Corporate Tax Avoidance and IP Boxes

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Abstract. We examine if tax avoidance opportunities at the firm level erode the effect of targeted tax incentives introduced by the State. Using the unique setting of the Belgian IP box regime as a quasi-experiment, we examine the effect of patent boxes on firms' corporate effective tax rates (ETRs) and patenting activities. We find that patent-owning firms experience a 3.0 % lower ETR after the introduction of the IP box regime than their non-patent owning counterparts. This translates into a loss of tax revenue of appr. 295 Mio. U.S. dollars or a 2.3 % reduction in corporate tax revenue. Additionally we find evidence that the reduction in ETR is especially pronounced for multinational enterprises without an incentive to shift income out of the country. In contrast, multinationals with an incentive to shift income out of the country do not experience significant decreases in ETR. We also find evidence that firms on average do not increase their patent applications or patent grants. However, especially multinationals experience a significant increase in the patent stock after the introduction of the patent box regime. Overall, we provide first evidence that corporate tax avoidance opportunities mute the effect of targeted tax incentives and may derail important tax policy tools.

JEL Classification: H21, H25

Keywords: IP boxes; tax avoidance; income shifting

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1 Introduction

Intellectual property (IP) or patent box regimes have become a widespread tool for countries to increase investment in innovation and attract or retain R&D activities. IP box regimes grant a significant tax rate cut on certain eligible IP income to decrease the cost of capital associated with R&D activities. As of today, 17 countries introduced special tax regimes cutting the tax rate on certain IP income. Therefore, IP boxes constitute a major tax policy tool to increase and incentivize investment in corporate R&D that suffers from negative externalities (Evers et al 2015). Recent research, however, suggests that especially multinational enterprises have access to an array of different tools to avoid corporate taxation in the first place. In contrast to domestic firms, multinationals locate highly mobile intangible assets in low-tax countries (Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012), shift income across countries Huizinga and Laeven (2008) or setup tax-optimized group structures (Weichenrieder and Mintz, 2008). Thus, multinationals engage in long-run corporate tax avoidance (Dyreng, Hanlon, and Maydew, 2008) to decrease their GAAP or Cash effective tax rates (ETR).

Against this backdrop, we ask the question whether or not corporate tax avoidance incentives erode the effectiveness of targeted tax incentives introduced by the State. Specifically, we analyse the introduction of the Belgian patent box regime on firms effective tax rate (tax benefit) dependent on whether the firm is a domestic firm, a multinational with incentives to shift income out of the country or a multinational without incentives to shift income out of the country. Besides assessing the tax benefit conferred on firms by the patent box regime, we assess whether or not firms then also increase patenting activities as a response. This question is of high importance as tax incentives are a major tax policy tool for States to offset negative externalities caused by R&D investments and to boost

socially desirable R&D. If corporate tax avoidance erodes the effectiveness of R&D tax incentives, countries may loose a major tool in their tax policy toolbox to steer investment.

Assessing the effects of patent boxes on firms effective tax rates and patenting activities is challenging for the following reasons. Comparing firms effective tax rates and patenting activities before and after the introduction of the patent box across all firms might just capture a spurious correlation or time trend that is not necessarily attributable to the patent box regime itself. Furthermore, limiting the analysis to firms that actually benefit from the patent box regime is difficult. Firms usually do not disclose whether they participate in the paten box or not and therefore escape direct observation. Additionally, most patent boxes stretch their scope of eligible IP income both from observable IP such as patents to non-observable IP such as trade secrets limiting a clear-cut identification of firms that hold these assets and fall within the scope of the regime. We therefore limit our analysis to the Belgian patent box regime as it provides for the following unique characteristics we can use as a quasi-experiment. First, the tax rate cut was large providing sufficient variation in tax benefits. The tax rate was cut from 33.99 % to 6.8 %. Secondly and more importantly, the Belgian patent box limits its benefits to patent income only. Firms that hold patents are observable in data. Therefore we can indirectly identify eligible firms that hold patents after the introduction of the patent box regime without running a risk to omit firms that benefit from the regime, but hold non-disclosed eligible assets such as trade secrets. The Belgian patent box therefore provides for the best institutional setting to indirectly identify firms that benefit from the patent box.

Using the Belgian patent box regime as a unique setting that provides for a quasi-experiment we apply a difference-in-difference estimation and find the following results. First, the introduction of the patent box regime confers a tax benefit on firms, but has no observable effect on firms patenting activities proxied by patent applications and patent

grants. Specifically, firms that hold eligible patents in the reform period decrease their Cash effective tax rate by about 2.8 % more relative to firms that do not hold eligible patents. This effect is even more pronounced for multinationals that decrease their Cash effective tax rate by about 9.3 % more relative to multinationals that do not hold patents in the reform period. Interestingly, the large reduction in Cash ETR is limited to multinationals without an incentive to shift income out of the country. The picture completely reverses if we look at multinationals that have an income shifting incentive. Patent-owning firms with an income shifting incentive experience no significant reduction in ETR after the introduction of the patent box regime. We interpret these results as evidence that corporate tax avoidance incentives have mediating effects on the effectiveness of tax incentives. Looking at patenting activities of firms we find no increase in patent applications and patent grants. However, especially multinationals increase their patent stock after the introduction of the patent box regime. The large decrease in Cash ETR with a simultaneous increase in patent stock suggests that especially multinationals take specific advantage of the Belgian regime and shift patents into Belgium. Overall, our results suggest that the patent box regime offers windfall gains for domestic firms that do not increase their patent applications and do not receive significantly more patent grants after the introduction of the patent box. Especially multinational firms without incentives to shift income take advantage of the patent box regime. Overall, we estimate a yearly loss in tax revenue of about 295 Mio. U.S. dollars attributable to the patent box regime.

Our study makes two contributions to the existing literature. First, we extend the literature by providing evidence that the impact of output-based tax incentives on R&D activity crucially depends on tax avoidance incentives available to the firm. While there has been extensive research on determinants of firms' tax avoidance (Rego, 2003; Dyreng, Hanlon, and Maydew, 2008) and income shifting (Klassen and Laplante, 2012; Chen,

De Simone, Hanlon, and Lester, 2016) there is surprisingly not much research on the interaction between tax avoidance and tax incentives. Our results suggest that tax avoidance incentives play an important role for the effectiveness of output-based tax incentives and hence should be taken into account when designing IP boxes. Second, we add to the growing body of literature that investigates the impact of IP boxes on R&D activities (Evers, Miller, and Spengel, 2015; Alstadsaeter, Barrios, Nicodeme, Skonieczna, and Vezzani, 2015; Chen, De Simone, Hanlon, and Lester, 2016). While previous studies focus on R&D-intensive firms or overall economic effects, we investigate cross-sectional differences in the effects of IP boxes. We contribute to this strand of literature by showing differing effects of IP boxes on ETRs and patenting activities of domestic and multinational firms. Our findings provide implications on the design of output-based R&D tax incentives, complementing literature on the design of R&D tax credits (Bloom, Griffith, and Van Reenen, 2002; Klemm, 2012). Moreover, our results suggest that IP boxes can be used to provide a tool to domestic firms that enables them to close the effective tax rates gap to MNEs and to steer overall R&D activities.

