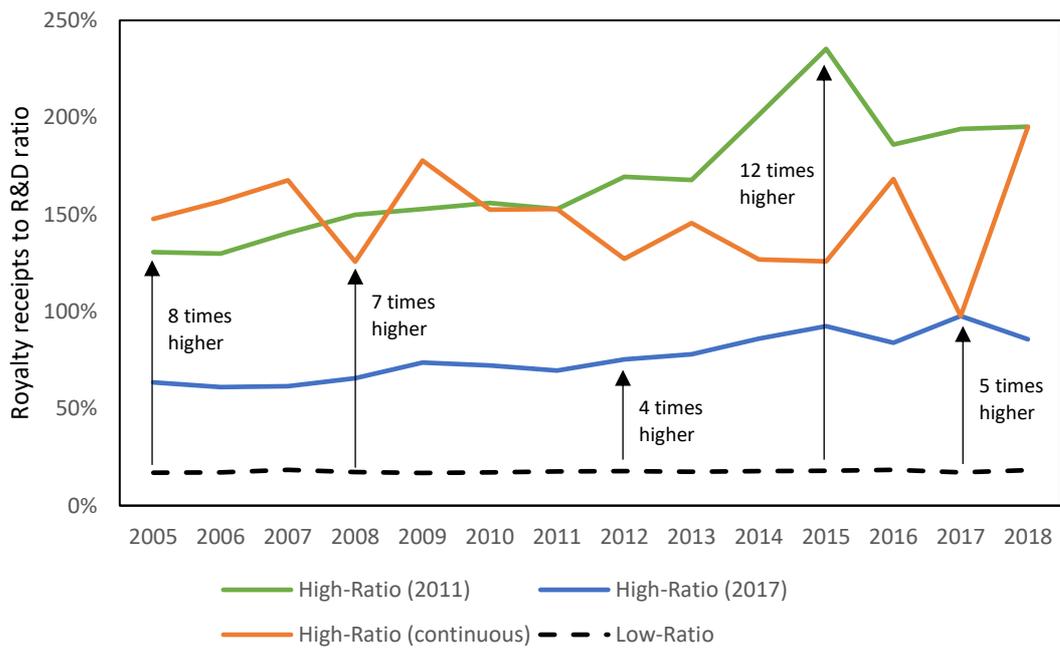
Notes: The dark blue line depicts the annual regression estimates for Indicator 4 and the light blue lines frame the 95% confidence interval.

Figure 6: Indicator 4 – Trends in international ETR differences (average treatment effects)



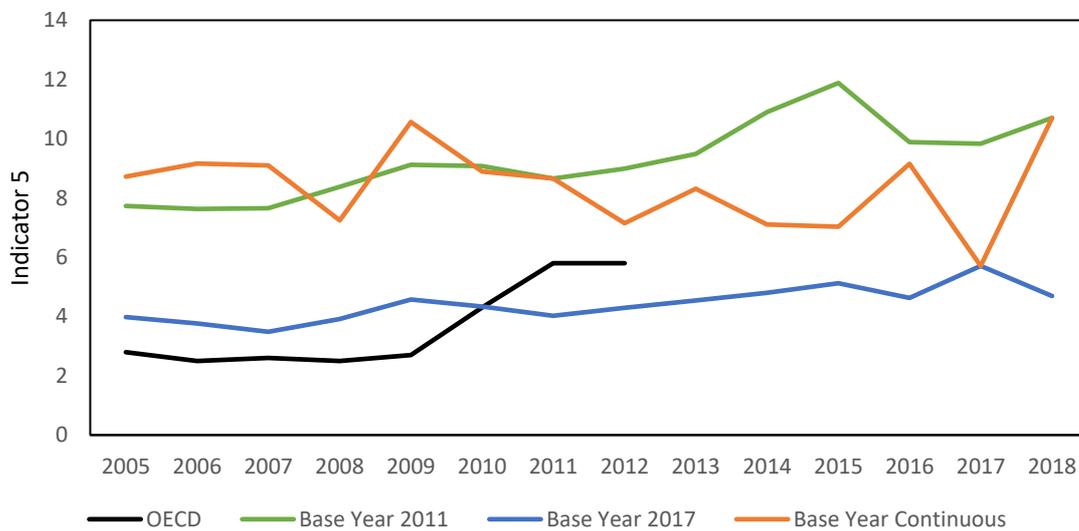
Notes: The dark blue line depicts the annual regression estimates for the ATE, based on the two-step propensity score matching method and the light blue lines frame the 95% confidence interval.

