# Is it just Luring Reported Profit?

## The Case of European Patent Boxes*

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First version: December 2015 - This version: July 2017

**Abstract**

The effectiveness of European patent boxes in triggering R&D and fostering new patentable innovations is the subject of a growing debate. These regimes are considered liable of tax-favouring already successful ideas, without imposing a nexus between the final location of the intellectual property (IP) and its related innovation. This paper brings the debate forward onto the assessment of the quantitative impact of patent box regimes on profit shifting by multinational firms. Our empirical strategy builds on a difference-in-difference model comparing the pre-tax profit of European subsidiaries affiliated to corporate conglomerates that owned patents long before the introduction of IP boxes, to that of European subsidiaries affiliated to corporate conglomerates with no historical record of patent ownership. We find that European subsidiaries affiliated to foreign IP owners report, after the introduction of a local patent box, on average 9 percentage points higher profit compared to European subsidiaries affiliated to non-IP-owning conglomerates. For countries where the patent box regime grants the IP related tax benefit only to newly created IP, the difference in the profits of the two groups is smaller in magnitude.

**JEL-Classification:** H25, H26, F23, C21, C23

**Keywords:** corporate tax avoidance, patent box, multinational enterprise, profit shifting

*Previous versions of the paper circulated under the title "Patent Boxes: Is it Luring Innovations or just Profit?" and "Is it Luring Innovations or Just Profits? The Case of European Patents Boxes". We are grateful to seminar and conference participants at the CESifo Delphi conference on Innovation (Munich, 1-2 July 2016), the IIPF annual meeting (Lake Tahoe, 9-11 August 2016), the EEA annual congress (Geneva, 24-27 August 2016), the Public Economics UK conference (CBT Oxford, 8-9 September 2016), the NTA annual conference on taxation (Baltimore, 10-12 November 2016), the University of Goettingen (Goettingen, 13 December 2016), Bocconi University (Milan, 3 April 2017), the CESifo PSE conference (Munich, 27-29 April 2017), the CESifo VSI Workshop "Fiscal competition and mobility: theory and empirics" (Venice, 16-17 June 2017), and at the University of Nuremberg-Erlangen (Nuremberg, 19 July 2017). In particular, we are grateful for the valuable comments made by Thiess Buettner, Mike Devereux, Andreas Oestreicher, Kurt Schmidheiny, Michael Smart, and Johannes Voget.

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# 1 Introduction

The economic literature has established significant evidence for income shifting of multinational firms (MNEs).[1] The consensus is that MNEs face a significantly lower tax burden, compared to domestic firms which do not have access to international tax avoidance strategies. Mintz and Smart (2004) show that the elasticity of taxable income with respect to tax rates is equal to 4.9 for multidivisional firms, compared to 2.3 for firms that are required by the law to file consolidated corporate accounts. Egger et al. (2010) estimate that foreign ownership reduces the tax burden by about 56 percent.

The most common channels to transfer profits from high-tax to low-tax jurisdictions encompass the manipulation of transfer pricing for intra-firm trade, the design of tax-driven financial policies - such as internal lending -, or the use of royalty payments for intangible assets - such as trademarks and patents. These practices are particularly harming since, as defined in the OECD 2015 BEPS report, they are used to "achieve low or no taxation by shifting profits away from the jurisdictions where the activities creating those profits take place".

Over the last decade, the introduction of so-called Patent Boxes has contributed in shifting the attention on the increasing role of intangible assets as a non-neglible tool for profit shifting. Popular in the early 2000s, Patent Box regimes were initially designed as an incentive to boost European research and development activity[2]: aside of differences in details, they generally grant preferential tax treatments to income originating from intellectual property (IP).[3] The EU (Ecofin assessment 2014) and OECD consent that aspects of these regimes are harmful to tax base erosion, particularly in light of their ability to attract patents created through innovative activity conducted elsewhere than the final country of registration. To resolve this drawback, the OECD and the G20 member countries endorsed the modified nexus approach (OECD, 2015). The latter stipulates that substantial economic activities related to the innovation need to be undertaken in the country offering the favourable tax regime, thereby linking the tax benefit directly to R&D expenditures.

The sequential introduction of Patent Boxes, as witnessed in most European countries over the last decade, has brought along a new strand of literature, focused on unveiling the phenomenon of tax-driven creation and location of patents. Karkinsky and Riedel (2012) find that patent applications are more likely filed by MNE's affiliates located in low tax countries,

[1] See Grubert and Mutti (1991) and Hines and Rice (1994) for two seminal papers on multinational income shifting and Hines (1997), Gresik (2001) and Dharmapala (2014), among others, for an overview of the literature).

[2] Between 2001 and 2015 Belgium, Cyprus, France, Hungary, Ireland, Lichtenstein, Luxembourg, Malta, the Netherlands, Portugal, Spain, Switzerland (Nidwalden) and the United Kingdom implemented Patent Box regimes.

[3] A rather broadly defined patent box may additionally include existing trademarks, trade secrets, know-how, designs and models, copyright, domain names, etc., while a narrowly defined patent box may grant the tax benefit only for newly developed patents and associated patent rights (see also Alstadsaeter et al., 2015).

whereas Griffith and al. (2014) estimate a negative elasticity of patent location to corporate tax rates. Alstadsaeter et al. (2015) decompose the effects of corporate tax rate and tax advantages offered by patent boxes on the number of registered patents. They find that patent boxes have a considerable effect on attracting patents, while deterring local innovative activities. Besides these valuable insights, the literature has yet to establish the actual quantitative role of patents and patent box regimes for profit shifting of worldwide MNEs.

Our paper fills this gap by directly estimating the difference in profits of European affiliates of worldwide MNEs which do (do not) own patents within their multinational conglomerate. Precisely, we collect information on firms that qualify as subsidiaries controlled by foreign corporations and are located in European countries which introduced patent boxes between 2007 and 2013 (our observational period). Our empirical strategy is to compare the profit of subsidiaries with low cost of accessing the IP related tax relief, due to patent ownership within their conglomerate, to the profit of firms with high cost of benefiting from the patent box regime, due to complete absence of patents within their conglomerate. We use historical information on research and development activity as well as on patent ownership and financial performance to classify the observed subsidiaries into these two groups. Our historical data refers to the decade preceding the introduction of any patent box regime in Europe (pre-2000).[4] We use the *coarsened exact matching* (CEM) method propose by King, Iacus and Porro (2008) to construct our sample, and estimate a profit shifting equation in the spirit of Hines and Rice (1994) using a difference-in-difference approach. In detail, our empirical strategy builds on a difference-in-difference model with the introduction of the patent box regime in the various European countries as the treatment effect. Patent ownership in the year 2000 at direct and indirect level, via the majority shareholder, defines our treatment group, and a matched sample of firms with no historical patent ownership (at any level in the conglomerate) serves as control group.

A very robust picture emerges from our regression analysis. We find that multinational (domestic) affiliates who pre-own patents either directly or indirectly within the conglomerate report on average 13 (4) percentage points higher pre-tax profits compared to affiliates that do not pre-own patents within their conglomerate. This result is robust with regard to various different specifications. Further, we are able to show that, if the patent box regime incorporates a clause granting the IP related tax benefit only to newly created patents (essentially disqualifying pre-existing and acquired patents), the difference in profits between the two groups disappears. Hence, our findings additionally provide evidence of those features which turn patent boxes

[4]With the exception of France and Ireland, which introduced the patent box regime already in the 1970s. Nevertheless, both countries had major amendments to their existing patent box regime within the analysed period.

into a suitable device for profit shifting rather than being an instrument which fosters R&D activities. To our knowledge, our paper is the first to directly isolate the effect of IP and patent box regimes on profit shifting of worldwide MNEs.

The paper proceeds as follows. Section 2 lays out the theoretical predictions that we put to a test. Section 3 specifies the empirical strategy and Section 4 describes the data. Estimation results are presented in Section 5 and Section 6 concludes.

## 2 Theoretical Predictions

Consider two firms, A and B, that are located in different countries and are divisions of a multinational enterprise (MNE). The division in country A sells the right to use intellectual property (IP) owned by division A to the division in country B that uses the input to generate sales $y_B$. The 'true' price of the IP input is unity and not directly observable by tax authorities. The multinational firm can set the royalty payment $q$ different to unity subject to a concealment cost $\theta(q)$ that satisfies

$$\theta(1) = 0,\ \theta'(1) = 0,\ sign(\theta') = sign(q-1),\ \theta''(q) > 0.$$

For $q > 1$ there is overpricing and for $q < 1$ there is underpricing of the internal input. Similarly, division A uses its intellectual property to produce an output that leads to pre-tax profits $y_A(i)$ that depend on its investment in innovations, $i$.[5] The cost of generating innovations is $c(i)$, where $c'(i), c''(i) > 0$.

The profit of the MNE is:[6]

$$\Pi = (1-t_A)(y_A(i) + q - 1) + (1-t_B)(y_B - q) - \theta(q) - c(i)$$

In choosing the profit-maximizing royalty payment, the MNE aligns the tax advantage $t_B - t_A$ with the marginal concealment cost:

$$t_B - t_A = \theta'(q). \tag{1}$$

For a positive (negative) tax differential $t_B - t_A > (<)\ 0$, the MNE overprices (underprices) the IP input (e.g., Haufler and Schjelderup, 2000). The optimal investment level aligns the marginal return on investment with the marginal cost:

$$(1-t_A)y_A'(i) = c'(i). \tag{2}$$

[5] We might also allow the investment to increase output in division B, $y_B$, possibly due to the public good character of innovations and technology transfer within the MNE. The relevant predictions of the model we put to a test in the empirical part will not change with this extension.

[6] The cost of investment might not be granted an immediate write off and might only be tax deductible over time, which is usually the case for machinery and equipment. For illustrative simplicity, we assume that $c(i)$ is not tax deductible.

The introduction of a patent box in country A leads to a lower tax rate on income that qualifies for the patent box. Provided the income $y_A(i) + q$ qualifies for the favorable tax treatment, the first-order conditions (1) and (2) imply that the drop in $t_A$ increases the amount of profit shifted into division A as well as investment in innovations that increases $y_A(i)$, i.e. $dq/dt_A > 0$ and $di/dt_A > 0$. Thereby, pre-tax profits in country $A$ increase under the patent box regime.[7] To summarize:

**Proposition:** *Assume country A introduces a patent box. Then, for firms with qualifying patent income, profit shifting into the patent box as well as productivity-enhancing investments increase.*

It is this proposition that we put to a test in the empirical analysis. However, in most data sets, the different profit components are not separately observable and only the total pre-tax profit can be observed. To still be able to infer the source of profit variation, we might compare the change in profits of a division of a MNE with the profit of firms that are either not divisions of a MNE (domestic firms) or do not have income that qualifies for the patent box. For instance, a firm that has qualifying income and is a domestic firm, pre-tax profits only change due to higher investments in innovations and the resulting productivity increase. In this case, $q \equiv 0$ and the first-order condition (2) summarizes the patent-box induced adjustment in profits. Differently, for a MNE division or a domestic firm that has no qualifying income, pre-tax profit will not change following the introduction of a patent box. Thus, looking at the profit difference between domestic firms with and without qualifying income separates out the productivity effect, while the profit differential of MNE divisions with and without qualifying income isolates the total profit effect. In the empirical analysis we hence resort to a triple diff-in-diff estimation strategy to isolate the different changes where the three dimensions of the comparison are before/after patent box introduction, domestic firms vs. MNEs, and control group vs. treated firms.