This paper proceeds as follows: in section 2 we develop our hypotheses, in section 3 we present detailed institutional information on the Belgian patent box regime. We present our research design in section 4 and explain the data and sample used in section 5 to more extent. Section 6 presents results and section 7 concludes.

2 Hypothesis development

2.1 The effect of IP box regimes on firms' ETR and patenting activities

Tax incentives are important policy tools to offset negative externalities of corporate R&D investments. Corporate R&D investments feature characteristics that evoke negative externalities pushing corporate R&D investments below socially optimal levels (Romer,

1990). Negative externalities arise from public-good characteristics of innovation. Ideas and inventions eventually spill over to competitors with exchanging high-skilled labor, unprotectable business secrets or leaking internal information systems. The public good nature of innovation therefore prevents firms from fully reaping all benefits of their R&D investments reducing firms' incentives to invest in R&D. Imperfect appropriation of innovation also prevents firms from passing on potentially value-relevant information on their R&D investments to the capital market (Hall, 2010). Disclosing value-relevant information to reduce information asymmetries firms run a risk to lose lead in the patent race. Facing large information asymmetries, however, investors find themselves in a market for lemons (Akerlof, 1970) in which they cannot distinguish between potentially good and bad R&D projects. Investors therefore demand a lemons premium increasing firms cost of capital for R&D. Imperfect appropriation and higher costs of capital therefore drive a wedge between tangible and R&D investment leading to underinvestment in corporate R&D.

Tax incentives aim at closing the gap between tangible and intangible investments by granting tax benefits to R&D investments. Tax benefits can either be directed at the investment stage (input incentives such as tax credits) or targeted at the return stage of the investment (output incentives such as patent or IP box regimes). Whereas tax credits apply unconditionally and grant a tax benefit for each (additional) dollar of R&D spent, patent boxes limit their benefits to successfully developed IP only. Despite of limiting their tax benefits to developed intellectually property, IP box regimes substantially decrease the (marginal) effective tax rate on R&D investments. The substantial tax benefit of IP boxes is not only triggered by a substantial tax rate cut, but also depends on the specific design of the IP box and its scope. Whereas, for example, the Netherlands stretch the scope of the IP box regime from patents to trade secrets or designs, Belgium on the other hand limits its patent box to patent income only. Besides the scope of eligible income, IP boxes also differ

in other characteristics such as the (non-)eligibility of existing IP or notional royalties. Evers, Miller, and Spengel (2015) explicitly take into account both the preferential tax rate, but also differences in the tax base and show that the marginal tax rate of IP boxes across Europe are considerably lower than statutory tax rates. Alstadsaeter, Barrios, Nicodeme, Skonieczna, and Vezzani (2015) show that particularly IP boxes with a broad scope of eligible IP income attract high-value patents. So far, there is no empirical evidence on how patent boxes affect firms' effective tax rate.

If, however, patent box regimes are effective policy tools we should first observe decreasing GAAP and cash effective tax rates of firms that benefit from the IP box regime. As IP boxes restrict their benefits to income-generating IP only, we expect IP boxes to have an immediate effect on firms' effective tax rates. The tax benefit of an IP box, as proxied by a lower GAAP or cash ETR after the introduction, is therefore increasing in the firm's share of IP box income in total taxable income. Before we focus our attention on curbing effects of corporate tax avoidance, we formalize our first hypothesis against we measure curbing effects of tax avoidance incentives:

H1a: *Firms that hold eligible IP decrease their effective tax rate relatively more than firms that do not hold eligible IP after the introduction of a patent box regime.*

To be an effective policy tool patent boxes should not only decrease firms' GAAP or cash ETRs, but also increase patenting activities of firms. Whereas there is long-standing empirical evidence for input-oriented tax incentives, there is only scarce evidence of IP or patent boxes on firms' innovativeness. Prior research on input incentives finds positive effects of R&D tax credits on corporate R&D spending across different countries such as the U.S. (Cordes, 1989; Berger, 1998; Finley, Lusch, and Cook, 2015), Canada (Klassen, Pittman, and Reed, 2004), different OECD countries (Bloom, Griffith, and Van Reenen, 2002), Norway (Cappelen, Raknerud, and Rybalka, 2012), Italy (Carboni, 2011) or the

Netherlands (Lokshin and Mohnen, 2012). In contrast to patent boxes, however, R&D tax credits apply irrespective of the R&D investment's success. The effectiveness of patent boxes, therefore, have long been questioned, also because R&D investments are usually associated with high degrees of risk. Chen, De Simone, Hanlon, and Lester (2016) find for example no evidence that the introduction of patent boxes increase firms' investment. Therefore, we conjecture

H1b: *Firms increase their patenting activities after the introduction of the IP box regime.*

Patent boxes are supposed to increase R&D investment. However, the targeted intangible assets these tax regimes target are highly mobile and usually associated with a high incentive to avoid corporate taxes. Therefore, we discuss potentially curbing effects of corporate tax avoidance on the effectiveness of patent box regimes in the following.

2.2 Curbing effects of tax avoidance on the effectiveness of IP boxes

Patent boxes grant tax incentives to income of intangible assets. Intangible assets, however, provide for significant opportunities to avoid corporate tax. Their high mobility allows especially multinational enterprises to shift intangible assets and associated income across countries. High degrees of private information on the true value of intangibles additionally complicate valuation for taxation by tax authorities. Recent research therefore suggests that especially low-tax countries attract intangible assets such as patents (Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012; Dinkel and Schanz, 2014; Ernst, Richter, and Riedel, 2014) or trademarks (Heckemeyer, Olligs, and Overesch, 2016). Other potential channels of tax avoidance are commonly accessible for larger multinational firms such as income shifting to low-tax countries (Huizinga and Laeven, 2008; Klassen and Laplante, 2012) or setting up cross-country group structures that exploit tax loopholes

(Weichenrieder and Mintz, 2008). Especially MNEs are therefore responsive to tax rate differentials across countries, shift income to and locate intangibles in low tax rate countries to avoid corporate taxes. In contrast to domestic firms multinational enterprises have different tools available to decrease GAAP and cash effective tax rates.

Tax avoidance does not come free of charge, but triggers an array of ancillary costs against potential tax benefits have to be compared. Ancillary costs include both explicit and implicit costs. Firms commit to intra-group transfer prices for goods and services on a long-term basis to avoid potential concerns by tax authorities of frequently adjusted intra-group transfer prices. Shifting intangible assets to and setting up special entities in low-tax countries triggers both explicit costs such as administration costs and implicit costs to adapt to the new group structure. Other costs comprise potential penalties for misconduct, additional interest on subsequent tax payments or double taxation. Recent research provides evidence that firms are sensitive to increasing costs of tax avoidance. Beer and Loeprick (2015) show that profit shifting decreases when countries tighten anti avoidance rules and introduce transfer pricing documentation requirements. Dischinger and Riedel (2011) find that anti avoidance rules mitigate the positive effect of low corporate tax rates on firms' stock of intangible assets. Dyreng and Markle (2016) find that financially constrained U.S. firms shift less income out of the U.S. as the repatriation of income triggers repatriation tax costs and is therefore costly to the firm. Other studies show that corporate tax avoidance is associated with reputational costs (Hanlon and Slemrod, 2009). However, it appears that tax avoidance activities benefit from scale effects as larger firms can spread costs for tax avoidance across larger sales bases. Mills, Erickson, and Maydew (1998) show that tax planning costs decrease in firm size. Setting up tax efficient group structures is therefore an investment to the firm that amortizes over longer periods of time and triggers adjustment costs once the firm deviates from its tax avoidance

strategy. Marginal adjustment costs increase especially for firms that already have a low ETR. Multinational firms therefore not only have a greater toolbox available to engage in tax avoidance, but also benefit from scale effects. We therefore reason that especially multinational firms not only engage in, but commit to tax avoidance in the long run.