Figure 7: Indicator 5 - Royalty receipts to R&D spending by groups



Notes: The green line and blue line depict the trend of the average royalty receipts to R&D spending ratio for the group of countries that have a ratio above 0.5 in 2011 and 2017, respectively. The orange line depicts the trend of for the group of countries that have a ratio above 0.5 in the particular year. The black dotted line displays the average ratio of the remaining (low-ratio) countries.

Figure 8: Indicator 5 – Indicator trend



Notes: The green line and blue line shows the trend of Indicator 5 using 2012 or 2018 as base year for group allocation. The orange line redefines the group allocation every year. The black line shows the indicator's trend estimated by the OECD in 2015.

TABLES

Table 1: Indicator 1 – Country-Year distribution

| Panel A | | Net FDI |
|----------------|-----------------|----------------|
| Year | No of Countries | |
| 2005 | 189 | |
| 2006 | 190 | |
| 2007 | 190 | |
| 2008 | 193 | |
| 2009 | 192 | |
| 2010 | 195 | |
| 2011 | 195 | |
| 2012 | 196 | |
| 2013 | 198 | |
| 2014 | 196 | |
| 2015 | 196 | |
| 2016 | 195 | |
| 2017 | 193 | |
| 2018 | 187 | |

| Panel B | | Gross FDI |
|----------------|-----------------|------------------|
| Year | No of Countries | |
| 2005 | 197 | |
| 2006 | 200 | |
| 2007 | 202 | |
| 2008 | 201 | |
| 2009 | 200 | |
| 2010 | 200 | |
| 2011 | 202 | |
| 2012 | 202 | |
| 2013 | 203 | |
| 2014 | 199 | |
| 2015 | 199 | |
| 2016 | 197 | |
| 2017 | 196 | |
| 2018 | 191 | |

Notes: The table shows the number of countries with available data per year. Panel A refers to the net FDI to GDP measure. Panel B refers to the gross FDI to GDP measure of Indicator 5. The years 2005 until 2012 rely on the BMD3 definition of Foreign Direct Investment while the years 2013 until 2018 rely on BMD4.

Table 2: Indicator 5 – Country-Year distribution

| Year | No of Countries |
|------|-----------------|
| 2005 | 64 |
| 2006 | 60 |
| 2007 | 72 |
| 2008 | 70 |
| 2009 | 70 |
| 2010 | 70 |
| 2011 | 69 |
| 2012 | 68 |
| 2013 | 74 |
| 2014 | 68 |
| 2015 | 74 |
| 2016 | 72 |
| 2017 | 76 |
| 2018 | 56 |

Notes: The table shows the number of countries with available data on receipts for the use of IP as balance of payments in current US dollar from the World Bank and available data on the gross domestic expenditure on R&D from the UNESCO Institute for Statistics per year.

Table 3: Indicator 1 – Countries in high-ratio group

| Panel A | | Net FDI |
|----------------|---------------------|--------------------------|
| | Base Year 2012 | Base Year 2018 |
| 1 | Bahamas | Barbados |
| 2 | Barbados | Cyprus |
| 3 | Bermuda | Dominica |
| 4 | Cayman Islands | Ireland |
| 5 | Hong Kong | Marshall Islands |
| 6 | Hungary | Mauritius |
| 7 | Ireland | Mongolia |
| 8 | Liberia | Netherlands |
| 9 | Malta | Panama |
| 10 | Marshall Islands | Papua New Guinea |
| 11 | Mauritius | St. Kitts and Nevis |
| 12 | Singapore | Singapore |
| 13 | St. Kitts and Nevis | Turks and Caicos Islands |
| 14 | Trinidad and Tobago | |

| Panel B | | Gross FDI |
|----------------|------------------|------------------|
| | Base Year 2012 | Base Year 2018 |
| 1 | Bahamas | Bahamas |
| 2 | Barbados | Barbados |
| 3 | Bermuda | Curacao |
| 4 | Cayman Islands | Cyprus |
| 5 | Curacao | Ireland |
| 6 | Ireland | Luxembourg |
| 7 | Luxembourg | Malta |
| 8 | Malta | Marshall Islands |
| 9 | Marshall Islands | Mauritius |
| 10 | Netherlands | Netherlands |
| 11 | | Switzerland |

Notes: The table shows the countries belonging to the high-ratio group. Countries with a ratio above 50 percent are assigned to the group of high-ratio countries while the other countries form the group of low-ratio countries. In Panel A the group structure is shown for the net FDI to GDP measure using base years 2012 and 2018, respectively. In Panel B the group structure is shown for the gross FDI to GDP measure using base years 2012 and 2018, respectively.