# 3 IP Box Regimes

The existing patent box regimes in Europe have in common a reduced tax burden on income generated through intellectual property vis-a-vis income derived from the firm's standard busi-

[7] The conclusion also holds when profit of division A, $\pi_A$, includes all cost of transfer pricing and investments in innovations. In this case, the total profit change of division A is

$$d\pi_A/dt_A = \left(y'_A(i) - c'(i)\right) di/dt_A + \left(1 - \gamma'(q)\right) dq/dt_A.$$

Using the first-order conditions (1) and (2), the profit term reduces to $t_A y'_A(i) di/dt_A + (1 - t_B + t_A) dq/dt_A$ which is positive in sign.

ness activity. In doing so, France, the Netherlands and the United Kingdom have introduced a separate rate of 15, 5 and 10 percent, respectively, for taxing income from intellectual property. All other European countries adjust the tax base, that is, they exempt between 50 and 80 percent of the income derived from IP when computing taxable income. These tax rate or tax base adjustments give rise to an effective tax burden as low as only 3 percent on IP income, as in the case of Ireland, Lichtenstein and Cyprus. The BeNeLux countries and Switzerland charge slightly higher, effective tax rates on IP income of between 5 to 6 percent, while the remaining countries, such as France, Hungary, Portugal, Spain and the United Kingdom, stipulate effective tax rates between 10 and 15 percent on IP income (see also Ernst & Young, 2015, World Corporate Tax Guide). Besides the magnitude of the effective tax burden on IP income, a second dimension along which European patent box regimes diverge is the type of income eligible for the tax benefit. Narrowly defined patent boxes grant preferential tax treatment only to income derived from newly developed patents (i.e. IPs registered *after* the introduction of the patent box regime) and associated IP rights, as it is the case in Belgium and the Netherlands, for instance. Other countries, like Luxembourg and Portugal, also do not grant any tax benefit to pre-existing patents, but instead provide a more generous and broad definition of the patent box itself. That is, besides income from patents, also income arising from trademarks, trade secrets, know-how, designs and models, copyright, domain names, etc., qualifies for the preferential tax treatment (Ernst & Young, 2015). This rather broad definition of the patent box seems to be the rule rather than the exception within European patent box designs, giving rise to the suspicion that fostering innovative activity is not the only purpose of these regimes.

# 4 Empirical Strategy

The debate around European IP boxes stems from the observation that these regimes facilitate profit shifting into selected affiliates that already benefit from income and royalties generated by successful ideas, which are protected by intellectual property rights. Ideally, IP boxes should trigger R&D and foster new patentable innovations. However, the affiliates with no history of innovation and R&D activity would have to bear significant costs, before registering the patents required to benefit from the IP Box regimes. In other words, the legislative design of IP boxes puts conglomerates with a history of R&D and innovation patenting at an advantage, compared to conglomerates that have never ventured into patent creation.

Our empirical strategy builds on this observation. We base our analysis around the time of introduction of the IP box regimes, and compare the change in pre-tax profit of European affiliates of conglomerates that have "easy access" to patent-box-related tax benefits, with the change in pre-tax profit of other European affiliates, which do not have this advantage. To sort

affiliates into the two comparison groups, we exploit firms heterogeneity in terms of industrial sector, age, size, profitability, asset intangibility, innovation and IP creation. Specifically, we expect that affiliates with an established path of investment in intangible assets and IP creation, are able to benefit from the patent box regime more easily than affiliates that operate on a similar scale in the same country and industry, but do not have the required set-up (i.e. IP ownership) needed to benefit from the IP box preferential tax treatment. For this second group of companies, the available options are to undergo structural changes and launch the research and development necessary to produce patentable innovations (i.e. establishment of R&D divisions, employment of high skilled labor), to purchase external patents or alternatively to acquire the control of firms who have the technology and the know-how to produce new patents. These options might all be sufficiently costly to offset the advantages offered by the patent box regime.

Simply comparing the response to the introduction of an IP box of affiliates with a history of R&D and IP, to the response of affiliates that have never innovated, is not sufficient to identify the volume of profit shifting activity due to the tax incentives associated with the IP box. In fact, the concentration of patentable innovations, which is the mechanical effect of the introduction of an IP box, can affect productivity and profitability, through the improvement of the production process and the accumulation of royalty income. To disentangle these from the profit shifting effect, which we are interested in identifying, we use a difference in difference in difference (DDD) approach, and allow the response to the introduction of the IP box to vary, according to whether the observed affiliate is part of a multinational or of a domestic conglomerate. The fundamental difference between affiliates of multinational and domestic conglomerates is that the former can exploit the IP box to shift profit (otherwise taxed at higher foreign tax rates) through royalty payments, on which the reduced IP rate applies, whereas the latter do not have such additional profit enhancing opportunity. Estimating the response of pre-tax profit to the IP box introduction for both types of affiliates, allows us to interpret the differential effect as the size of the profit shifting activity.

In defining our treatment group, we additionally account for the fact that the ability of multinational conglomerates to exploit the tax incentives introduced by the IP-box, and shift profit among their affiliates, heavily relies on the mobility of intangible assets and IPs. As shown in recent literature, patent relocation is a major effect of the introduction of IP-related tax incentives (Karkinsky and Riedel (2012), Griffith and al. (2014) and Alstadster et al. (2014)). Building a treatment group based exclusively on *direct* IP ownership, would exclude from our analysis all the European firms affiliated to conglomerates with historical ownership of IPs that can be potentially relocated, after the introduction of the IP box. To account for

all this, we do not limit IP ownership to the establishment of the European affiliate observed in our sample. Instead, we compute the number of patents owned by each shareholder linked to the observed European affiliate. We compute the number of all patents that can be potentially relocated in the country of the European affiliate, once the IP box is introduced. This represents a novelty in the literature, as it allows to directly account for the ability of the multinational parent to react to the introduction of patent box regimes with a redistribution of its own patents among the European affiliates located in countries offering the reduced tax rates on IP income and royalties.

Our baseline estimation departs from the following DDD regression model:

$$\begin{aligned}\pi_{ist} =&\beta_0 + \beta_1 k_{it} + \beta_2 \ell_{it} + \beta_3 f_{if} + \beta_4 TAX_{it} \times MNE_i + \\ &\gamma_1 T_{it} \times DOM_i + \gamma_2 T_{it} \times MNE_i + \theta_\tau + \\ &+ \lambda_{st} + \eta_i + \epsilon_{ist}\end{aligned} \tag{3}$$

where $\pi_{ist}$ is unconsolidated (logged) pre-tax profit reported in year $t$ by the European affiliate $i$ operating in sector $s$, $k_{it}$ is logged fixed assets, $\ell_{it}$ is logged total labor compensation, $f_{it}$ is financial leverage and $TAX_{it} \times MNE_i$ is a tax indicator accounting for differences between the tax system of affiliate $i$ and the rest of its conglomerate, in case the affiliate belongs to a multinational group. This setup, generally adopted in the corporate tax literature to estimate the extent of profit shifting practices among multinational firms, is augmented with the DDD interaction terms. Specifically, $T_{it}$ is the treatment indicator variable, which, for all affiliates $i$ that owned IPs before the year 2000, takes value 1 *after* the introduction of the IP-Box, and value 0 otherwise. $DOM_i$ and $MNE_i$ are other indicator variables, which distinguish whether affiliate $i$ belongs to a Domestic or Multinational conglomerate. $\theta_\tau$ is a set of treatment-year dummies, which account for the distance in time from the introduction of the IP-Box, as in $\tau = t - t_{PB}$, with $t_{PB}$ being the year of IP-Box introduction. Finally, we control for industry-year fixed effects, $\lambda_{st}$, and specify the composite error term as the sum of the affiliate unobserved fixed effects, $\eta_i$, and of the idiosyncratic error $\epsilon_{it}$.

The baseline specification of equation (3) follows the literature on income shifting and adopts the "Hines-Rice" (1994) approach, in assuming that observed unconsolidated pre-tax profit is the sum of two unobserved components, one derived from true economic activity and the other shifted from the firm's affiliates (most likely its majority shareholder, or "parent" firm).[8] The portion of profit generated through the production process is a function of capital and labor inputs, proxied in our analysis by fixed assets ($k_{it}$) and labor costs ($\ell_{it}$). The portion

[8]For a review of the literature see, for instance, Dharmapala (2014).

of profit shifted from other affiliates is, instead, dependent on the tax incentives faced by the conglomerate as a whole. The tax variable $TAX_{it}$ captures the part of tax incentives due to the differences in tax rates between the affiliate and its shareholders, and independent on the introduction of patent boxes. With the $T_{it}$ dummy, instead, we capture the change in reported pre-tax profit due to the introduction of patent boxes. Finally, the difference between $\gamma_2$ and $\gamma_1$ identifies the pre-tax profit response to the introduction of the IP box due to profit shifting activities led by the European affiliates of multinational conglomerates.

# 5 Data

To build our database, we follow four steps. First, we use corporate ownership data to identify European affiliates of multinational and domestic groups. Second, we collect data on yearly balance sheets around the year of introduction of the European IP Boxes. Third, we use historical information to identify affiliates with historical IP ownership and to track their past performance. Fourth, we use corporate ownership data to track yearly changes in the profit shifting tax incentives faced by the conglomerate as a whole, and independent on the newly introduced IP box. Our main source is the Bureau van Dijk database ORBIS, which provides historical information on corporate ownership structure for the years 2007-2013, along with information on affiliates financial accounts and patent registration for the years 1996-2012. As we do not observe any ownership link beyond the most recent seven years interval, we only select active affiliates that are located in countries that introduced an IP box between 2007 and 2012, and whose majority shareholder is an active firm.

As of step one, we distinguish between affiliates of domestic and multinational conglomerates, by looking at the location of the affiliate corporate shareholders. We use the historical ownership links available in ORBIS, and discard links to individuals, mutual funds, employees, insurance companies or corporations with unidentified location. If all shareholders are located and incorporated in the same country as the affiliate, then we define the group as Domestic. We identify the affiliate parent, as the firm in the conglomerate that controls the affiliate largest share. For the cases where ownership of the affiliate is equally distributed among several shareholders, we select as parent the firm that is also listed as global ultimate owner (GUO). [9] We finally exclude all European firms that are independent standalone units, as in not linked to any other active firm, and rather fully controlled by individuals or funds. We follow the existing literature and limit our analysis to the sample of affiliates who report positive pre-tax profits for at least two consecutive years during our observational period 2007-2012. In addition we

[9] We only use first level links, and do not investigate on whether domestic shareholders are themselves linked to any foreign corporation.

condition on the affiliate to preserve the same ownership structure (Domestic vs Multinational) over the entire observational period. This procedure leaves us with a sample of 90,662 European affiliates, of which just short of 10% (8,249 affiliates) belong to Multinational conglomerates.