The introduction of a patent box regime that cuts the tax rate on pre-defined IP income should therefore constitute only just another tax avoidance tool available for multinational enterprises. In contrast, domestic firms with less opportunities to engage in tax avoidance and smaller scale effects should benefit relatively more from the introduction of a tax rate cut on IP income. Therefore we conjecture

H2a: *Domestic firms with access to the patent box regime, but no tax avoidance incentives decrease their effective tax rates relatively more than subsidiaries of MNEs with access to the patent box regime.*

However, not all subsidiaries of multinationals indeed have tax avoidance incentives available. If, for example, the subsidiary of the multinational enterprise has no incentives to shift income out of the country simply because there are no tax-rate differentials available the subsidiary may as well benefit from the introduction of an IP box regime in the same way as a domestic firm. We therefore break hypothesis 2a further down to the following hypothesis:

H2b: *Subsidiaries of MNEs with access to the patent box, but no income shifting incentives decrease their ETRs relatively more than subsidiaries of MNEs with access to the patent box and income shifting incentives after the introduction of the patent box.*

In line with our first hypothesis H1b on firms' patenting activities, we predict differences in patenting activities between domestic and subsidiaries of multinational firms after the introduction of the patent box regime.

H2c: *Domestic firms increase their patenting activities more strongly than subsidiaries of multinational firms after the introduction of a patent box regime.*

After deriving our hypotheses in a general form, we proceed by providing for a detailed description of the institutional setting in which we conduct our tests.

3 Institutional setting

IP boxes are output-based tax incentives that apply a lower corporate tax rate on IP-related income compared to other sources of business income. A reduced tax rate on IP-related income affects the return side of R&D investments. Hence, firms only benefit from the regime if the R&D investment results in the commercialization of successfully developed IP. This is in contrast to an R&D tax credit, which grants a credit for corresponding R&D expenditures and is independent from the success of the underlying R&D activities (Evers, Miller, and Spengel, 2015).

Although all IP box regimes apply a preferential tax rate on IP-related income, they differ in their preferential tax rates as well as in the eligible IP income (tax base). Malta offers the lowest preferential tax rate at 0% and at the same time the biggest tax rate differential of 35%. In contrast, the Swiss canton of Nidwalden applies an IP box tax rate of 8.8% which is 3.86 percentage points lower than the statutory corporate income tax rate (12.66%). The scope of eligible income ranges from solely patent income (United Kingdom and Belgium) to income associated with a broader array of intangible assets including patents, income of trade secrets, trademarks or domains (e.g. The Netherlands). Evers, Miller, and Spengel (2015) and Alstadsaeter, Barrios, Nicodeme, Skonieczna, and Vezzani (2015) provide a comprehensive overview of differences across IP boxes.

Our study exploits the introduction of an IP box in Belgium in 2008. The Belgian legislator followed two goals when passing the law: (1) increasing domestic R&D activities

to create high value jobs, and (2) preventing erosion of its (mobile) tax base due to its relatively high statutory tax rate of 33.99% (Eynatten, 2008; Eynatten and Brauns, 2010; Evers, Miller, and Spengel, 2015).[1] All firms that are headquartered in Belgium or that have a subsidiary in Belgium are eligible for the IP box.[2] We use this setting for two reasons.

First, the setting allows clean identification of firms that are eligible for the IP box. The Belgian IP box only covers patents. This includes any granted patent worldwide, irrespective of the patent office it is registered in.[3] The requirement of registering patents at patent offices allows us to cleanly identify which Belgian firms are eligible for the regime. In contrast, other regimes include various forms of IP such as brands, trademarks or secretly held know-how. However, public information is not available for most of the other intangibles which makes a clean empirical identification of the potential beneficiaries very difficult.

Second, despite the limited scope, Belgium offers a competitive IP box regime. With an effective statutory tax rate of 6.8%, the Belgian IP box applied in 2008 the second lowest statutory tax rate on intangibles.[4] Technically, the IP box grants a tax allowance of 80% of patent-related earnings. Hence the statutory tax rate for patent-related income is reduced from 33.99% to 6.8%. The reduced corporate tax rate applies to patent-related earnings (royalties or usage rights) paid by another firm to the patent-holder. The underlying patents need to be commercialized after January 1, 2007 and the Belgian firm must fully

[1] Especially the lower statutory tax rates of its neighboring countries Luxembourg (29.63% in 2008) and Netherlands (25.5% in 2008) as well the fact that these two countries also introduced IP boxes are considered as one of the main drivers.

[2] Belgian law also requires a separate research center in order to use the IP box. However, the research center can be also located abroad.

[3] While also Supplementary Protections Certificates (SPC) are allowed, these provide merely an extension of expired patents. Moreover, the Belgian IP box requires a further development of IP when the IP was acquired which is considered to incentivize R&D activities (Evers, Miller, and Spengel, 2015).

[4] Belgium had after Luxembourg the second lowest tax rate on patent income in the EU until 2010, in which Malta and the Netherlands reduced their IP box tax rate to 5% and 0%, respectively.

or partially own the patent (Eynatten, 2008).[5] While the Belgian IP box is limited in its scope the country offers other R&D tax incentives that can lower the effective tax burden of a marginal investment to -1.92% (Evers, Miller, and Spengel, 2015).[6] This can be achieved through a tax credit in the form of an investment deduction that is in place since 2006 (Eynatten, 2008). While this might influence our results, we will conduct in section 6.4 robustness tests to mitigate this concern.

4 Research design

4.1 Identification strategy

We exploit the unique institutional setting of the Belgian IP box regime to overcome several challenges in identifying muting effects of tax avoidance on targeted tax incentives. The main challenge is to identify firms that benefit from a patent box regime. Tax returns are confidential and firms usually do not publicly disclose if they opted for the patent box regime. Thus, beneficiaries of patent box regimes escape our direct observation. Patent box regimes, however, tie their benefits to income derived from certain intangible assets allowing for indirect identification. Firms holding intangible assets, which fall within the scope of the IP box are also potential beneficiaries of the patent box. However, almost all introduced IP boxes apply a broad scope of eligible income including income derived from non-observable intangible assets. Once the scope of the patent box regime stretches from observable IP (e.g. patents) to non-observable IP (e.g. trade secrets), we may omit firms that benefit from the IP box. These limitations restrict our analysis to the Belgian IP box regime that features some favorable conditions to overcome these hurdles.

We try to overcome challenges in identification by using some unique characteristics in

[5] This applies to self-developed and acquired patents. The preferential tax rate is not applicable for potential capital gains.

[6] This calculation is based on a self-developed patent under equity-financing in 2013.

the institutional design of the Belgian patent box regime. The Belgian patent box regime limits the tax benefit to income derived from patents only. Patents are observable in archival data. Thus, we can indirectly identify patent-holding firms in the reform period as potential beneficiaries of the patent box. We assume that eligible firms act rationally and opt in to the patent box regime once they hold patents. Administrative or compliance costs to opt for the patent box should be minimal. Another favorable feature of the Belgian institutional setting is the large tax rate cut. The statutory tax rate was cut from 33.99 % to 6.8 % applicable to patent income offering enough variation in 2008. Given the limitation on patent income and a significant tax rate cut, the Belgian IP box provides for a unique setting to test our hypotheses.