Table 4: Indicator 1 - Results

| Panel A | | Net FDI | | | | | |
|----------------|-------------------|----------------|-----|-----------|----------------|-----|-----------|
| Year | OECD Indicator | Base Year 2012 | | | Base Year 2018 | | |
| | | High | Low | Indicator | High | Low | Indicator |
| 2005 | 37,6 | 79% | 2% | 37,5 | 4% | 3% | 1,3 |
| 2006 | 36,3 | 89% | 2% | 43,1 | 6% | 3% | 1,8 |
| 2007 | 37,4 | 101% | 2% | 44,6 | 26% | 3% | 8,0 |
| 2008 | 31,9 | 102% | 3% | 31,3 | 28% | 4% | 6,8 |
| 2009 | 41,9 | 134% | 3% | 42,3 | 21% | 5% | 4,5 |
| 2010 | 44,9 | 143% | 3% | 44,3 | 23% | 5% | 4,8 |
| 2011 | 43,1 | 132% | 3% | 41,4 | 36% | 4% | 8,5 |
| 2012 | 99,2 | 157% | 3% | 54,8 | 39% | 4% | 9,2 |
| 2013 | | 102% | 4% | 23,9 | 63% | 4% | 14,3 |
| 2014 | | 105% | 6% | 16,3 | 68% | 7% | 10,4 |
| 2015 | | 100% | 7% | 14,6 | 88% | 7% | 13,3 |
| 2016 | | 96% | 7% | 13,9 | 69% | 7% | 9,9 |
| 2017 | | 91% | 7% | 12,9 | 102% | 6% | 15,8 |
| 2018 | | 77% | 7% | 11,7 | 88% | 6% | 14,9 |

| Panel B | | Gross FDI | | | | | |
|----------------|-------------------|------------------|-----|-----------|----------------|-----|-----------|
| Year | OECD Indicator | Base Year 2012 | | | Base Year 2018 | | |
| | | High | Low | Indicator | High | Low | Indicator |
| 2005 | 13,0 | 175% | 14% | 12,4 | 125% | 14% | 8,9 |
| 2006 | 13,9 | 202% | 15% | 13,1 | 145% | 15% | 9,4 |
| 2007 | 15,9 | 247% | 16% | 15,0 | 167% | 17% | 9,9 |
| 2008 | 17,4 | 262% | 16% | 16,5 | 176% | 16% | 10,9 |
| 2009 | 18,9 | 323% | 18% | 17,7 | 207% | 19% | 11,0 |
| 2010 | 21,1 | 349% | 18% | 19,9 | 215% | 18% | 11,9 |
| 2011 | 23,4 | 359% | 16% | 22,1 | 215% | 17% | 12,8 |
| 2012 | 26,7 | 406% | 17% | 24,4 | 240% | 17% | 14,0 |
| 2013 | | 504% | 21% | 23,5 | 332% | 21% | 15,6 |
| 2014 | | 518% | 23% | 22,5 | 363% | 22% | 16,3 |
| 2015 | | 602% | 25% | 24,0 | 417% | 24% | 17,2 |
| 2016 | | 612% | 26% | 23,5 | 434% | 25% | 17,4 |
| 2017 | | 660% | 27% | 24,4 | 482% | 26% | 18,7 |
| 2018 | | 524% | 25% | 20,8 | 422% | 23% | 18,0 |

Notes: The table depicts the values of Indicator 1. In Panel A net FDI is used to estimate the indicator. In Panel B gross FDI is used. Column 2 shows Indicator values estimated by the OECD (OECD (2015)). For each country, the ratio of FDI to GDP is calculated. Based on this ratio in a pre-defined base year, countries are assigned to high-ratio groups or low-ratio groups. The threshold values amounts to 50% in Panel A and 200% in Panel B. In columns 3 to 5 2012 is the base year and column 3 and 4 show the ratio of the countries in the high-ratio group and low-ratio group, respectively. Column 5 displays the estimated indicator value. In columns 6 to 8, 2018 is the base year and column 6 and 7 show the ratio of the countries in the high-ratio group and low-ratio group, respectively. Column 8 displays the estimated indicator value. The years 2005 until 2012 rely on the BMD3 definition of Foreign Direct Investment as data source while the years 2013 until 2018 rely on BMD4.