Once the sample of European affiliates is constructed, we proceed with collecting unconsolidated financial accounts. A description of the variables used in our estimation is reported in Table 2. Geographically, we include affiliates located in Belgium, the Netherlands, Luxembourg, Spain, Hungary and France. Other European countries, notably Cyprus, Italy, Liechtenstein, Malta, Portugal, Switzerland, and the United Kingdom, have patent box regimes in place, but introduced them before or after our observational period and are for this reason excluded from our analysis. Ireland had a patent box in place during our observational period, which was withdrawn in 2010. [10] Across the seven countries considered, patent boxes differ substantially in terms of both the time of their introduction and the details of their design, as discussed in section 3. It follows that the affiliates contained in our sample are differently exposed to the tax incentives associated with R&D investment, IP creation or relocation. We will exploit these differences in our empirical analysis, by allowing the effect of the patent box regime to vary according to whether the country qualifies pre-existing patents and acquired patents. This is particularly relevant for our analysis, as it gives a premium advantage to those affiliates who already had patents registered before the IP box introduction.

For step three, as discussed in section 4, our approach is to identify the European affiliates that have an established pattern of R&D, innovation and patenting activity. Due to partial observability of R&D expenses, we focus on historical direct and indirect patent ownership. For each affiliate in ORBIS, we collect data on the number of patents (IPs) owned and their year of registration. We use these information to define direct and indirect patent ownership. As we do not have data on links among patents, we simply construct indicator variables that take value 1 if any patent is owned at each control level and 0 otherwise. This partly resolves the issues related to patent quality, patent double counting and skewness in the distribution of patent numbers. The year 2000 is chosen as a reference point for the identification of historical patent ownership, because it is antecedent to the introduction of any patent boxes in all European countries.[11] According to our empirical strategy, the treatment group includes the affiliates that have low costs of accessing the tax benefits associated with the introduction of an IP box

[10] The Irish scheme was withdrawn in 2010 under the National recovery Plan 2011-2015 of the Republic of Ireland. At the time of the withdrawal, it was also announced that a new scheme, called Knowledge Development Box, would substitute the old one later in in 2015, offering a reduced tax rate of 6.25% on qualifying profits generated in periods commencing on or after 1 January 2016.

[11] The concept of patent box was first introduced in 2000 by the Irish and in 2001 by the French Tax Authorities as a reduced rate on revenue from IP licensing or the transfer of qualified IP. We also experimented with reference years 1995 and 1997. This yield similar results to using year 2000, except that the sample was very much reduced, due to partial observability of earlier dated IP ownership.

(during the period 2007-2013). These are defined as the European affiliates that owned patents, as well as the affiliates whose majority shareholder (parent) owned patents, before the year 2000. The control group is constituted by the European affiliates who did not own any patent, directly or indirectly, before the year 2000: these can take advantage of the IP box only after bearing significant costs for the creation or acquisition of an eligible patent.

In our baseline sample, Table 3, we find that 24.65% of the Multinational affiliates and 15.35% of the Domestic affiliates qualify as treated. The higher concentration of patent ownership among Multinational affiliates is expected, given the known competitiveness advantage of Multinational conglomerates. Affiliates are unevenly distributed among countries, Table 4, but we generally observe that the introduction of IP boxes corresponds to an increase in patent (direct and indirect) ownership among affiliates of Multinational conglomerates. The same is not true, on average, for affiliates of Domestic conglomerates. Note that only between 0.7 and 3% of the observed Multinational affiliates had IPs directly owned within their establishment by the year 2000, with this figures being even lower for domestic affiliates. However, up to more than 30% (20%) of affiliates were majority owned by shareholders that directly owned patents before the year 2000. The concentration of IP ownership on majority shareholders has been largely documented in the innovation literature, but, to our knowledge, it has not been exploited in the profit-shifting literature. Our approach accounts for exactly this link of IP ownership, as we argue that those affiliates with their majority shareholder already owning intangible assets face comparably low costs associated with profit shifting. Based on records on the year of incorporation, we can identify whether the observed affiliates are newly created establishments, namely if legally incorporated around the year of entry into the database.[12] Note that newly created affiliates can be controlled by majority shareholders who themselves owned patents before the year 2000, so they can be in both the treatment or the control group.

For step four, to construct affiliate-time specific tax measures that account for the different profit shifting incentives faced by the affiliate foreign majority shareholder, which proxies the $TAX_{it}$ variable of equation 3, we follow the established literature on profit shifting (Huizinga and Laeven, 2008). For each multinational affiliate in our sample, we use the ORBIS ownership structure database, and reconstruct the list of subsidiaries owned by the foreign majority shareholders in each year between 2007 and 2013. For each European affiliate $i$, part of the multinational conglomerate $c$, we identify the parent located in country $p$ and the $N$ other affiliated firms located in countries $j = 1, ..., J$, $\forall j \neq i$. We then construct the simple difference between the corporate statutory tax rate levied in the country of the affiliate and that of the country of the parent $(\tau_i - \tau_p)$. We also construct the difference between the tax rate levied by

[12] We define an affiliate as newly created if its incorporation date is in the year before or in the year of entry into the database.

the country of the affiliate and the lowest tax rate faced by the entire conglomerate ($\tau_i - \tau_{min}$), where $\tau_{min} = min\{\tau_j\}_{j=1}^{J}$.

Table 5 reports average statutory tax rates faced by the Multinational affiliates in the treatment and control groups used in our analysis, averaged over the years 2007-2013. Comparing the second and third column, we see that the affiliates in the treated group on average face higher statutory tax rates domestically and in the location of their parent and of their other affiliates. Only the tax differential between affiliate and parent is higher for the control than for the treated group.

# 6 Matching

Our definition of the treatment and control groups is based on historical information prior to the introduction of any European IP box regime, which happened during the rather narrow time span of 2007-2012. We argue that the assignment of an affiliate into the treatment group is affected by firms structural characteristics and is therefore endogenous to a series of factors.

The innovation literature has a long tradition in the analysis of the features distinguishing firms involved in R&D and IP production. Early works such as Pakes (1980), Bound et al. (1982) and Acs and Audretsch (1988) show that innovators are influenced by their patent system, as well as by their industry structure. More recently, the attention has shifted on the relationship between productivity and innovation, and models drawing from the literature on trade and heterogeneous firms have been used to explain the entry of firms into innovative activities. Studies have shown that firms who patent are generally large, highly productive, intensive in research and development, involved in international trade and unaffected by major financial frictions (Peeters and van Pottelsberghe, 2006, Hall and Lerner, 2009, Atkeson, Andrew & Ariel Toms Burstein, 2010 and Gorodnichenko & Schnitzer, 20013). These findings are key to our analysis, as they support the argument that among our control group there are affiliates that will never consider or be able to afford the costs needed to produce or acquire intellectual property. As this implies self-selection of firms into the group of patent owners, not accounting for the absence of random treatment assignment would bias our estimates of the effects of the introduction of an IP box regime. To achieve balance between the treated and control group, we proceed with implementing a matching procedure of controlled to treated affiliates.

We proceed with the *coarsened exact matching* (CEM) based on the affiliates structural characteristics, such as ownership structure (domestic vs multinational), country of incorporation, industrial sector, and historical size and performance. Exact matching would be problematic in our application, as we intend to account for multiple characteristics of the observed subsidiaries,

and this would produce very few matches. On the other hand, propensity score matching (PSM) would be impractical, as we intent to match affiliates within country and industrial sector. By these means, CEM constitutes a valuable alternative, as it belongs to the class of matching methods called monotonic imbalance bounding (MIB) ( Blackwell et al., 2009, and Iacus et al., 2012). This method bounds the maximum imbalance in some features of the empirical distributions, in our case through coarsening on the ex-ante chosen characteristics. The main advantage of this approach stands in the fact that increasing balance on one variable cannot increase imbalance on another (this can happen in PSM). To show that our results are not qualitatively affected by the choice of matching method, we show, in an extension to our analysis, results from a full unmatched sample estimation, as well as results from a sample matched using propensity score.

To reduce the imbalance in the pre-treatment variables, we coarsened on firm-specific characteristics that proxy for the type of business led by the affiliate, its performance and its R&D intensity. We match affiliates on their ownership structure, country of establishment and sector of activity (in 2 digit NACE code), and coarsen them according to their age in the year 2000 and financial performance. We collect affiliate specific averages over the 1996-2006 decade for performance indicators such as size, profit margin and intangible to total asset ratio.[13] The volume of sales is used as a proxy for size, and the ratio of pre-tax profit to sales as a proxy of operating profit margin. Finally, we collect information on the number of patents owned by minority shareholders, as registered before the year 2000. Before the matching, we measure global imbalance through the $\mathcal{L}$ statistic introduced by Iacus et al. (2012), based on the difference between the multidimensional histogram of the chosen pre-treatment characteristics. While $\mathcal{L} = 1$ indicates complete imbalance, and $\mathcal{L} = 0$ perfect balance, the value computed on the full sample is only used as a reference point to the value obtained after the matching is completed.

Table 6 reports the results from the CEM based on the above described pre-treatment variables. The first and fourth column report the $\mathcal{L}$, as computed for each single variable, before and after the matching. The second and fifth column report the difference in means between treated and control group, also before and after the matching. Our one-to-one matching solution resulted in a reduction of the overal $\mathcal{L}$ statistic from 0.9856 to 0.6350. From the full sample of 14,686 treated and 75,976 control affiliates, this methodology allows us to select 14,266 one-to-one matches (see Table 7). Comparing columns three and six from Table 6, it is evident that the matched sample achieves increased balance in all pre-treatment covariates. As indicated from the results in columns 6, after matching we do not find a statistically significant difference in

[13]Taking the ten-years average guarantees independence from the business cycle.

the means of the treated and matched control group. Figure 1 compares the evolution of yearly pre-tax profit, EBIT and Net Sales during the period 2007-2013, normalized around the year of introduction of the IP box regime. For both the multinational and domestic samples, it is clear that treated affiliates are large, and do not share a common trend with the control affiliates. Figure 2 replicates the same figure for the CEM-matched sample. The matching procedure clearly eliminates from the sample the largest affiliates of multinational conglomerates. We can see that matched affiliates on average report lower pre-tax profit, EBIT and sales. It also becomes evident that affiliates in the two matched groups (domestic and multinational) follow a similar trend until around the introduction of the IP box. Later, we observe that pre-tax Profit and EBIT of multinational affiliates gradually increases, compared to that of control affiliates. We do not find much difference for the domestic affiliates. Regarding Net Sales, it seems that an increase for multinational affiliates occurs only later on in the sample, starting from about four years after the introduction of the IP box.