Using the restriction of the Belgian patent box regime on patent income allows us to distinguish between eligible and non-eligible firms based on observable data. We sort firms into "treated" firms and "control firms". "Treated" firms are defined as firms owning patents in the reform period (2008 onwards). "Control" firms are firms not holding any patents in the reform period. We assume that absent the introduction of the patent box regime effective tax rates of treated and control firms would have evolved in the same way (parallel trends assumption). Applying a difference-in-difference estimation we can overcome the drawback of comparing differences in effective tax rates and patenting activities before and after the reform across all firms which might as well capture a spurious correlation or time trends. The Belgian IP box regime offers a suitable quasi-experiment to test our predictions.

4.2 Income shifting incentives

MNEs have income shifting opportunities to countries that provide lower statutory tax rates (Huizinga and Laeven, 2008; Dischinger and Riedel, 2011; McGuire, Omer, and

Wilde, 2014). Since we use data derived from unconsolidated financial statements, we observe profits of a MNE's parent/subsidiary after potential income shifting took place. Hence, the calculated GAAP and cash ETRs might be affected by income shifting incentives. In order to account for this, we follow Huizinga and Laeven (2008) and Markle (2016) and construct an indicator variable that captures the incentive and opportunity to shift income among countries in which the multinational operates. Due to data constraints, however, we can only compute this measure based on the statutory tax rates of the immediate parent and/or subsidiary of the Belgian firm. Hence, we model these income shifting incentives by creating the tax rate differentials between Belgium and the jurisdiction in which the parent and/or subsidiary of the MNE is located in. *Shift* takes the value of 1 if any of the two tax rate differentials results in an incentive to shift income out of Belgium and 0 otherwise. While using only the tax rate differential of the parent and subsidiary might be a concern, the findings of Markle (2016) suggest that shifting involving the parent country is especially relevant for firms in territorial tax systems. Hence, we are confident that we approximate the income shifting incentives for the respective Belgian group entity in a proper way.

4.3 Patenting metrics

In order to measure firms' patenting activities we use metrics derived from the innovation economics literature (Hall, Thoma, and Torrisi, 2007; Hall, Helmers, Rogers, and Sena, 2014). These include patent applications, patent grants, and patent stocks.[7] Patent applications is a widely used proxy for R&D activities that are required to successfully develop an invention. While not every patent application results in a patent that can be commercially exploited, we also use patent grants as a metric (Hall, Thoma, and Torrisi,

[7] While also R&D investments are used in the literature to proxy for R&D activities, our data does not allow us to derive sufficient observations to use this proxy. In addition, R&D expenses do not necessarily proxy for R&D activities (Koh and Reeb, 2015).

2007; Hall, Helmers, Rogers, and Sena, 2014). Granted patents are a commonly used proxy to quantitatively formulate successful R&D activities. In addition, we use patent stock as a metric to proxy for the firm's total number of patents available for commercial exploitation. Patent stock is an aggregated measure of granted patents over the last 20 years but also reflects re-assignments or purchases of patents. The application of this measure allows us to set the overall available patent pool in perspective to current patent applications and grants. Following prior literature (Balsmeier, Fleming, and Manso, 2016), we use the natural logarithm to account for the skewness of the underlying patenting metrics *ln(Patent Applications), ln(Patent Grants), ln(Patent Stock).* Table 1 provides definitions for the respective variables.

4.4 Empirical setup

4.4.1 The effect of the IP box on firms' ETR

To assess the effect of Belgian patent box regime on firms' effective tax rates, we use a difference-in-difference (DD) specification. The DD specification reveals the *additional* change in the effective tax rate of the treatment group relative to the control group after the introduction of the patent box regime. In particular, we estimate the following regression model to test hypothesis 1a and 2a:

$$\begin{aligned} \text{ETR}_{i,t} = \alpha + \beta_1\ \mathit{Reform}_{i,t} + \beta_2\ \mathit{Treat}_{i,t} + \beta_3\ \mathit{Reform}_{i,t} \times \mathit{Treat}_{i,t} \\ + \beta_4\ \mathit{Reform}_{i,t} \times \mathit{Treat}_{i,t} \times \mathit{MNE}_{i,t} + \delta\ \text{X}_{i,t} + \mu_t + \mu_i, \end{aligned} \tag{1}$$

where *ETR* is either GAAP or Cash ETR for firm i in year t. *Reform* is an indicator variable that takes a value one for all years after the introduction of the patent box regime (2008 onwards) and zero otherwise. *Treat* is an indicator variable that takes a value one for firms in the treatment group and zero for firms in the control group. Treated firms

are defined as firms owning at least one patent in the reform period. *MNE* is an indicator variable that takes value one if firm i is held by a foreign shareholder or owns foreign subsidiaries. We estimate the equation for both our matched and full sample. Although our matched sample should account for any differences between our treatment and control group, we additionally include a vector X of variables that control for *Size*, *Leverage*, *Intangibility*, *Return on Assets*, *Capital Intensity* and *Inventory*. Table 1 presents detailed definitions of each covariate and and predicted variables.

Our main coefficients of interest are β_3 and β_4. The coefficient β_3 estimates the *additional* change in the effective tax rate of the treatment group relative to the control group after the introduction of the patent box regime (Hypothesis 1a). If patent-owning firms pay relatively less taxes than non patent-owing firms after the introduction of the patent box regime, coefficient β_3 should be negative. The coefficient β_4 captures the effect of the firm being a multinational or not. If multinational enterprises respond relatively less to the introduction of the patent box regime, we expect β_4 to be positive indicating mediating effects (Hypothesis 2a).

To test whether MNEs with an income shifting incentive respond less to the introduction of the patent box regimes than their counterparts without incentives to shift income (hypothesis 2b), we estimate the following regression in a sub-sample of multinational firms

$$\begin{aligned} \text{ETR}_{i,t} = \alpha + \gamma_1 \, \textit{Reform}_{i,t} + \gamma_2 \, \textit{Treat}_{i,t} + \gamma_3 \, \textit{Reform}_{i,t} \times \textit{Treat}_{i,t} \\ + \gamma_4 \, \textit{Reform}_{i,t} \times \textit{Treat}_{i,t} \times \textit{Shift}_{i,t} + \delta \, \text{X}_{i,t} + \mu_t + \mu_i, \end{aligned} \tag{2}$$

where *Shift* takes value one if the firm is a multinational enterprise with an incentive to shift income out of Belgium and zero otherwise. We expect the coefficient γ_3 to be negative given MNEs respond to the introduction of the patent box regime. The coefficient γ_4 captures

expected mediating effects of MNEs' income shifting incentives on the effectiveness of the patent box regime. If patent-owning Belgian subsidiaries with an incentive to shift income out of the country respond relatively less to the introduction of the patent box regime, we expect coefficient γ_4 to be positive. Thus, $\gamma_3 + \gamma_4$ captures the *additional* change in effective tax rate of patent-owning MNEs' subsidiaries with an income shifting incentive. If income shifting incentives curb the effectiveness of patent box regimes, $\gamma_3 + \gamma_4$ should be insignificantly different from zero.