Table 5: Indicator 4 - Descriptive Statistics

| Variable | n | Mean | SD | Min | Median | Max |
|---------------------|-----------|------------|------------|-------|-----------|-------------|
| ETR | 5,048,716 | 31.248 | 20.075 | 0.000 | 28.073 | 100.000 |
| Employees | 5,048,716 | 136 | 2,477 | 1 | 15 | 1,477,200 |
| Large dummy | 5,048,716 | 0.075 | 0.263 | 0.000 | 0.000 | 1.000 |
| MNE dummy | 5,048,716 | 0.220 | 0.414 | 0.000 | 0.000 | 1.000 |
| Profitability | 5,048,716 | 0.116 | 0.122 | 0.000 | 0.077 | 1.000 |
| Total Assets (TOAS) | 5,048,716 | 123,32.850 | 31,017.534 | 0.249 | 1,579.236 | 158,697.237 |
| Innovation | 5,048,716 | 0.054 | 0.117 | 0.000 | 0.007 | 0.785 |
| Position in group | 5,048,716 | 0.684 | 0.465 | 0.000 | 1.000 | 1.000 |

Notes: The table depicts the descriptive statistics. ETR is the ratio of tax payments to profit and loss before tax. Employees is the number of staff per firm. Large is a dummy variable that is equal to one for all firms with more than 250 employees. MNE is a dummy variable that is equal to one for all firms that belong to a group with a least one cross-border relationship. Profitability is the ratio of earnings before income and taxes (EBIT) to total assets (TOAS), innovation is the ratio of intangible fixed assets (IFAS) to total assets and position in group is a dummy variable that is equal to one for all headquarters. ETR, Profitability, Innovation are measured in percent. Employees in total numbers and total assets in thousand Euro.

Table 6: Indicator 4 - Baseline regression

| Variable | (1) | (2) |
|----------------------------|-------------------------|-------------------------|
| Large | 0.5886*** (0.0855) | 0.7142*** (0.1059) |
| Large x MNE | -0.9606*** (0.0982) | -1.4648*** (0.1221) |
| Profitability (EBIT/TOAS) | -23.4167*** (0.0940) | -19.0960*** (0.1095) |
| log Total Assets (TOAS) | -0.2308*** (0.0088) | -0.1130*** (0.0105) |
| Innovation (IFAS/TOAS) | -2.3959*** (0.1010) | -3.5671*** (0.1148) |
| Position in Group | -0.7428*** (0.0300) | -0.8877*** (0.0352) |
| Country-Year Fixed Effects | x | x |
| Industry Fixed Effects | x | x |
| Time limited to 2010 | | x |
| R2 (within) | 0.362 | 0.363 |
| Number of firms | 1,001,429 | 751,148 |
| Observations | 5,048,716 | 2,796,459 |

Notes: This table presents the regression results for OECD BEPS Indicator 4. The dependent variable is the effective tax rate (ETR). Large is a dummy variable that is equal to one for all firms with more than 250 employees. MNE is a dummy variable that is equal to one for all firms that belong to a group with a least one cross-border relationship. Profitability is the ratio of earnings before income and taxes (EBIT) to total assets (TOAS), innovation is the ratio of intangible fixed assets (IFAS) to total assets and position in group is a dummy variable that is equal to one for all headquarters. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 7: Indicator 4 - Yearly estimates