# 7 Results

## 7.1 Baseline DDD Model

We start the analysis with a simple linear panel model, to estimate the correlation between pre-tax profit, fixed assets, cost of employees, and financial leverage, all measured at the unconsolidated level. Table 8 presents these preliminary results, with use of the full sample in columns [1] and [2], and a restriction to the sub-sample of affiliates of multinational conglomerates in columns [3] to [6]. Regarding the full sample estimates, we distinguish between unmatched and matched full samples, in column [1] and [2] respectively. We then show estimates for the sub-sample of MNE affiliates, because this allows us to augment the model with the tax variables that account for pre-existing profit shifting incentives to the multinational conglomerates. All specifications additionally include treatment year dummies and year-industry dummies.[14]

Results in columns [1] and [2] of Table 8 show that, despite the substantial difference in sample size, the correlation between pre-tax profit and the inputs of production is virtually unaltered over the different samples. The sub-sample results in columns [3] to [6], instead, include affiliate-specific, time-variant tax measures explained in section 5. This set-up follows the well-established Hines-Rines (1994) approach which is still widely used to identify profit shifting behavior of multinational firms. We expect the coefficient for the tax measure to capture the

[14]We also estimate a version of the model that includes affiliate-country-year fixed effects and majority shareholder-country-year fixed effects. The results from these richer specifications do not change with respect to our other results. In our main analysis, we choose to exclude these sets of fixed effects for two reasons. First, the restriction of having only affiliates whose ownership structure has not changed over time (between domestic and multinational status), limits the within affiliate time-variability of the shareholder country-year pairs. Second, the inclusion of country-year fixed effects drains the effects of the tax variables included in the analysis (and crucial for identifying the effects of counding tax incentives, see Table 11).

size of the profit shifting incentives faced by the conglomerate the affiliate is linked to, which is independent and pre-existing with respect to the introduction of any IP box. In the first two specifications, we use the tax differential between the tax rate of the affiliate in country $i$ and the headquarter in the parent country, column [3], or between the affiliate in country $i$ and the affiliate facing the lowest tax rate in the conglomerate, column [4]. In the last two specifications, we use indicator variables that equal one if the affiliate in country $i$ faces a lower tax rate than the headquarter in the parent country, column [5], or if the affiliate faces the lowest tax rate within the entire conglomerate, column [6]. In line with the existing literature, we find that higher pre-tax profit is associated with those affiliates, facing a local tax rate lower than the one of their parents. In detail, our results suggest semi-elasticities of around 0.004. That is, a reduction of 10 percentage points in the tax differential between the country of the affiliate and the parent country increases pre-tax profits of the affiliate by around 0.04%. Additionally, we find that affiliates with a lower tax rate than their foreign majority shareholder (parent) report on average a 6.3% higher pre-tax profit, than affiliates with higher rates than their parents. Similarly, subsidiaries facing the lowest tax rate of the entire conglomerate report on average a 5.8% higher pre-tax profit than all other subsidiaries. The results of the last two columns compare in size with the results found in the literature using panel affiliate level data (see Dharmapala, 2014, for a discussion of the existing evidence on the size of tax semi-elasticity).

With Table 9, we move on to the analysis of our DDD model results, estimated following equation 3. As explained in section 6, our baseline treatment definition - on which the matching is based - remains that of an affiliate that has "low-cost" of accessing the preferential tax treatment granted after the introduction of an IP-box. These affiliates are identified as those that owned patents directly, or through their majority shareholder, before the year 2000. The baseline DDD results are presented as follows. Column [1] of Table 9 shows a simple homogeneous treatment effect; column [2] allows for the treatment effect to differ among affiliates of Domestic and Multinational conglomerates; column [3] augments the model with the control variables used in our profit shifting equation (same as in Table 8); columns [4] and [5] re-estimate these specifications using as dependent variables EBIT and Net Sales respectively, instead of pre-tax profit. In line with our hypothesis, we find that those affiliates who had historical record of patent ownership (dated as before the year 2000), column [1], report 4,7% higher pre-tax profit after the introduction of the patent box compared to similar affiliates, who did not own any patent by the year 2000. This result is significant, but leaves some room for doubt that the effect of interest is unambiguously identified. In fact, the accumulation of intellectual property and the related innovation activity conducted over the years can enhance productivity and prof-

itability of the treated affiliates, which could explain higher reported pre-tax profits. To derive a conclusion on the profit shifting effect of IP-Boxes, we need to disentangle the productivity from the tax incentive channel.

To insure identification of the effect of interest, we extend the specification of column [1], by allowing the effect to vary across multinational and domestic affiliates. We conjecture that the estimated effect for treated domestic affiliates is entirely due to productivity enhancements accumulated over the years since the historical creation of patents. Affiliates who have owned patents for a long number of years have a comparative advantage with respect to matched affiliates who have not owned any patents during the same time. This difference in productivity is reflected in the higher *pre-tax* profit of treated domestic affiliates. Treated multinational affiliates are able to benefit from similar productivity enhancements, but in addition they can also benefit from shifting profit into the IP-Box country through royalty payments in favor of the treated affiliate.[15] The results reported in column [2] confirm our hypothesis. We find that, in the case of domestic conglomerates, pre-tax profit after the introduction of an IP-box is 4% higher for treated than for control affiliates. In contrast, for multinational conglomerates, the post-treatment difference among treated and control affiliates is 9 percentage points higher. Introducing the controls for the profit shifting equation, as estimated with the Hines and Rice approach (column [3]) , reduces the absolute magnitude of the two treatment effects, and brings the difference between the multinational and the domestic treated affiliates down to 5 percentage points. We will show that this changes are due to confounding tax incentives, which are only accounted for with the inclusion of the control variables. We interpret the difference between the magnitude of the effect among the domestic and multinational affiliates as the size of the profit shifting effect of the introduction of IP-boxes.

In column [4] we replace the dependent variable with logged EBIT (Earnings before Interests and Taxes), which delivers an even larger effect of the introduction of the IP-box. We do find that the difference in the change of EBIT for multinational affiliates is now 7.4 percentage points higher than the difference in the change of EBIT for domestic affiliates. This result further validates hypothesis that the difference among the effect for treated domestic and multinational firms captures the profit shifting incentives associated to the introduction of IP-Boxes. In fact, we expect higher multinational treatment effects on EBIT, due to the incentive of multinational affiliates to redirect shifted profits back to low tax countries through internal debt financing, which generates higher interest before tax. Interest payments, which are accounted for in the pre-Tax Profit measure, reduce the effect of the IP-box introduction, compared to what found

[15]The limit of our specification is that if multinational conglomerate experience higher productivity enhancement of domestic conglomerate, then our estimates would represent the upper bound of the actual profit shifting effect of the introduction of the IP Box.

for the EBIT measure.

To expand on the conjecture that the overall IP-Box treatment effect is the sum of the productivity enhancement and of the newly created profit shifting channel, we proceed with estimating our model on logged Net Sales (Column [5]). Using sales as a dependent variable allows us to test whether the observed post-treatment increase in pre-tax profit translates into real economic activity, as measured by the total volume of sales from goods and services. Such an outcome is expected in case the introduction of the IP-box translates in higher productivity of treated affiliates. However, our findings show that this is not the case, and that for neither domestic or multinational treated affiliates the introduction of IP-Boxes lead to higher sales volumes, compared to affiliates in the control group.

Finally, we proceed with an investigation of the dynamics of the treatment effect by means of a generalized DDD model, which allows for the treatment to change over time. Understanding how the effect of the introduction of IP-Boxes evolves over time is fundamental for our identification strategy. To expand on this, while we conjecture that the introduction of IP-Boxes impacts on both the affiliate productivity and its profit shifting incentives, we expect the timing of these effects to be very different. Specifically, we expect productivity effects to appear in the long run, once investment and R&D costs of patent developing have diluted, but we expect profit shifting effects to appear almost immediately after the introduction of the IP-Box. Table 10 shows the results of the generalized DDD model. The model reported in column [1], which mirrors the specification from column [3] of Table 9, suggests that treated multinational affiliates benefit from an initial effect of 7% increase of pre-tax profit, which subsequently doubles from year one to year two after the treatment, and again in the long-term to year 3, 4 and 5. In contrast, domestic affiliates do not show any highly significant effect on pre-tax profits within the first two years after the treatment. After year three, we find an effect equal to 5%, closer in size to what was found in the baseline specification. This pattern is in line with the conjecture that the results for the group of domestic affiliates predominantly capture the productivity effect of the introduction of IP-Boxes, whereas the results for the group of multinational affiliates additionally capture the effect emerging from the increased profit shifting incentives. The specification in column [2] simply replicates the exercise, while also controlling for pre-treatment effects. This is important because in more than one instance, IP-box regimes were pre-announced, or introduced in neighboring countries. Nevertheless, we find no evidence of significant pre-treatment.

### 7.2 IP-Boxes and Confounding Tax Incentives

Our baseline analysis shows that IP-boxes generate a significant profit shifting incentive for affiliates of Multinational conglomerates. We further intend to establish whether the introduction of IP-boxes has the effect of altering the tax-advantage associated with being located in a specific country. In a scenario where countries compete over corporate tax rates to attract foreign capital, a patent box could be seen as an instrument implemented by high-tax countries to select firms with high productivity and attract them through a preferential tax treatment of IP income, a so-called "cherry-picking" policy. Then it becomes relevant to establish whether conglomerates that used a given profit shifting channel, like income shifting into low tax countries or tax heavens, would alter their strategy once the IP-box is introduced. Take a multinational where the shareholder owns two affiliates: one in a tax heaven and one in a high-tax European country. With the IP-box, the European affiliate represents a new profit shifting opportunity for its parent, which has to decide whether to move their profits away from the tax heaven and into IP royalty payments in favor of the European affiliate, or whether to keep the status quo. If profit shifting channels are substitute, then we would expect no significant change in reported pre-Tax Profit (or EBIT) of affiliates who already benefit from a preferential tax treatment, due to their location in a (relatively) low tax country.

Table 11 augments the baseline DDD specification (column [3] Table 9) with interactions of variables that proxy for confounding tax incentives. Column [1] of Table 11 allows for the effect on treated multinational affiliates to vary, according to whether the affiliate is located in a country with a lower tax rate than the country of its majority shareholders (parent country). Column [2] allows for the effect on treated multinational affiliates to vary, according to whether the affiliate is located in a country with the minimum tax rate faced at the conglomerate level. Finally Column [3] allows for the effect on treated multinational affiliates to vary, according to whether the affiliate is linked to any (majority or minority) shareholder located in a tax haven. Columns [4] to [6] repeat the exercise, after substituting pre-Tax Profit with EBIT, as the dependent variable.

The results show that confounding tax incentives are fundamental in identifying the effect of the introduction of IP-Boxes for multinational affiliates. While the results for treated domestic affiliates are invariant, with respect to previous findings, the estimates show that multinational affiliates located in high tax countries report larger effects than multinational affiliates located in low tax countries, all compared to the control group. We find that, after the introduction of the IP-Box, multinational affiliates facing a larger tax rate than their parent company report 13% higher pre-tax profit than the matched control affiliates, and multinational affiliates facing a tax rate higher than the minimum tax rate within the conglomerate report 12% higher pre-tax

profit than the matched control affiliates. The effects are smaller for multinational affiliates who already benefit from comparative tax advantages, but still significant. Regarding tax havens, we do find that the IP-box introduction yield a 11% effect for multinational affiliates that are not linked to a tax haven, whereas the effect is negative but insignificant for the multinational affiliates linked to a tax haven.