We also predict directions for some covariates based on prior research. We predict negative coefficients for *Leverage* and *Intangibility* that account for potential tax planning activities of firms (Chen, Chen, Cheng, and Shevlin, 2010; Dyreng, Hanlon, and Maydew, 2008). We predict a positive effect of *Return on Assets* on firms' effective tax rate in line with prior work (Gupta and Newberry, 1997; Rego, 2003; Chen, Chen, Cheng, and Shevlin, 2010). Following Mills, Erickson, and Maydew (1998) and Dyreng, Hoopes, and Wilde (2016) we also add *Capital Intensity* and *Inventory* for which we do not predict directions. We also do not take any directional predictions for *Size* due to previous ambiguous results. On the one hand, studies predict a positive effect of *Size* on firms' ETR due to political costs (Zimmerman, 1983). On the other hand, *Size* may also just as well proxy for better tax planning opportunities allowing for a negative prediction (Rego, 2003) Prior studies, however, do not find a significant link between *Size* and effective tax rates (Gupta and Newberry, 1997; Dyreng, Hanlon, and Maydew, 2008). Additionally to an array of control variables, we use robust standard errors clustered at the firm level to mitigate potential concerns of understated standard errors (Peterson, 2009). All regressions are estimated including year (μ_t) and firm or industry (μ_i) fixed effects to account for unobservable time-invariant effects.

4.4.2 The effect of the IP box on firms' patenting activities

Additionally to testing whether or not firms gain a substantial tax benefit after the introduction of the patent box regime, we also ask the question if the patent box regime provides enough financial incentives to increase firms' patenting activities. Patenting activities are proxied by patent applications, patent grants and a firm's patent stock. Specifically, we estimate the following model

$$\text{Pat}_{i,t} = \alpha + \lambda_1 \, \textit{Reform} + \lambda_2 \, \textit{MNE} + \lambda_3 \, \textit{Reform} \times \textit{MNE} + \theta \, \text{Y}_{i,t} + \mu_t + \mu_i, \qquad (3)$$

where *Pat* is the natural logarithm of either patent applications, patent grants or patent stock of firm i in year t. We also include a vector of control variables Y as well as year fixed effects (μ_t) and firm or industry fixed effects (μ_i). Following recent literature that investigates the effects on patenting activities, we include *Size* and *Leverage* as control variables (Hall, Thoma, and Torrisi, 2007; Balsmeier, Fleming, and Manso, 2016). Given that firms increase their patenting activities after the introduction of the patent box regime, we expect the coefficient λ_1 to be positive (Hypothesis 1b). If the introduction of the patent box has no effect on MNEs we expect the coefficient λ_3 to be negative.

5 Data and sample

Our tests are based on a sample of Belgian industrial firms including sample years from 2003 to 2012. We specifically choose a ten-year sample period including five years before and after the introduction of the Belgian patent box regime in 2008 for the following reasons. First, patenting is a lasting process. In our sample, it takes an average of approximately 2.5 years after the filing of the patent until it is ultimately granted or refused. Secondly, data coverage for patents significantly decreases after 2012 as it takes

additional time until granted patents are recorded in the database. A ten-year sample period should therefore reliably capture firms' patenting and financial data.

We construct our sample using unconsolidated financial and ownership data provided by the Bureau van Dijk's *ORBIS* database performing the following steps. In a first step, we retrieve a sample of 3,380,860 firm-year observations. Next, we exclude firm-year observations with missing values for total assets (-1,275,208), profit before tax (-608,454), annual income tax expense (-75), non-current liabilities (-948), current liabilities (-24), intangible fixed assets (-37,120), tangible fixed assets (-4), and inventory (-2,422). We then drop firm-year observations with negative values for total assets (- 53) and profit/loss before tax (-313,344). Lastly, we winsorize all covariates at the 1st and 99th percentile to accommodate for potential outliers. In line with Dyreng, Hanlon, and Maydew (2008), we winsorize GAAP ETR at $[0, 1]$. Applying these adjustments results in a final sample of 1,143,208 firm-year observations of 234,624 unique firms.

We also use data provided by the *National Bank of Belgium* to derive *cash ETR* of firms in the underlying sample. Following Dyreng, Hanlon, and Maydew (2008), we use *Cash ETR* as the ratio of payments made to Belgian tax authorities and pretax financial accounting income on a unconsolidated basis. While the data is only available for a small part of the whole sample and about 57 % of the matched sample, the variable approximates for the ability to pay a low amount of cash income taxes. We complement our sample of financial data with patent data retrieved from the *Worldwide Patent Statistical Database (PATSTAT)* (Autumn 2015 edition) that is maintained and distributed by the European Patent Office (EPO). *PATSTAT* offers rich bibliographic patent data of more than 100 patent offices including information on firms' patent applications, granted patents and patent citations, but does not feature a common firm identifier. We therefore identify and match patent and financial data using Bureau van Dijk's reverse search algorithm taking

into account the firm's name, city and country of residence. In so doing, we are able to merge over 80% of Belgian firms featured in *PATSTAT* to firms retrieved from *ORBIS*. Merging financial, ownership and patent data we can identify firms owning patents in the reform period being eligible to benefit from the IP box regime (or "treated" firms).

Using the full sample, we then find a matching (or "control") firm for each treated firm that is comparable in *Size*, *Leverage*, *Intangibility*, *Return on Assets*, *Capital Intensity* and *Inventory* before the introduction of the IP box. Reducing the full sample to a matched sample should further account for time-invariant and unobservable differences between firms. We match firms using a propensity score matching without replacement and apply a widely used caliper of 0.1. Matching firms reduces our sample size to 8,531 firm-year observations, but removes differences in mean across covariates. As presented in Table 2, the mean of *Size*, *Leverage*, *Intangibility*, *Return on Assets*, *Capital Intensity* and *Inventory* are not significantly different after matching firms. Reported t-statistics range from 1.230 for *Capital Intensity* in 2007 to 0.040 for *Inventory* in 2005. However, we are unable to mitigate differences in the distribution of covariates across treatment and control firms except for *Size*. In the following tests we use both the full and matched sample for further analysis.

6 Results

6.1 Descriptive statistics and graphical evidence

Table 3 presents descriptive statistics. *Panel A* includes information for the unmatched sample of treated and control firms. 0.5% of the firm-year observations in the full sample involve firms holding patents. This ratio is in line with findings of the innovation economics literature (Hall, Helmers, Rogers, and Sena, 2014). [8] The mean of (GAAP) *ETR* for the

[8] The study states that only 4% of UK companies that conduct some form of R&D and report to have an innovation apply in fact for a patent.

full sample is 30.4%, for the treatment group 25.8%, and for the control group 30.5%. The mean of *Cash ETR* is for the full sample is 31.7%, for the treatment group 26.3%, and for the control group 32.0%. Firms that hold patents are larger in *Size*, and have lower *Leverage*, *ROA*, and *Capital Intensity* ratios, but higher *Intangibility* and *Inventory* ratios.

Panel B contains information about the matched sample. As a result of the matching procedure, 49.6% of the firm-year observations involve firms holding patents. The mean of (GAAP) *ETR* for the matched sample is 27.5%, for the treatment group 27.1%, and for the control group 27.8%. The mean of *Cash ETR* is for the matched sample is 28.4%, for the treatment group 27.9%, and for the control group 28.9%. Overall, the means and the distributions of the variables among the treatment and control group firms converged in the matched sample.