| Variable | (1) | (2) | (3) | (4) |
|------------------|------------------------|------------------------|------------------------|------------------------|
| 2000:Large | -0.7736* (0.3954) | -1.0850*** (0.3939) | -1.5108*** (0.4585) | -2.2380*** (0.4781) |
| 2001:Large | 0.3147 (0.3462) | -0.1126 (0.3458) | -0.5575 (0.4338) | -1.5111*** (0.4350) |
| 2002:Large | 2.1868*** (0.2877) | 2.0076*** (0.2872) | 0.9700*** (0.3543) | -0.5627 (0.3896) |
| 2003:Large | 1.9998*** (0.2496) | 1.7776*** (0.2487) | 1.1361*** (0.3303) | 0.2366 (0.3794) |
| 2004:Large | 2.4646*** (0.2148) | 2.3151*** (0.2143) | 1.6728*** (0.3107) | 0.8735** (0.3476) |
| 2005:Large | 1.6306*** (0.2075) | 1.4252*** (0.2087) | 0.6555** (0.2853) | -0.1470 (0.3082) |
| 2006:Large | 1.7789*** (0.1828) | 1.4896*** (0.1835) | 0.0942 (0.2573) | -0.4781* (0.2764) |
| 2007:Large | 0.7786*** (0.1840) | 0.3788** (0.1859) | -0.7637*** (0.2478) | -1.3707*** (0.2505) |
| 2008:Large | 1.0072*** (0.1883) | 0.6677*** (0.1897) | 0.1081 (0.2579) | -0.9128*** (0.2527) |
| 2009:Large | 0.3695* (0.1894) | 0.1497 (0.1901) | -0.5623** (0.2498) | -1.3280*** (0.2600) |
| 2010:Large | 0.2563 (0.1759) | 0.0688 (0.1767) | -0.2922 (0.2338) | -1.0931*** (0.2493) |
| 2011:Large | 1.3874*** (0.1664) | 1.1905*** (0.1671) | 0.8417*** (0.2229) | 0.3256 (0.2426) |
| 2012:Large | 0.9766*** (0.1652) | 0.8262*** (0.1659) | 0.2858 (0.2246) | -0.1289 (0.2493) |
| 2013:Large | 0.4664*** (0.1581) | 0.3126** (0.1591) | -0.1981 (0.2142) | -1.0866*** (0.2350) |
| 2014:Large | 0.4995*** (0.1556) | 0.3621** (0.1565) | 0.2058 (0.2110) | -0.8728*** (0.2286) |
| 2015:Large | -0.3790*** (0.1449) | -0.4503*** (0.1463) | -0.7946*** (0.1934) | -1.7849*** (0.2139) |
| 2016:Large | -0.6421*** (0.1468) | -0.6898*** (0.1482) | -1.0967*** (0.1963) | -1.9308*** (0.2175) |
| 2000:Large x MNE | -1.7451*** (0.4446) | -1.5094*** (0.4435) | -1.6024*** (0.4997) | -1.3151** (0.5462) |
| 2001:Large x MNE | -2.0168*** (0.3979) | -1.7351*** (0.3978) | -1.6660*** (0.4783) | -1.0466** (0.4984) |
| 2002:Large x MNE | -2.1409*** (0.3257) | -1.9829*** (0.3253) | -1.1959*** (0.3976) | -1.0171** (0.4454) |
| 2003:Large x MNE | -1.2244*** (0.2988) | -1.0260*** (0.2978) | -1.0556*** (0.3723) | -1.2429*** (0.4335) |
| 2004:Large x MNE | -2.4361*** (0.2469) | -2.2845*** (0.2463) | -1.8052*** (0.3470) | -1.6114*** (0.3947) |
| 2005:Large x MNE | -1.5695*** | -1.3694*** | -1.0705*** | -0.9054** |

| | | | | |
|----------------------------|------------|-------------|-------------|-------------|
| | (0.2423) | (0.2431) | (0.3185) | (0.3516) |
| 2006:Large x MNE | -2.0878*** | -1.8566*** | -0.7579*** | -0.7890** |
| | (0.2100) | (0.2101) | (0.2895) | (0.3176) |
| 2007:Large x MNE | -0.9689*** | -0.6266*** | -0.3101 | -0.0279 |
| | (0.2208) | (0.2219) | (0.2812) | (0.2908) |
| 2008:Large x MNE | -1.5318*** | -1.2965*** | -1.5250*** | -0.8234*** |
| | (0.2275) | (0.2279) | (0.2937) | (0.2941) |
| 2009:Large x MNE | -0.8038*** | -0.5968*** | -0.2437 | -0.2402 |
| | (0.2269) | (0.2268) | (0.2890) | (0.3038) |
| 2010:Large x MNE | -0.8344*** | -0.5917*** | -0.7783*** | -0.7657*** |
| | (0.2069) | (0.2069) | (0.2680) | (0.2868) |
| 2011:Large x MNE | -1.1547*** | -0.8956*** | -1.0909*** | -1.6932*** |
| | (0.1966) | (0.1964) | (0.2576) | (0.2806) |
| 2012:Large x MNE | -1.1871*** | -0.9812*** | -1.3222*** | -1.6207*** |
| | (0.1950) | (0.1949) | (0.2575) | (0.2894) |
| 2013:Large x MNE | -0.5882*** | -0.4110** | -0.5016** | -0.4745* |
| | (0.1872) | (0.1873) | (0.2463) | (0.2750) |
| 2014:Large x MNE | -0.7135*** | -0.5245*** | -0.9343*** | -0.6510** |
| | (0.1825) | (0.1826) | (0.2418) | (0.2673) |
| 2015:Large x MNE | -0.3270* | -0.2036 | -0.5201** | -0.0968 |
| | (0.1705) | (0.1711) | (0.2225) | (0.2520) |
| 2016:Large x MNE | -0.7032*** | -0.5873*** | -1.0718*** | -0.6808*** |
| | (0.1720) | (0.1724) | (0.2241) | (0.2530) |
| Profitability (EBIT/TOAS) | | -23.4167*** | -23.5781*** | -26.1302*** |
| | | (0.0940) | (0.1250) | (0.1065) |
| log Total Assets (TOAS) | | -0.2317*** | -0.0433*** | -0.3191*** |
| | | (0.0088) | (0.0102) | (0.0098) |
| Innovation (IFAS/TOAS) | | -2.3973*** | -2.3508*** | -2.6047*** |
| | | (0.1010) | (0.1048) | (0.1057) |
| Position in Group (GUO=1) | | -0.7448*** | -0.5962*** | -0.8345*** |
| | | (0.0300) | (0.0328) | (0.0337) |
| Country-Year Fixed Effects | x | x | x | x |
| Industry Fixed Effects | x | x | x | x |
| Country Restriction | - | - | OECD | EU |
| R2 (within) | 0.345 | 0.362 | 0.354 | 0.365 |
| Number of firms | 1,001,429 | 1,001,429 | 843,911 | 854,141 |
| Observations | 5,048,716 | 5,048,716 | 4,320,449 | 4,353,789 |