Estimating this specification on the logged EBIT, instead of the logged pre-tax profit, allows us to extend our interpretation. As previously mentioned, EBIT excludes interest payments, which are generally boosted in case of affiliates located in high-tax countries and involved in intra-firm debt shifting. Once again, we expect to find that the coefficient for the logged EBIT specification are larger than those for the pre-tax profit specification. Results in columns [4] to [6] of Table 11 are consistent with these considerations.

Table 12 presents results from specifications that investigate further the role of links to tax havens. In particular, we allow for the treatment effect of multinational affiliates to vary, according to the position of the tax haven in the corporate organizational structure. Specifically, we differentiate between multinational conglomerates that have shareholders located in a tax haven, and those that have one or more subsidiaries located in a tax haven. This distinction becomes relevant if we assume that shareholders ultimately intend to repatriate profits back to the headquarter, as in Dischinger et al. (2014). In this case, the profit shifting of a multinational whose headquarter is already located in a tax haven is not affected by the introduction of a new tax incentive, such as the IP-Box. Instead, the profit shifting of a multinational that has been using a tax haven subsidiary to shift profits might be affected by the opportunity of repatriating profits toward the high tax country through the IP-Box. The reason is that in the latter case concealment costs might be considerably reduced if profits are shifted from the tax haven subsidiary and into the high tax country. Our results show that treated multinational affiliates linked to shareholders located in a tax haven report no effect after the introduction of the IP-Box (Column [1]), whereas treated multinational affiliates linked to a conglomerate that has one or more tax haven subsidiaries report a 12% higher profit, compared to multinational affiliates in the control group. Similar results hold for the specifications where logged EBIT is used as the dependent variable (Columns [4] to [6]). This result is reassuring, particularly because the presence of a tax haven at the subsidiary level can also be interpreted as a way of identifying those multinational affiliates that are most likely involved in some form of profit shifting. The results for the treated domestic affiliates and for the treated multinational affiliate with no tax haven links remain consistent with previous findings.

### 7.3 IP-Box Restrictions and Relevance of the Nexus Approach

The last step of our analysis entails exploiting differences in the type of IP ownership and in the patent box legislation. This approach serves to disentangle the confounding effect that increased innovation activity at the affiliate level could have on the reported pre-Tax Profit (for example, due to increased capital expenses). In Table 13 we depart from a simpler DDD specification with homogeneous effects among domestic and multinational affiliates (columns [1] to [3]), and allow the treatment effect to vary according to whether the treated affiliate i) had been directly involved in the registration of patents (column [1]), ii) is located in a country qualifying acquired patents for the IP-box (column [2]), and iii) is located in a country qualifying pre-existing patents for the IP-box (column [3]). The same three restrictions are then tested on the specification with differential treatment among domestic and multinational affiliates (columns [4], [5] and [6], respectively). We allow the effect of the introduction of the patent box to differ, according to whether the affiliates in the treated group directly owned any of the IPs registered before the year 2000, because being directly involved in the registration of patents makes it more likely for a firm to conduct local R&Ds. In fact, we find that the treated affiliates that directly owned patents in the year 2000 report a negative, though insignificant, effect of the introduction of the IP-Box, compare to control affiliates (columns [1] and [4]). On the contrary, the affiliates that had been selected into the treatment group because of IPs being registered by their foreign majority shareholder before the year 2000, report, after the introduction of patent boxes, a 4% higher profit than the affiliates in the control group. In the case of multinational affiliates this effect is stronger and equal to 12%.

We then look at whether the implementing country qualifies income derived by acquired and pre-existing patents for the preferential IP-box tax treatment. For the homoegenous treatment model, we find that treated affiliates that owned acquired patents report a significantly lower profit than affiliates in the control group (column [2]), whereas we find no effect of the introduction of the IP-box on treated affiliates that can only file for newly created patents (column [3]). When it comes to multinational affiliates specifically, we find no significant effect for the treated affiliates in countries that do not qualify acquired patents (column [5]), and a much smaller significant effect for the affiliates in countries that do not qualify pre-existing patents (column [6]).

These results are relevant from a policy perspective, because they validate the effort done by the OECD. Following the OECD initiative against base erosion and profit shifting (BEPS 2015), a nexus between the cost of the R&D activity required for producing a patent and the qualification of IP royalties for the tax benefit granted by an IP-Box is planned to be introduced in the near future. Despite our results do not constitute a direct test for the solidity of the

nexus approach, we conclude that they suggests that restriction on IP-box legislations can help single out the harmful use of these tax incentives.

### 7.4 Robustness Analysis

We start with testing the external validity of our results. In Table 14 we replicate the estimates of our baseline model (column [1]), and then present results from the same model estimated on two propensity score (PS) matched samples (columns [2] and [3]) and on two unmatched samples (columns [4] and [5]). For the PS matched samples, we choose a similar set up to what we did with the CEM. We estimate the propensity score of multinational and domestic affiliates separately, and then include affiliates country and industry fixed effects. After estimation of the propensity score, we proceed with *within* type (multinational and domestic) one-to-one matching of affiliates. To ensure common support, in column [2] we discard the 5% of the treatment observations at which the propensity score density of the control observations is the lowest, while in column [3] we discard the 1%. For the full unmatched sample, instead, we impose no restriction for the specification in column [4], while we exclude all affiliates that increased their IP ownership between the year 2000 and the year of introduction of the IP boxes for the specification of column [5].

The overall result is one of consistency. The PS-matched samples are very different in composition, compared to the CEM matched sample. The common support restriction leaves us with a smaller total number of affiliates, and an under-representation of the domestic conglomerates. Yet, our results confirm previous findings regarding the larger reported pre-Tax Profit effects on multinational affiliates, compared to domestic affiliates. We do find that treated multinational affiliates report a 10% higher pre-Tax profit after the introduction of IP boxes, compare non treated affiliates. Treated domestic affiliates report instead a 3.8% higher pre-Tax profit after the introduction of IP boxes. This leaves us with a 6% approximate increase of pre-Tax Profit due to profit shifting activity, just 1 percentage point higher than what was estimated with the CEM-matched sample. The results of the full sample are strikingly similar to those of the CEM-matched sample (column [4]). Most importantly, excluding the affiliates that changed their IP holdings after the year 2000 (column [5]) does not affect these results, indicating that our estimates of the profit shifting effects are not due to IP purchases made after the year 2000 and before the introduction of the IP box.

We proceed with testing our results on an alternative treatment definition. In our baseline model, we define an affiliate as treated if we find records of IP ownership before the year 2000, either directly on the affiliate itself or on its majority shareholder. In Table 15 we expand this definition, and include as treated also those affiliates whose minority shareholders owned patents before the year 2000. We call this 2-nd tier IP Ownership. The sample is larger than in

our baseline, summing to a total of 29,422 affiliates, of which 1,669 are treated multinationals and 13,042 are treated domestic. Results are qualitatively similar, but we do find that the size of the effect is smaller than in the baseline sample. For the pre-Tax profit, column [1], we find no effect on treated Domestic affiliates, and a total slightly significant effect of 5% for treated multinational affiliates. For EBIT, column [2], we find that 6 of the percentage points increase in treated multinational affiliates can be attributed to profit shifting activities. For Net Sales, column [3], we find no significant treatment effect. One possible argument for the lower size and significance of these results is that minority shareholders have less power over the profit shifting strategies designed at the conglomerate level, and simply introduce noise in our estimates.

Finally, we estimate our DDD model on an alternative sample, which spans a longer time frame than our baseline sample. We collect data covering the period 2007 and 2015, and include affiliates geographically located in Belgium, France, Spain, the United Kingdom and the Netherlands. Using this longer sample allows us to estimate the effects of the introduction of the UK IP-box, which happened only in 2013, and also to look at longer period effects that extend after five years from the policy introduction. Shortcomings of using this sample are mostly two. First, we cover a period that is between two different phases of the economic cycle, and we cannot fully control for macro-economic confounding factors. Second, we lose a substantial amount of observations through the matching on historical data, because the online ORBIS database does not allow us to track down as many affiliates in the historical balance sheet data as we were able to do with the version used for the baseline sample. So from an initial number of 196,677 affiliates, we are able to keep only 12,638 after the CEM matching. Tables 16 and 17 report the results for this alternative sample. For the simple DDD model, Table 16, once again we find consistency with previous findings. The size of the profit shifting activity counts for just below 4 percentage point of the change in pre-Tax Profit of treated multinational affiliates (column [2]), and for just below 5 percentage points of the change in EBIT. For Net Sales, column [3], we do find that both domestic and multinational treated affiliates now report a small significant change of around 2 percentage points, after the introduction of IP boxes. We believe the longer time frame of this sample allows for the productivity effects reflected in Net Sales to become stronger, something that was not observable in the shorter baseline sample. Also, we find these results reassuring, because they point at a similar size of the productivity effect of IP box on both multinational and domestic affiliates, indicating that our baseline results should not be biased by any structural difference between these two types of firms. For the generalized DDD model, Table 17, we again find confirmation of the different treatment dynamics observed in table 10. Model [1] shows that the pre-Tax Profit of treated multinational affiliates significantly respond to IP-boxes from the second year after their introduction, whereas

the pre-Tax Profit of treated domestic affiliates does so only from the fifth year onwards. When accounting for pre-treatement effects, column [2], we find no effects for multinational affiliates and a barely significant effects for domestic affiliates.

# 8 Conclusion

In this paper we apply a difference-in-difference model to identify the role of European patent box regimes for the innovative activity and profit shifting of European affiliates of foreign MNEs. Our insights are threefold and highly policy relevant. First, we conclude that not the direct pre-ownership of IP at the level of the affiliate induces major profit shifting incentives after the introduction of a patent box regime, but the access to IP within a firm conglomerate, most likely the IP ownership at the level of the foreign majority shareholder. In fact, our estimates show that affiliates selected into the treatment group because of IP being registered by their foreign majority shareholder before the year 2000, report a 12% higher profit than the affiliates in the control group after the introduction of patent box, while multinational affiliates that directly owned patents in the year 2000, seem to be not affected by the introduction of the patent box.

Second, the patent box regime seems to be a particularly suitable instrument for luring internationally mobile profits to those countries, which are not necessarily perceived as low tax countries. We find that, with the introduction of the patent box, the treated multinational affiliates located in countries where the top statutory rate is higher than the one of their parents, report a 12% higher pre-tax profit than the affiliates in the control group. Contrary to that, treated affiliates located in countries where the top statutory rate is lower than the one of their parents report a 7% higher pre-tax profit compared to the affiliates in the control group.