< Insert Table 3 here >

Table 4 presents Pearson correlations for the full sample. Correlation coefficients significant at the 1% level are marked bold. As expected, the correlation between *ETR* and *cash ETR* is high. The correlation coefficients of *Size* is negatively correlated with *ETR* whereas the coefficients of *Leverage, Capital Intensity, and Inventory* are positively correlated.[9] *ETR* as the main variable of interest, exhibits a relatively weak correlation with variables proxying for patenting activities *Patent Applications*, *Patent Grant*, and *Patent Stock*.

< Insert Table 4 here >

Figure 1 uses the full sample of firms to illustrate the DD. The figure plots *ETR* over

[9] We attribute the positive coefficient for *Leverage* to the notional interest regime that was enacted in Belgium in 2006. Since this covers a major part of our sample period, the benefit of using high leverage to reduce tax payments is small in Belgium.

the treatment and control group over the years 2003 to 2012. We observe from Figure 1 a parallel trend in the ETR of both groups prior to the reform. Following the IP box introduction in 2008, the ETRs of these two groups diverge. While the ETRs of the treatment group drop, the ETR level of the control group remains at a similar level as prior to the reform. We observe an immediate effect, since the lower tax rate applies on income of existing, non-commercialized patents. This is in line with our predictions of hypotheses 1a and 1b.

< Insert Figure 1 here >

Following our conjectures in hypotheses 2a and 2b, we investigate heterogeneous effects of IP boxes on MNEs' ETRs.

Figure 2a plots *ETR* of MNEs that hold patents in the reform period and hence are assigned to the *treatment group*. To explore differences in income shifting incentives, we split the group into two sub-groups. The first sub-group consists of MNEs that have an incentive to shift income out of Belgium and the second sub-group does not have. As above, we observe a parallel trend for the two sub-groups prior to the reform. In line with our hypotheses, we observe a sharp drop in the ETR for the "No Shifting Incentive" sub-group but only a small drop for the "Shifting Incentive" set of firms in the reform period.

< Insert Figure 2a here >

Figure 2b plots *ETR* of multinationals without patents (*control group*) in the reform period. Again, we split the group into a "No Shifting Incentive" and a "Shifting Incentive" sub-group. While *ETRs* prior to the reform are identical for the two groups, we find a slight difference between the two groups in the reform period. In the reform period,

however, *ETRs* for MNEs without an incentive to shift income are even higher. Taken together, these findings provide first evidence for our hypotheses 2a and 2b.

< Insert Figure 2b here >

6.2 The effect of the IP box on firms' ETR

In the following we provide evidence that the introduction of a patent box regime confers a significant tax benefit to patent owning domestic firms and especially patent owning multinational firms that do not have an incentive to shift income out of the country. In contrast, we do not find evidence that multinationals with an incentive to shift income out of the country experience an additional reduction in their effective tax rates after the introduction of the patent box regime.

We start our analysis by assessing the overall effect of the introduction of the patent box regime on firms' GAAP and Cash ETRs to get a grasp for the tax benefit conferred. We predict that patent-owning firms experience an additional reduction in GAAP and Cash ETRs after the introduction of the patent box regime relative to non patent-owning firms (Hypothesis 1a). The DD estimator (β_3) in regression model 1 specifically takes account for *additional* changes in ETR of treated firms relative to control firms. Regression results are presented in table 5 for our full sample in panel A and for our matched sample in panel B, respectively.

< Insert Table 5 here >

In line with our hypothesis, the coefficient β_3 is negative across all specifications. In particular, β_3 suggests an incremental reduction in GAAP ETR of 3.0 % and a reduction in Cash ETR of 2.8 % for treated firms relative to control firms in our full sample. The coefficients are statistically significant at the 1 % level. Our matched sample supports these results with an incremental reduction in GAAP ETR of 1.6 % and an incremental

reduction in Cash ETR of 2.7 %. A reduction in Cash ETR by about 2.8 % translates into 284.3 million EUR (approx. 295 million U.S. Dollar) of foregone yearly tax revenue.[10] Overall, these results suggest that the introduction of the patent box regime confers a tax benefit to patent-owning firms.

We now turn to the analysis of differences in responses between domestic firms and multinational firms. In Hypothesis 2a we predicted that treated domestic firms experience a higher reduction in ETR than their treated multinational counterparts. In regression model 1 the coefficient β_4 captures the effect of the introduction of the patent box regime on treated multinationals. As before, results are presented in table 5. The coefficient β_4 of the triple interaction term (*Reform* $\times$ *Treatment* $\times$ *MNE*) is positive for the full sample as predicted, but statistically insignificant. For our matched sample the coefficient switches signs providing for ambiguous results. It appears that treated multinationals experience at least the same incremental reduction in effective tax rates as domestic firms do. Hence, there seems to be no difference in the conferred tax benefit of the patent box regime between purely domestic firms and multinational firms at first sight. However, if we distinguish between multinationals with and without an incentive to shift income out of the country, we find the following interesting results.

We run our DD specification again in a sub-sample of multinational firms and distinguish between firms with and without an incentive to shift income out of Belgium. Based on hypothesis 2b we expect firms with an incentive to shift income out of Belgium to respond less to the introduction of a patent box regime as their counterparts without an incentive to shift income out of Belgium. We estimate regression model 2 to test this hypothesis. Comparable to our prior estimation, the coefficient γ_3 captures the additional

[10] We calculate this by taking the average multiplying the average profit/loss of firms holding patents in the post-reform period (32,321,210 EUR) by the Cash ETR reduction (2.8 %). This results in an average tax revenue loss per firm of 902,473 EUR. Having 315 firms that are eligible for the IP box, this leads to an overall yearly loss for the Belgian state of 284,279,272 EUR.

decrease in ETR of eligible (patent owning) *multinationals* relative to non-eligible (non patent owning) *multinationals*. Table 6 presents results of regression model 2 for the full sample (panel A) and the matched sample (panel B).

< Insert Table 6 here >

Comparing γ_3 to β_3 shows that the introduction of the patent box regime has an even more pronounced negative effect on the GAAP and Cash ETRs of multinational firms. Coefficient estimates range from -.083 for GAAP ETR to -.093 for Cash ETR using the full sample indicating an *additional* reduction in GAAP ETR of 8.3 % and Cash ETR of 9.3 % of patent owning multinationals relative to non patent owning multinationals. In our matched sample the effect even increases to *additional* reductions in GAAP ETR of 17.0 % and in Cash ETR of 15.1 %. This effect is large in scale. The large scale of the ETR reduction suggests that almost all taxable income by multinational firms must be attributable to patent income. Indeed, as explained in section 3 the Belgian patent box provides for a large reduction in effective tax rates on IP income. Although the effect is large in scale, we think it is reasonable against the backdrop of the powerful tax incentive the Belgian patent box provides.