Notes: This table presents the regression results for OECD BEPS Indicator 4. The dependent variable is the effective tax rate (ETR). Large is a dummy variable that is equal to one for all firms with more than 250 employees. MNE is a dummy variable that is equal to one for all firms that belong to a group with a least one cross-border relationship. Profitability is the ratio of earnings before income and taxes (EBIT) to total assets (TOAS), innovation is the ratio of intangible fixed assets (IFAS) to total assets and position in group is a dummy variable that is equal to one for all headquarters. The dummy variables of interest are interacted with a year dummy to provide annual estimates. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 8: Indicator 4 - Robustness change of outcome variable

| Variable | (1) |
|----------------------------|------------------------|
| 2000:Large x MNE | -0.0151 (0.0597) |
| 2001:Large x MNE | -0.1056** (0.0464) |
| 2002:Large x MNE | -0.1709*** (0.0361) |
| 2003:Large x MNE | -0.0489 (0.0328) |
| 2004:Large x MNE | -0.1017*** (0.0275) |
| 2005:Large x MNE | -0.0553* (0.0297) |
| 2006:Large x MNE | -0.1501*** (0.0244) |
| 2007:Large x MNE | -0.0983*** (0.0258) |
| 2008:Large x MNE | -0.1209*** (0.0255) |
| 2009:Large x MNE | -0.0399* (0.0221) |
| 2010:Large x MNE | -0.0697*** (0.0200) |
| 2011:Large x MNE | -0.1158*** (0.0198) |
| 2012:Large x MNE | -0.1221*** (0.0188) |
| 2013:Large x MNE | -0.0537*** (0.0179) |
| 2014:Large x MNE | -0.0632*** (0.0178) |
| 2015:Large x MNE | -0.0483*** (0.0173) |
| 2016:Large x MNE | -0.0883*** (0.0177) |
| Country-Year Fixed Effects | x |
| Industry Fixed Effects | x |
| Controls | x |
| R2 (within) | 0.666 |
| Number of firms | 1,001,429 |
| Observations | 5,048,716 |

Notes: This table presents the regression results for OECD BEPS Indicator 4. The dependent variable is the ratio of tax payments to total assets (TOAS). Large is a dummy variable that is equal to one for all firms with more than 250 employees. MNE is a dummy variable that is equal to one for all firms that belong to a group with a least one cross-border relationship. For the sake of brevity, we do not display the coefficient estimates for the control variables: Profitability is the ratio of earnings before income and taxes (EBIT) to total assets (TOAS), innovation is the ratio of intangible fixed assets (IFAS) to total assets and position in group is a dummy variable that is equal to one for all headquarters. The dummy variables of interest are interacted with a year dummy to provide annual estimates. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 9: Indicator 4 - Propensity score matching evaluation

| Matching Evaluation | Standardized Differences | | | Variance Ratio | |
|---------------------|--------------------------|---------|----------------|----------------|---------|
| | Raw | Matched | Bias reduction | Raw | Matched |
| ln(TOAS) | 1.2628 | -0.0134 | 98.94% | 1.3302 | 0.9296 |
| ln(PROD) | 0.1151 | -0.0351 | 69.51% | 1.0248 | 0.9369 |
| D/E Ratio | -0.2246 | 0.0267 | 88.14% | 0.4634 | 0.9854 |
| Innovation | -0.0967 | -0.0091 | 90.57% | 0.8897 | 0.9408 |