Third, the modified nexus approach (OECD, 2015) endorsed by the OECD and the G20 member countries seems to be a fruitful path to undermine the profit shifting incentives originating from those, broadly defined, patent boxes which also grant a preferential tax treatment to acquired pre-existing IP. We find that affiliates in the treatment group that can file for pre-existing patents report, after the introduction of the patent box, a striking 22% higher profit than the affiliates in the control group.

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# Tables & Figures

Table 1: **European Patent Box Regimes Characteristics**

| | BE | ES | FR* | HU* | IE* | LU | NL |
|---|---|---|---|---|---|---|---|
| Top CIT Rate | 0.330 | 0.280 | 0.333 | 0.190 | 0.125 | 0.292 | 0.250 |
| WT on Royalties | 0.250 | 0.240 | 0.333 | 0.000 | No | No | No |
| Effective Tax rate on IP | 0.660 | 0.112 | 0.150 | 0.950 | 0.025 | 0.058 | 0.050 |
| Base Exempted from CIT | 0.800 | 0.600 | 0.000 | 0.500 | 0.800 | 0.800 | 0.000 |
| Separate Rate on IP | No | No | Yes | No | No | No | Yes |
| IP Box: Base Adjustment | Yes | Yes | No | Yes | Yes | Yes | Yes |
| New Patents | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Existing Patents | No | Yes | Yes | Yes | Yes | No | No |
| Acquired Patents | Yes | No | Yes | Yes | Yes | Yes | Yes |
| Trademarks | No | Yes | No | Yes | Yes | Yes | No |
| Know-How | No | Yes | No | Yes | Yes | Yes | No |
| Development Nexus | Yes | Yes | No | No | No | No | Yes |
| Year | 2008 | 2008 | 2010 | 2012 | 2008 | 2008 | 2010 |

*The table only lists the countries that introduced or majorly reformed their patent box regime in the period 2007-2013. (*) indicates that the country introduced a reform in the year reorted in the last row with amendements to the patent box regime in place.*

Table 2: **Definition of Variables**

| Variable | Definition |
|---|---|
| Pre-Tax Profit | Operating profit + Financial Profit before tax (in logs) |
| EBIT | Earnings Before Interests and Taxes (in logs) |
| Sales | Volume of Net Sales (in logs) |
| Financial leverage | Ratio of total debt to total assets |
| Capital | Volume of fixed assets (in logs) |
| Labour | Total Cost of Employees (in logs) |
| Intangible Assets | Volume of intangible fixed assets (in logs) |
| Profit Margin | (Profit before tax / Operating revenue) * 100 |
| Liquidity Ratio | (Current assets - Stocks) / Current liabilities |
| Industrial Sector | affiliate 2-digit NACE code |
| Number of Patents | Sum of all patents owned by affiliate and shareholders |
| Tax Rates* | Top statutory tax rate on corporate income (between 0 and 1) |

*All financial accounts were originally provided in EUR units, and then converted to 2005 EUR units. Tax Rates are collected from the Worldwide Corporate Tax Guide, Ernst & Young*

Table 3: **Sample Composition**

| Affiliate Type | Treated | Control | Total |
|---|---|---|---|
| Domestic | 12,653 | 69,760 | 82,413 |
| Multinational | 2,033 | 6,216 | 8,249 |

*Table reports the number of treated and control affiliates, by conglomerate group. Affiliate Type depends on the corporate structure of the conglomerate that the European affiliate belongs to. Treatment is defined as the historical (pre-2000) direct and indirect ownership of IP.*

Table 4: **Geographical Distribution of Patent Ownership (pre-2000 & post-PB)**

| Affiliate Country | Domestic Pre-2000 | Domestic Post-PB | Multinational Pre-2000 | Multinational Post-PB | Number of Affiliates |
|---|---|---|---|---|---|
| Spain | 0.111 | 0.096 | 0.197 | 0.239 | 47,284 |
| France | 0.024 | 0.201 | 0.233 | 0.269 | 35,964 |
| Belgium | 0.235 | 0.196 | 0.323 | 0.350 | 6,881 |
| Hungary | 0.216 | 0.199 | 0.396 | 0.422 | 365 |
| Netherlands | 0.034 | 0.065 | 0.172 | 0.282 | 145 |
| Luxembourg | 0.083 | 0.086 | 0.091 | 0.143 | 23 |

*The table shows the geographical distribution of Domestic and Multinational European affiliates linked to IPs registered before the year 2000, against those owned after the the introduction of the PB regime. Patent ownership follows our treatment definition, and includes both patents directly owned by the affiliate, and patents owned by the affiliate's majority shareholder. Total sample size is 90,662 affiliates, of which 82,413 belong to domestic (DOM) and 8,249 belong to multinational (MNE) conglomerates.*

Table 5: **Tax Rates across Treatment and Control Groups (2007-2013 average)**

| Tax Measure | Full Sample | Treated | Control |
|---|---|---|---|
| $\tau_i$ | 32.58 | 32.76 | 32.37 |
| $\tau_p$ | 29.75 | 29.83 | 28.97 |
| $\tau_{min}$ | 27.40 | 27.59 | 27.19 |
| $(\tau_i - \tau_p)$ | 2.83 | 2.94 | 3.39 |
| $(\tau_i - \tau_{min})$ | 4.80 | 5.18 | 5.12 |

*The table reports average tax indexes computed for different samples of affiliates, over the observational period of 2007-2013. Tax indexes are defined as in section 3.2. Samples include: the full sample, the treated, the control and the matched control sample.*

Table 6: **Coarsened Exact Matching**

| | Full Sample (N=90,662) | | | Matched Sample (N=28,532) | | |
|---|---|---|---|---|---|---|
| | $\mathcal{L}$ | Mean Diff. | T-test | $\mathcal{L}$ | Mean Diff. | T-test |
| MNE/Domestic | 0 | 0 | - | 0 | 0 | - |
| Country | 0.091 | -0.096 | - | 0 | 0 | - |
| Industrial Sector | 0.217 | -5.475 | - | 0 | 0 | - |
| Age in year 2000 | 0.157 | 4.246 | 0.000 | 0.009 | -0.0002 | 0.9767 |
| Int. to Total Asset Ratio | 0.033 | -0.007 | 0.000 | 0.051 | -0.0017 | 0.2376 |
| Profit Margin | 0.001 | 624.310 | 0.023 | 0.011 | 0.079 | 0.0789 |
| Log(Sales) | 0.203 | 0.803 | 0.000 | 0.047 | 0.019 | 0.2884 |
| Num. Employees | 0.176 | 36.457 | 0.000 | 0.026 | 0.003 | 0.9992 |
| Number of Indirect Patents | 0.137 | 339.360 | 0.000 | 0.063 | 4.7548 | 0.5665 |

*The matched sample includes 14,266 treated affiliates matched with an equal number of non-treated affiliates. The percentage of affiliates controlled by MNEs is equal to 9.09% in the original sample, and equal to 11.50% in the matched sample. After matching 846 out of 2,348 strata, the overal $\mathcal{L}$ statistic measure is reduced from 0.9856 to 0.6350. The t-statistic in the third and sixth columns reports the result from a two sided test for the equality of means between the treated and untreated group, before and after the matching.*

Table 7: **Matched Sample Composition**

| | Full Sample | | Matched Sample | |
|---|---|---|---|---|
| | Treated | Control | Treated | Control |
| Affiliates of MNEs | 2,033 | 6,216 | 1,642 | 1,642 |
| Affiliates of DOMs | 12,653 | 69,760 | 12,624 | 12,624 |
| Total | 14,683 | 75,976 | 14,266 | 14,266 |

Table 8: **Benchmark Profit Shifting Regression**

| Dep. Variable: | Full Sample | Matched Sample | Parent Tax Differential | Minimum Tax Differential | Parent Tax Dummy | Minimum Tax Dummy |
|---|---|---|---|---|---|---|
| ln(pre-tax Profit) | [1] | [2] | [3] | [4] | [5] | [6] |
| Fixed Assets | 0.0300*** | 0.0215*** | 0.0440*** | 0.0435*** | 0.0442*** | 0.0440*** |
| | (0.0034) | (0.0058) | (0.0080) | (0.0080) | (0.0080) | (0.0080) |
| Cost of Employees | 0.2668*** | 0.2701*** | 0.3352*** | 0.3356*** | 0.3336*** | 0.3339*** |
| | (0.0053) | (0.0095) | (0.0177) | (0.0176) | (0.0176) | (0.0176) |
| Financial Leverage | -0.1982*** | -0.1750*** | -0.2015*** | -0.2011*** | -0.2035*** | -0.2031*** |
| | (0.0067) | (0.0115) | (0.0172) | (0.0172) | (0.0172) | (0.0172) |
| Tax Differential: $\tau_i - \tau_j$ | | | -0.0038* | -0.0032*** | | |
| | | | (0.0021) | (0.0010) | | |
| Tax Dummy: $1[\tau_i < \tau_j]$ | | | | | 0.0626*** | 0.0575*** |
| | | | | | (0.0212) | (0.0202) |
| Treatment Year Dummies | YES | YES | YES | YES | YES | YES |
| Year x Industry Dummies | YES | YES | YES | YES | YES | YES |
| Observations | 409,776 | 131,592 | 37,723 | 37,723 | 37,723 | 37,723 |
| Affiliates | 90,662 | 28,532 | 8,249 | 8,249 | 8,249 | 8,249 |

*Models are estimated using a linear panel model with FE. Samples for columns [1] and [2] include both domestic and multinational affiliates, for the unmatched and matched sample respectively. Sample for columns [3]-[6] includes the full sample of multinational affiliates. For the tax variables, j refers to the parent country in column [3] and [5], and to the country with the smallest tax rate in the conglomerate in column [4] and [6]. Standard Errors in parenthesis:* ***$p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 9: **DDD Model - Baseline Results**

| Dep. Variable: | pre-Tax Profit | | | EBIT | Sales |
|---|---|---|---|---|---|
| | Hom. Treatment | MNE vs DOM | Controls | same as col. [3] | same as col. [3] |
| | [1] | [2] | [3] | [4] | [5] |
| After * Treated | 0.0472*** | | | | |
| | (0.0122) | | | | |
| After * Treated * DOM Affiliate | | 0.0358*** | 0.0346** | 0.0320*** | 0.0055 |
| | | (0.0125) | (0.0141) | (0.0122) | (0.0045) |
| After * Treated * MNE Affiliate | | 0.1335*** | 0.0854*** | 0.1063*** | -0.0028 |
| | | (0.0262) | (0.0287) | (0.0249) | (0.0092) |
| Fixed Assets | | | 0.0219*** | 0.0458*** | 0.0381*** |
| | | | (0.0058) | (0.0051) | (0.0019) |
| Cost of Employees | | | 0.2698*** | 0.2666*** | 0.5448*** |
| | | | (0.0095) | (0.0083) | (0.0030) |
| Financial Leverage | | | -0.1745*** | -0.0327*** | 0.0644*** |
| | | | (0.0115) | (0.0105) | (0.0037) |
| MNE Affiliate in Low Tax Country | | | 0.0535** | 0.0602*** | -0.0043 |
| | | | (0.0249) | (0.0217) | (0.0079) |
| Treatment Year Dummies | YES | YES | YES | YES | YES |
| Year x Industry Dummies | YES | YES | YES | YES | YES |
| Observations | 131,592 | 131,592 | 131,592 | 131,794 | 144,400 |
| Total Number of Affiliates | 28,532 | 28,532 | 28,532 | 28,379 | 27,896 |
| Treated MNE Affiliates | 1,624 | 1,624 | 1,624 | 1,624 | 1,624 |
| Treated DOM Affiliates | 12,624 | 12,624 | 12,624 | 12,624 | 12,624 |