However, if we look at firms with an incentive to shift income out of Belgian the large reduction in GAAP and Cash ETR is completely reversed. The estimates of coefficient γ_4 suggest that firms with an shifting incentive experience only slightly decreasing or even increasing GAAP and Cash ETRs after the introduction of the patent box regime relative to non-patent-owning multinationals. In our full sample patent owning multinationals with an incentive to shift income experience only a decrease in GAAP ETR of 2.0 % and no reduction in Cash ETR whatsoever. The same applies for our matched sample in which patent-owning multinationals with an incentive to shift income out of Belgium only experience a reduction in GAAP ETR of 0.1 % and and an increase in Cash ETR

of about 2.3 % relative to patent-owning firms without an income shifting incentive. The coefficient is statistically significant across all our specifications suggesting that the patent box regime confers no tax benefit upon patent owning multinationals with an incentive to shift income out of Belgium.

Our results suggest that in general the introduction of the patent box regime confers a significant tax benefit on firms in form of additional reductions in GAAP and Cash ETRs. This effect is most pronounced for multinationals that do not have an incentive to shift income out of the country. In contrast, multinationals with an income shifting incentive do not experience significant reductions in GAAP and Cash ETR after the introduction of the patent box regime. Combined these results suggest that some multinationals specifically take advantage of the patent box regime. The significantly higher reduction in GAAP and Cash ETR for multinationals than domestic firms suggests that subsidiaries of multinationals exclusively feature patent income that benefits from the patent box regime.

6.3 The effect of the IP box on firms' patenting activities

In a next step, we test hypothesis 1b and hence the question whether the IP box results in increased patenting activities of firms. To examine this question we use the DD specification presented in equation 3. Our findings are depicted in table 7 and include year fixed and firm fixed or industry fixed effects. According to hypothesis 1b, we expect a positive coefficient (λ_1) indicating an enhancing effect of the IP box on patenting activities. We find first support for this conjecture in column (5) which indicates a significant increase (at the 1 % level) for the patent stock. The coefficient for (λ_1) reflects an average increase of 0.3 % of patent stock in the reform period. In contrast, column 6 indicates a significant *decrease* in patent stocks by 0.2 %. Due to the opposing signs of the coefficients and the rather small magnitude of the observed effects, we cannot draw a conclusion from these

two specifications about the effect of the IP box on patenting activities. The same holds for the estimations of (λ_1) in columns 1 to 4.

To explore in detail potential differences between domestic and multinational firms as conjectured in hypothesis 2c, we turn to the interaction term of *Reform* and *MNE*. Here we derive a clearer pattern and a bigger magnitude of the coefficient estimations. The coefficients (λ_3) are positive for patent stock (significant at the 1 % level in column 5 reflecting an increase of 1.7 % in patent stock). In contrast, the coefficients of columns 3 and 4 are significantly negative at the 1 % level for patent grants reflecting a 0.7 % decrease of patent grants for multinationals relative to domestic firms. One potential explanation for these opposing effects can be given when we recall the findings of section 6.2.

In section 6.2 we found that especially multinationals reduce their ETRs in the post-reform period. This is in line with the positive coefficients for (λ_3) in the patent stock specifications in table 7.[11] Combined with the negative coefficients for the specifications 3 and 4 in table 7, we conclude that multinational firms do not apply for or receive more patents through their Belgian subsidiaries, but rather re-assign patents from other locations to Belgium which leads to an increased patent stock (column 5 and 6). In this way, multinationals reap in the benefits of the Belgian patent box without increasing patenting activities in Belgium. Taken together, we cannot find support for hypotheses 1b and 2c. While our results show inconclusive results for overall patenting activities of firms, we find that specifically multinationals increase their patent stocks in Belgium but relatively decrease their patent filings.

< Insert Table 7 here >

[11] Another explanation is that the coverage of the database for patent applications is reduced especially towards the end of our sample period.

6.4 Robustness tests

DD estimation requires that treatment and control firms exhibit parallel trends in the outcome variable in the period prior to the treatment. Therefore, we conduct several additional tests examine whether this assumption is fulfilled. First, we conduct placebo tests in which we change the post-reform period. This ensures that we do not capture other events that lead to a reduction of firms' effective tax rates (e.g. the introduction of the R&D tax credit in 2006). We re-estimate equation 1 assuming placebo reforms in 2005, 2006 and 2007. If the parallel trends assumption is satisfied, we expect the coefficients (β_3) to be insignificant. Table 8 depicts the results in the respective placebo reform years. The results in panel A depict no significant coefficient (β_3) indicating the placebo reform in 2005. In 2006, however, we find a significant coefficient for the interaction of the *Reform* and *Treatment2006* term for GAAP ETR. While this is a concern, we re-run the regression for the matched sample as indicated in panel B. Although the coefficient (β_3) shows a similar magnitude, it is neither significant for GAAP ETR nor for cash ETR estimations. Lastly, we re-run the regression assuming a reform in 2007. While we find significant effects in panel A for both ETR measures, we do not find significant coefficients (β_3) for the matched sample in panel B. One explanation for the observed significant coefficient may be attributed to an institutional detail. Some firms were able to make use of a phase-in period that allowed to partly apply the reduced tax rate on income derived from patents 2007 onwards (Eynatten, 2008).

< Insert Table 8 here >

Second, as another way to corroborate that the inference is not due to random chance, we assign randomly firms to either treatment or control group. We define a variable *TreatmentRandom* and re-estimate equation 1. As depicted in table 9, we do not observe

any significant coefficient (β_3) for the interaction term of *Reform* and *TreatmentRandom*. Based on the results of the conducted robustness tests, we are confident that the parallel trend assumption holds.

< Insert Table 9 here >

7 Conclusion

In this paper, we examine whether firms' tax avoidance opportunities erode the effect of targeted tax incentives. Using the Belgian IP box regime as a quasi-experiment, we investigate its effect on corporate effective tax rates and patenting activities. We find that firms holding patents experience a 3.0 % lower ETR after the introduction of the patent box regime than their non-patent owning counterparts. Additionally we find evidence that the reduction in ETR is especially pronounced for multinational enterprises without cross-border income shifting incentives. The observed effect is in stark contrast to multinationals with cross-border income shifting incentives. This group of multinationals does not experience significant decreases in ETR. We also find evidence that on average firms do not increase their patent applications, patent grants, and patent stocks. However, especially MNEs experience a significant increase in their patent stocks after the introduction of the patent box regime. We also document some evidence that this is achieved through shifting patents from other locations to Belgium.

We contribute to two streams of research. First, we provide evidence that corporate tax avoidance opportunities mute the effect of targeted tax incentives and may derail important tax policy tools. While there has been extensive research on determinants of firms' tax avoidance (Rego, 2003; Dyreng, Hanlon, and Maydew, 2008) and income shifting (Huizinga and Laeven, 2008; Klassen and Laplante, 2012) there is surprisingly scarce research on the interaction between tax avoidance and tax incentives. Our results suggest

that the level of tax avoidance plays an important role for the effectiveness of output-based tax incentives and hence should be taken into account when designing IP boxes. Second, we add to the growing IP box literature (Evers, Miller, and Spengel, 2015; Alstadsaeter, Barrios, Nicodeme, Skonieczna, and Vezzani, 2015; Chen, De Simone, Hanlon, and Lester, 2016) by linking effects of the tax regime on ETRs and patenting activities. This allows us to disentangle the effects of an IP box on different groups of firms and draw conclusions on strategies how especially multinationals use IP boxes. Our findings indicate that multinationals reap in benefits of IP boxes by re-assigning patents from abroad to Belgium without carrying out significantly more patenting activities. Overall, our findings suggest heterogeneous effects of IP boxes on different groups of firms and provide implications for the design of tax incentives.