Notes: This table presents the evaluation of the matching procedure on the logarithm of total assets (TOAS), the logarithm of productivity (PROD), which is the ratio of sales to total wages, the debt to equity ratio, and innovation, which is the ratio of intangible fixed assets (IFAS) to total assets (TOAS). The column Raw depicts the standardized differences and variance ratios in the unmatched sample. The column Matched depicts the standardized differences and variance ratios in the matched sample. The column Bias Reduction is the percentage reduction in the standardized differences between the unmatched and matched sample. The values depict the averages of all years. Standardized differences close to 0 and variance ratios close to 1 are indicators of a good matching quality.

Table 10: Indicator 4 - Propensity score matching estimates on the ETR difference (ATE)

| Year | ATE |
|--------------|------------------------|
| 2000 | -1.0154*** (0.3164) |
| 2001 | -0.7162** (0.2794) |
| 2002 | -0.2295 (0.2754) |
| 2003 | -0.4179 (0.2605) |
| 2004 | -0.5825** (0.2290) |
| 2005 | -0.7053*** (0.2086) |
| 2006 | -0.1611 (0.1900) |
| 2007 | -0.5774*** (0.1758) |
| 2008 | -0.8239*** (0.1835) |
| 2009 | -0.1339 (0.1780) |
| 2010 | -0.1824 (0.1688) |
| 2011 | -0.4686*** (0.1627) |
| 2012 | -0.5112*** (0.1591) |
| 2013 | -0.5548*** (0.1576) |
| 2014 | -0.3559** (0.1528) |
| 2015 | -0.5237*** (0.1555) |
| 2016 | -0.9351*** (0.1572) |
| Observations | 3,669,138 |

Notes: The table depicts the annual average treatment effects (ATE) of being a multinational corporation on the ETR. The ATE estimates are based on a propensity score estimation procedure. The groups of multinational and domestic firms are matched on the logarithm of total assets (TOAS), the logarithm of productivity (PROD), which is the ratio of sales to total wages, the debt to equity ratio and innovation, which is the ratio of intangible fixed assets (IFAS) to total assets (TOAS). Standard errors are rely on the adjustment by Abadie and Imbens (2012) and take into account that the propensity scores to match the groups are estimated. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 11: Indicator 5 - Countries in the high-ratio group

| | Base Year 2011 | Base Year 2017 |
|---|----------------|----------------|
| 1 | Guatemala | El Salvador |
| 2 | Hungary | Hungary |
| 3 | Ireland | Luxembourg |
| 4 | Lesotho | Madagascar |
| 5 | Luxembourg | Malta |
| 6 | Madagascar | Netherlands |
| 7 | Malta | Singapore |
| 8 | Netherlands | Switzerland |
| 9 | | United Kingdom |

Notes: The table shows the countries belonging to the high-ratio group. High-ratio countries are those countries that have a royalty receipts to R&D spending ratio of above 0.5 in a pre-defined base year. Column 1 and 2 refer to base years 2011 and 2017, respectively.