*Models are estimated using a linear panel model with FE. Sample in columns [1] to [5] includes all affiliates matched with CEM. Treatment is defined as owning patents directly, or through the majority shareholder, before the year 2000. Sample in column [6] is the unmatched full sample. Sample in column [7] excludes from the unmatched full samples the 541 affiliates in the control group that created a direct patent between 2000 and the year of IP-Box introduction. Standard Errors in parenthesis:* $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 10: **Generalized DDD**

| Dependent Variable: pre-Tax Profit | Short/Long Term Effects [1] | | Pre and Post Treatment [2] | |
|---|---|---|---|---|
| | MNE | DOM | MNE | DOM |
| Treated x (1 and 2) Years PRE-T | | | 0.0076 | 0.0112 |
| | | | (0.0434) | (0.0223) |
| x Year of Treatment | 0.0694** | 0.0285* | 0.0750* | 0.0368 |
| | (0.0344) | (0.0170) | (0.0472) | (0.0237) |
| x 1 Year POST-T | 0.0687* | 0.0309* | 0.0744 | 0.0392* |
| | (0.0687) | (0.0171) | (0.0453) | (0.0238) |
| x 2 Year POST-T | 0.1250*** | 0.0156 | 0.1306*** | 0.0237 |
| | (0.0366) | (0.0179) | (0.0493) | (0.0244) |
| x (3, 4 and 5) Year POST-T | 0.2570*** | 0.0494*** | 0.2628*** | 0.0579** |
| | (0.0401) | (0.0190) | (0.0527) | (0.0254) |
| Controls | YES | | YES | |
| Treatment Year FE | YES | | YES | |
| Year x Industry FE | YES | | YES | |
| Observations | 139,229 | | 139,229 | |
| Affiliates | 28,532 | | 28,532 | |
| Treated MNE Affiliates | 1,624 | | 1,624 | |
| Treated DOM Affiliates | 12,624 | | 12,624 | |

*Models are estimated using a linear panel model with FE. Sample includes all affiliates matched with CEM. Treatment is defined as owning patents directly, or through the majority shareholder, before the year 2000. Treatment effects are allowed to vary over the post-treatment years (POST-T). Model [2] controls for pre-treatment (PRE-T) effects. Control variables are the same as in col. [3] of Table 9, but are omitted from the table. Standard Errors in parenthesis: ***$p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 11: **Difference in Difference - Confounding Tax Incentives**

| Dependent Variable: | pre-Tax Profit | | | EBIT | | |
|---|---|---|---|---|---|---|
| | Parent Tax [1] | Minimum Tax [2] | Tax Haven [3] | Parent Tax [4] | Minimum Tax [5] | Tax Haven [6] |
| After * Treated * DOM Affiliates | 0.0285** | 0.0285** | 0.0289** | 0.0251** | 0.0255** | 0.0257** |
| | (0.0138) | (0.0138) | (0.0138) | (0.0120) | (0.0120) | (0.0120) |
| After * Treated * MNE Affiliates: | | | | | | |
| in low-tax countries | 0.0912* | 0.1045** | | 0.1463*** | 0.1298*** | |
| | (0.0522) | (0.0464) | | (0.0452) | (0.0401) | |
| in high-tax countries | 0.1306*** | 0.1219*** | | 0.1495*** | 0.1389*** | |
| | (0.0315) | (0.0292) | | (0.0273) | (0.0254) | |
| linked to a Tax Heaven | | | -0.0886 | | | 0.0608 |
| | | | (0.1366) | | | (0.1206) |
| not linked to a Tax Heaven | | | 0.1088*** | | | 0.1317*** |
| | | | (0.0268) | | | (0.0233) |
| Controls | YES | YES | YES | YES | YES | YES |
| Treatment Year FE | YES | YES | YES | YES | YES | YES |
| Year x Industry FE | YES | YES | YES | YES | YES | YES |
| Observations | 139,229 | 139,229 | 139,229 | 144,400 | 144,400 | 144,400 |
| Affiliates | 28,532 | 28,532 | 28,532 | 27,896 | 27,896 | 27,896 |
| Treated MNE Affiliates | 1,624 | 1,624 | 1,624 | 1,624 | 1,624 | 1,624 |
| Treated DOM Affiliates | 12,624 | 12,624 | 12,624 | 12,624 | 12,624 | 12,624 |

*Models are estimated using a linear panel model with FE. Sample includes all affiliates matched with CEM. Treatment is defined as owning patents directly, or through the majority shareholder, before the year 2000. For multinational affiliates, treatment is allowed to vary according to the confounding tax incentives faced by the affiliate conglomerate. Control variables are the same as in col. [3] of Table 9, but are omitted from the table. Standard Errors in parenthesis:* $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 12: **Difference-in-Difference - Role of Tax Havens (TH)**

| Dependent Variable: | pre-Tax Profit | | | EBIT | | |
|---|---|---|---|---|---|---|
| | Shar. in TH [1] | Affiliate in TH [2] | Any in TH [3] | Shar. in TH [4] | Affiliate in TH [5] | Any in TH [6] |
| After * Treated * DOM Affiliate | 0.0289** | 0.0290** | 0.0290** | 0.0257** | 0.0257** | 0.0257** |
| | (0.0138) | (0.0138) | (0.0138) | (0.0120) | (0.0120) | (0.0120) |
| After * Treated * MNE Affiliate | | | | | | |
| linked to Tax Haven | -0.0886 | 0.1170*** | 0.1045*** | 0.0608 | 0.1370*** | 0.1300*** |
| | (0.1366) | (0.0388) | (0.0374) | (0.1206) | (0.0339) | (0.0327) |
| not linked to Tax Haven | 0.1088*** | 0.0966*** | 0.1074*** | 0.1317*** | 0.1293*** | 0.1358*** |
| | (0.0268) | (0.0345) | (0.0354) | (0.0233) | (0.0297) | (0.0305) |
| Controls | YES | YES | YES | YES | YES | YES |
| Treatment Year FE | YES | YES | YES | YES | YES | YES |
| Year x Industry Dummies | YES | YES | YES | YES | YES | YES |
| Observations | 139,229 | 139,229 | 139,229 | 144,400 | 144,400 | 144,400 |
| Affiliates | 28,532 | 28,532 | 28,532 | 28,379 | 28,379 | 28,379 |
| Treated MNE Affiliates | 1,624 | 1,624 | 1,624 | 1,624 | 1,624 | 1,624 |
| Treated DOM Affiliates | 12,624 | 12,624 | 12,624 | 12,624 | 12,624 | 12,624 |

*Models are estimated using a linear panel model with FE. Sample includes all affiliates matched with CEM. Treatment is defined as owning patents directly, or through the majority shareholder, before the year 2000. For multinational affiliates, treatment is allowed to vary according to the type of link the affiliate has to a Tax Heaven. Control variables are the same as in col. [3] of Table 9, but are omitted from the table. Standard Errors in parenthesis:* $***p < 0.01$, $** p < 0.05$, $* p < 0.1$

Table 13: **IP-Box Restrictions**

| | Homogeneous Treatment | | | DOM vs MNE | | |
|---|---|---|---|---|---|---|
| Dependent Variable: pre-Tax Profit | Direct Patents [1] | Acquired Patents [2] | Existing Patents [3] | Direct Patents [4] | Acquired Patents [5] | Existing Patents [6] |
| **After * Treated Affiliates** | | | | | | |
| without direct patents | 0.0435*** | | | | | |
| | (0.0136) | | | | | |
| with direct patents | -0.0120 | | | | | |
| | (0.0358) | | | | | |
| in Unrestricted PB countries | | 0.0715*** | 0.2813*** | | | |
| | | (0.0138) | (0.0340) | | | |
| in Restricted PB countries | | -0.2496*** | 0.0137 | | | |
| | | (0.0339) | (0.0138) | | | |
| **After * DOM Treated Affiliates** | | | | 0.0289** | 0.0290** | 0.0290** |
| | | | | (0.0138) | (0.0138) | (0.0138) |
| **After * MNETreated Affiliates** | | | | | | |
| without direct patents | | | | 0.1180*** | | |
| | | | | (0.0277) | | |
| with direct patents | | | | -0.0094 | | |
| | | | | (0.0874) | | |
| in Unrestricted PB countries | | | | | 0.1220*** | 0.2190*** |
| | | | | | (0.0277) | (0.0624) |
| in Restricted PB countries | | | | | -0.0533 | 0.0865*** |
| | | | | | (0.0871) | (0.0289) |
| Controls | YES | YES | YES | YES | YES | YES |
| Treatment Year FE | YES | YES | YES | YES | YES | YES |
| Year x Industry Dummies | YES | YES | YES | YES | YES | YES |
| Observations | 139,229 | 139,229 | 139,229 | 139,229 | 139,229 | 139,229 |
| Affiliaties | 28,532 | 28,532 | 28,532 | 28,532 | 28,532 | 28,532 |
| Treated MNE Affiliates | 1,624 | 1,624 | 1,624 | 1,624 | 1,624 | 1,624 |
| Treated DOM Affiliates | 12,624 | 12,624 | 12,624 | 12,624 | 12,624 | 12,624 |

*Models are estimated using a linear panel model with FE. Sample includes all affiliates matched with CEM. Treatment is defined as owning patents directly, or through the majority shareholder, before the year 2000. Treatment effect is allowed to vary according to whether the IP box legislation allows to qualify acquired or existing patents. Control variables are the same as in col. [3] of Table 9, but are omitted from the table. Standard Errors in parenthesis: ***$p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 14: **Propensity Score Matching and Full Sample Estimation**

| Dep. Variable: pre-Tax Profit | CEM Matched Sample [1] | PSCore 1 Matched Sample [2] | PSCore 2 Matched Sample [3] | Full Sample [4] | Full Restricted Sample [5] |
|---|---|---|---|---|---|
| After * Treated * DOM Affiliate | 0.0346** | 0.0378** | 0.0380** | 0.0346*** | 0.0344*** |
| | (0.0141) | (0.0161) | (0.0157) | (0.0107) | (0.0107) |
| After * Treated * MNE Affiliate | 0.0854*** | 0.1033*** | 0.1023*** | 0.0755*** | 0.0761*** |
| | (0.0287) | (0.0348) | (0.0345) | (0.0236) | (0.0236) |
| Fixed Assets | 0.0219*** | 0.0330*** | 0.0335*** | 0.0304*** | 0.0304*** |
| | (0.0058) | (0.0077) | (0.0076) | (0.0034) | (0.0034) |
| Cost of Employees | 0.2698*** | 0.3264*** | 0.3271*** | 0.2667*** | 0.2658*** |
| | (0.0095) | (0.0126) | (0.0124) | (0.0053) | (0.0053) |
| Financial Leverage | -0.1745*** | -0.1823*** | -0.1881*** | -0.1978*** | -0.1974*** |
| | (0.0115) | (0.0150) | (0.0148) | (0.0067) | (0.0067) |
| MNE Affiliate in Low Tax Country | 0.0535** | 0.0148 | 0.0141 | 0.0907*** | 0.0886*** |
| | (0.0249) | (0.0304) | (0.0302) | (0.0150) | (0.0151) |
| Treatment Year Dummies | YES | YES | YES | YES | YES |
| Year x Industry Dummies | YES | YES | YES | YES | YES |
| Observations | 131,592 | 84,166 | 86,795 | 409,776 | 407,198 |
| Affiliates | 28,532 | 17,816 | 18,328 | 90,662 | 90,121 |
| Treated MNE Affiliates | 1,642 | 1,003 | 1,009 | 2,033 | ??? |
| Treated DOM Affiliates | 12,624 | 7,905 | 8,155 | 43,298 | ??? |

*Models are estimated using a linear panel model with FE. Samples vary across columns: col. [1] uses the CEM matched sample of Table 9; col.s [2] and [3] use propensity score (PS) matching; col. [4] uses the full unmatched sample; col. [5] uses the full unmatched sample, excluding the affiliates that created new patents between the 2000 and 2007. Standard Errors in parenthesis: ***$p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 15: **Alternative Treatment: Historical 2nd Tier IP Ownership**

| Dependent Variable: | pre-Tax Profit [1] | EBIT [2] | Net Sales [3] |
|---|---|---|---|
| After * Treated * DOM Affiliate | 0.0184 | 0.0236** | -0.0009 |
| | (0.0138) | (0.0119) | (0.0044) |
| After * Treated * MNE Affiliate | 0.0521* | 0.0811*** | -0.0037 |
| | (0.0285) | (0.0247) | (0.0090) |
| Fixed Assets | 0.0186*** | 0.0376*** | 0.0400*** |
| | (0.0056) | (0.0050) | (0.0018) |
| Cost of Employees | 0.2861*** | 0.2753*** | 0.5692*** |
| | (0.0096) | (0.0084) | (0.0030) |
| Financial Leverage | -0.1988*** | -0.0540*** | 0.0646*** |
| | (0.0114) | (0.0104) | (0.0036) |
| MNE Affiliate in Low Tax Country | 0.0737*** | 0.0554*** | -0.0123 |
| | (0.0246) | (0.0213) | (0.0078) |
| Treatment Year Dummies | YES | YES | YES |
| Year x Industry Dummies | YES | YES | YES |
| Observations | 135,887 | 136,162 | 149,007 |
| Affiliates | 29,422 | 29,266 | 28,770 |
| Treated MNE Affiliates | 1,669 | 1,669 | 1,669 |
| Treated DOM Affiliates | 13,042 | 13,042 | 13,042 |

*Models are estimated using a linear panel model with FE. Sample includes all affiliates matched with CEM. Treatment is defined as owning patents directly, through the majority shareholder as well as through any minority shareholders, before the year 2000. Standard Errors in parenthesis: ***$p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 16: **Alternative Sample with Longer Time Span (2007-2015)**

| | MNE vs. DOM [1] | Controls [2] | EBIT [3] | Sales [4] | Full Sample [5] |
|---|---|---|---|---|---|
| After * Treated DOM Affiliates | 0.0370** | 0.0358** | 0.0383** | 0.0179*** | 0.0240* |
| | (0.0179) | (0.0182) | (0.0166) | (0.0065) | (0.0142) |
| After * Treated MNE Affiliates | 0.0824*** | 0.0729*** | 0.0849*** | 0.0221** | 0.0551*** |
| | (0.0221) | (0.0232) | (0.0211) | (0.0089) | (0.0178) |
| Controls | YES | YES | YES | YES | YES |
| Treatment Year FE | YES | YES | YES | YES | YES |
| Year x Industry Dummies | YES | YES | YES | YES | YES |
| Observations | 74,186 | 67,853 | 67,456 | 62,023 | 861,905 |
| Affiliates | 12,638 | 12,638 | 12,638 | 12,638 | 196,677 |
| Treated MNE Affiliates | 1,428 | 1,428 | 1,428 | 1,428 | 3,404 |
| Treated DOM Affiliates | 4,891 | 4,891 | 4,891 | 4,891 | 54,639 |

*Models are estimated using a linear panel model with FE. Sample includes all affiliates matched with CEM. Treatment is defined as owning patents directly, or through the majority shareholder, before the year 2000. The sample span the period 2007-2015, and includes affiliates located in Belgium, France, Spain, United Kingdom and the Netherlands. Control variables are the same as in col. [3] of Table 9, but are omitted from the table. Standard Errors in parenthesis:* $***p < 0.01$, $** p < 0.05$, $* p < 0.1$

Table 17: **Alternative Sample with Longer Time Span (2007-2015) - Generalized DDD Model**

| Dependent Variable: pre-Tax Profit | Short/Long Term Effects [1] | | Pre and Post Treatment [2] | |
|---|---|---|---|---|
| | MNE | DOM | MNE | DOM |
| Treated x (1 and 2) Years PRE-T | | | -0.0063 | 0.0473* |
| | | | (0.0285) | (0.0255) |
| x Year of Treatment | 0.0448 | 0.0395 | 0.0406 | 0.0716** |
| | (0.0324) | (0.0255) | (0.0374) | (0.0308) |
| x 1 Year POST-T | 0.0484 | 0.0267 | 0.0441 | 0.0587* |
| | (0.0328) | (0.0261) | (0.0378) | (0.0313) |
| x 2 Year POST-T | 0.0758** | -0.0081 | 0.0717* | 0.0238 |
| | (0.0332) | (0.0270) | (0.0380) | (0.0317) |
| x 3 Year POST-T | 0.1825*** | 0.0338 | 0.1772*** | 0.0680* |
| | (0.0448) | (0.0353) | (0.0494) | (0.0398) |
| x 4 Year POST-T | 0.1452*** | 0.0561 | 0.1401*** | 0.0902** |
| | (0.0455) | (0.0364) | (0.0499) | (0.0410) |
| x 5+ Year POST-T | 0.0851* | 0.1917*** | 0.0799 | 0.2255*** |
| | (0.0475) | (0.0392) | (0.0518) | (0.0432) |
| Treatment Year FE | YES | | YES | |
| Year x Industry FE | YES | | YES | |
| Observations | 67,853 | | 67,853 | |
| Affiliaties | 12,638 | | 12,638 | |
| Treated MNE Affiliates | 1,428 | | 1,428 | |
| Treated DOM Affiliates | 4,891 | | 4,891 | |

Figure 1: **Full Sample, before Matching**
(N = 90,662 - figures in Mil. EUR)

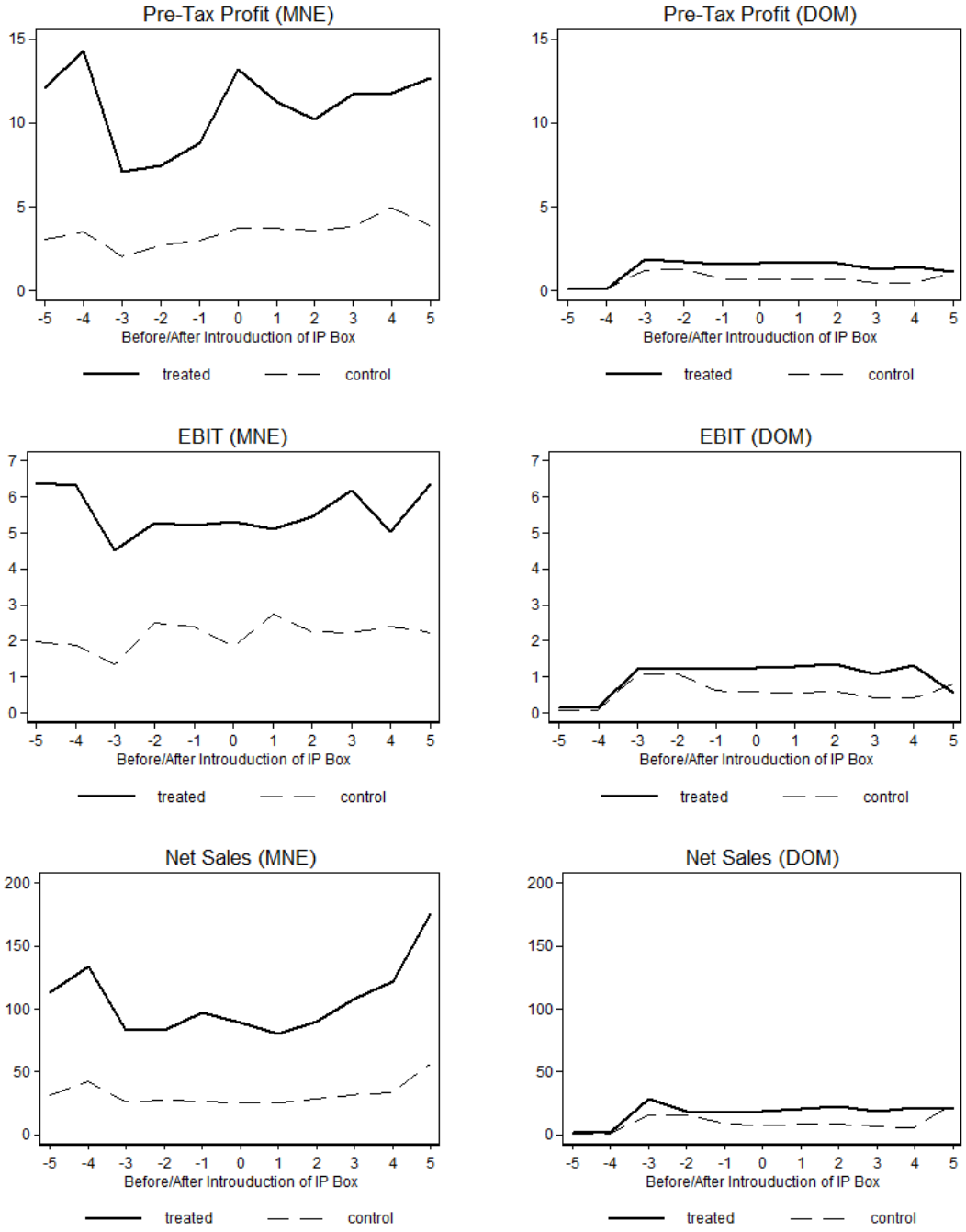

Figure 2: **CEM Matched Sample**
(N = 28,532 - figures in Mil. EUR)