Table 12: Indicator 5 - Results

| Year | OECD Indicator | Base Year: 2011 | | | Base Year: 2017 | | | Base Year: Continuous | | |
|------|-------------------|-----------------|-----|-----------|-----------------|-----|-----------|-----------------------|-----|-----------|
| | | High | Low | Indicator | High | Low | Indicator | High | Low | Indicator |
| 2005 | 2,8 | 131% | 17% | 7,7 | 64% | 16% | 4,0 | 148% | 17% | 8,7 |
| 2006 | 2,5 | 130% | 17% | 7,6 | 61% | 16% | 3,8 | 157% | 17% | 9,2 |
| 2007 | 2,6 | 140% | 18% | 7,7 | 62% | 18% | 3,5 | 168% | 18% | 9,1 |
| 2008 | 2,5 | 150% | 18% | 8,4 | 66% | 17% | 3,9 | 126% | 17% | 7,2 |
| 2009 | 2,7 | 153% | 17% | 9,1 | 74% | 16% | 4,6 | 178% | 17% | 10,6 |
| 2010 | 4,3 | 156% | 17% | 9,1 | 72% | 17% | 4,3 | 152% | 17% | 8,9 |
| 2011 | 5,8 | 153% | 18% | 8,7 | 70% | 17% | 4,0 | 153% | 18% | 8,7 |
| 2012 | 5,8 | 169% | 19% | 9,0 | 75% | 18% | 4,3 | 127% | 18% | 7,2 |
| 2013 | | 168% | 18% | 9,5 | 78% | 17% | 4,5 | 146% | 18% | 8,3 |
| 2014 | | 201% | 18% | 10,9 | 86% | 18% | 4,8 | 127% | 18% | 7,1 |
| 2015 | | 235% | 20% | 11,9 | 92% | 18% | 5,1 | 126% | 18% | 7,0 |
| 2016 | | 186% | 19% | 9,9 | 84% | 18% | 4,6 | 168% | 18% | 9,2 |
| 2017 | | 194% | 20% | 9,8 | 98% | 17% | 5,7 | 98% | 17% | 5,7 |
| 2018 | | 195% | 18% | 10,7 | 86% | 18% | 4,7 | 195% | 18% | 10,7 |

Notes: The table depicts the values of Indicator 5. Column 2 shows Indicator values estimated by the OECD (OECD, 2015). For each country the ratio of royalty receipts to R&D spending is calculated. Based on this ratio in a pre-defined base year, countries are assigned to high-ratio groups or low-ratio groups. The threshold values amounts to 50%. Column 3 and 4 show the ratio of the countries in the high-ratio group and low-ratio group, respectively. Column 5 shows the estimated indicator value. Each panel refers to a different base year for group assignment. The Worldbank and UNESCO are used as data source.

Table 13: Indicator 5 - Results alternative data

| Year | OECD Indicator | Base Year: 2011 | | | Base Year: 2017 | | | Base Year: Continuous | | |
|------|-------------------|-----------------|-----|-----------|-----------------|-----|-----------|-----------------------|-----|-----------|
| | | High | Low | Indicator | High | Low | Indicator | High | Low | Indicator |
| 2005 | 2,8 | 111% | 13% | 8,2 | 78% | 14% | 5,7 | 143% | 14% | 10,5 |
| 2006 | 2,5 | 112% | 14% | 8,1 | 102% | 14% | 7,3 | 148% | 14% | 10,7 |
| 2007 | 2,6 | 137% | 16% | 8,8 | 117% | 16% | 7,5 | 182% | 16% | 11,6 |
| 2008 | 2,5 | 157% | 16% | 9,8 | 89% | 16% | 5,7 | 134% | 16% | 8,6 |
| 2009 | 2,7 | 148% | 14% | 10,2 | 101% | 15% | 6,9 | 170% | 15% | 11,7 |
| 2010 | 4,3 | 144% | 15% | 9,4 | 96% | 15% | 6,2 | 144% | 15% | 9,4 |
| 2011 | 5,8 | 154% | 17% | 9,3 | 101% | 17% | 6,0 | 154% | 17% | 9,3 |
| 2012 | 5,8 | 160% | 17% | 9,3 | 110% | 16% | 6,7 | 117% | 16% | 7,4 |
| 2013 | | 164% | 16% | 10,2 | 116% | 16% | 7,2 | 122% | 16% | 7,8 |
| 2014 | | 198% | 17% | 12,0 | 135% | 17% | 8,1 | 148% | 16% | 9,2 |
| 2015 | | 197% | 17% | 11,8 | 128% | 16% | 8,1 | 126% | 15% | 8,3 |
| 2016 | | 156% | 16% | 10,0 | 112% | 16% | 7,1 | 130% | 15% | 8,5 |
| 2017 | | 166% | 17% | 9,9 | 129% | 15% | 8,4 | 129% | 15% | 8,4 |
| 2018 | | 179% | 16% | 11,4 | 147% | 16% | 9,0 | 202% | 16% | 12,9 |

Notes: The table depicts the values of Indicator 5. Column 2 shows Indicator values estimated by the OECD (OECD, 2015). For each country the ratio of royalty receipts to R&D spending is calculated. Based on this ratio in a pre-defined base year, countries are assigned to high-ratio groups or low-ratio groups. The threshold values amounts to 50%. Column 3 and 4 show the ratio of the countries in the high-ratio group and low-ratio group, respectively. Column 5 shows the estimated indicator value. Each panel refers to a different base year for group assignment. The Worldbank and OECD are used as data source.