References

Akerlof, G. A. (1970): "Market for Lemons - Quality Uncertainty and Market Mechanism," *Quarterly Journal of Economics*, 84(3), 488–500.

Alstadsaeter, A., S. Barrios, G. Nicodeme, A. M. Skonieczna, and A. Vezzani (2015): "Patent Boxes Design, Patents Location and Local R&D," *IPTS Working Papers on Corporate R&D and Innovation*, (6/2015).

Balsmeier, B., L. Fleming, and G. Manso (2016): "Independent boards and innovation," *Journal of Financial Economics*, (forthcoming).

Beer, S., and J. Loeprick (2015): "Profit shifting: drivers of transfer (mis)pricing and the potential of countermeasures," *International Tax and Public Finance*, 22(3), 426–451.

Berger, P. (1998): "Explicit and Implicit Tax Effects of the R&D Tax Credit," *The Accounting Review*, 31(2), 131–171.

Bloom, N., R. Griffith, and J. Van Reenen (2002): "Do R&D tax credits work? Evidence from a panel of countries 1979-1997," *Journal of Public Economics*, 85(1), 1–31.

Cappelen, A., A. Raknerud, and M. Rybalka (2012): "The effects of R&D tax credits on patenting and innovations," *Research Policy*, 41(2), 334–345.

Carboni, O. (2011): "R&D subsidies and private R&D expenditures: evidence from Italian manufacturing data," *International Review of Applied Economics*, 25(4), 419–439.

Chen, S., L. De Simone, M. Hanlon, and R. Lester (2016): "The effect of Innovation Box regimes on income shifting and real activity," *Working Paper*, (No. 3453).

Chen, S. P., X. Chen, Q. Cheng, and T. Shevlin (2010): "Are family firms more tax aggressive than non-family firms?," *Journal of Financial Economics*, 95(1), 41–61.

Cordes, J. J. (1989): "Tax Incentives and R-and-D Spending - a Review of the Evidence," *Research Policy*, 18(3), 119–133.

Dinkel, A., and D. Schanz (2014): "Tax Attractiveness And the Location of Patents," .

Dischinger, M., and N. Riedel (2011): "Corporate Taxes and the Location of Intangible Assets within Multinational Firms," *Journal of Public Economics*, 95(7-8), 691–707.

Dyreng, S., and K. Markle (2016): "The Effect of Financial Constraints on Income Shifting by U.S. Multinationals," *The Accounting Review*, 91(6), 1601–1627.

Dyreng, S. D., M. Hanlon, and E. L. Maydew (2008): "Long-run corporate tax avoidance," *Accounting Review*, 83(1), 61–82.

Dyreng, S. D., J. L. Hoopes, and J. H. Wilde (2016): "Public Pressure and Corporate Tax Behavior," *Journal of Accounting Research*, 54(1), 147–186.

Ernst, C., K. Richter, and N. Riedel (2014): "Corporate taxation and the quality of research and development," *International Tax and Public Finance*, 21(4), 694–719.

Evers, L., H. Miller, and C. Spengel (2015): "Intellectual Property Box Regimes: Effective Tax Rates and Tax Policy Considerations," *International Tax and Public Finance*, 22(3), 502–530.

Eynatten, W. (2008): "European R&D and IP tax regimes: a comparative study," *Intertax*, 36(11), 502–519.

Eynatten, W., and P. Brauns (2010): "Benelux tax competition to attract IP income is on again," *International Tax Review*, 21(2), 43–45.

Finley, A., S. Lusch, and K. Cook (2015): "The Effectiveness of the R&D Tax Credit: Evidence from the Alternative Simplified Credit," *Journal of the American Taxation Association*, 37(1), 157–181.

Gupta, S., and K. Newberry (1997): "Determinants of the variability in corporate effective tax rates: Evidence from longitudinal data.," *Journal of Accounting and Public Policy*, 16(1), 1–34.

Hall, B. H. (2010): "The Financing of Innovative Firms," *Review of Economics and Institutions*, 1(1), 1–30.

Hall, B. H., C. Helmers, M. Rogers, and V. Sena (2014): "The Choice between Formal and Informal Intellectual Property: A Review," *Journal of Economic Literature*, 52(2), 375–423.

Hall, B. H., G. Thoma, and S. Torrisi (2007): "The Market Value of Patents and R&D: Evidence from European Firms.," *Academy of Management Annual Meeting Proceedings*, 8(1), 1–6.

Hanlon, M., and J. Slemrod (2009): "What does tax aggressiveness signal? Evidence from stock price reactions to news about tax shelter involvement," *Journal of Public Economics*, 93(1-2), 126–141.

Heckemeyer, J., P. Olligs, and M. Overesch (2016): "Corporate Taxes and the Location of US Trademarks.," *Working Paper*.

Huizinga, H., and L. Laeven (2008): "International profit shifting within multinationals: A multi-country perspective," *Journal of Public Economics*, 92(5-6), 1164–1182.

Karkinsky, T., and N. Riedel (2012): "Corporate taxation and the choice of patent location within multinational firms," *Journal of International Economics*, 88(1), 176–185.

Klassen, K. J., and S. K. Laplante (2012): "Are US Multinational Corporations Becoming More Aggressive Income Shifters?," *Journal of Accounting Research*, 50(5), 1245–1285.

Klassen, K. J., J. A. Pittman, and M. P. Reed (2004): "A cross-national comparison of R&D expenditure decisions: Tax incentives and financial constraints," *Contemporary Accounting Research*, 21(3), 639–680.

Klemm, A. (2012): "Empirical evidence on the effects of tax incentives," *International Tax and Public Finance*, 19(3), 393–423.

Koh, P. S., and D. M. Reeb (2015): "Missing R&D," *Journal of Accounting & Economics*, 60(1), 73–94.

Lokshin, B., and P. Mohnen (2012): "How effective are level-based R&D tax credits? Evidence from the Netherlands," *Applied Economics*, 44(12), 1527–1538.

Markle, K. (2016): "A Comparison of the Tax-Motivated Income Shifting ofMultinationals in Territorial and Worldwide Countries," *Contemporary Accounting Research*, 33(1), 7–43.

McGuire, S., T. Omer, and J. Wilde (2014): "Investment Opportunity Sets, Operating Uncertainty, and Capital Market Pressure: Determinants of Investments in Tax Shelter Activities?," *Journal of the American Taxation Association*, 36(1), 1–26.

Mills, L., M. Erickson, and E. Maydew (1998): "Investments in tax planning," *Journal of the American Taxation Association*, 20(1), 1–20.

Rego, S. O. (2003): "Tax-avoidance activities of US multinational corporations," *Contemporary Accounting Research*, 20(4), 805–833.

Romer, P. M. (1990): "Endogenous Technological-Change," *Journal of Political Economy*, 98(5), S71–S102.

Weichenrieder, A. J., and J. Mintz (2008): "What Determines the use of Holding Companies and Ownership Chains?," *Oxford University Centre for Business Taxation*, Working Paper Series No. 803.

Zimmerman, J. L. (1983): "Taxes and Firm Size," *Journal of Accounting & Economics*, 5(2), 119–149.

Appendix

Figure 1: *Development of GAAP ETR over time of treatment and control group. Introduction of patent box regime in 2008 is indicated.*

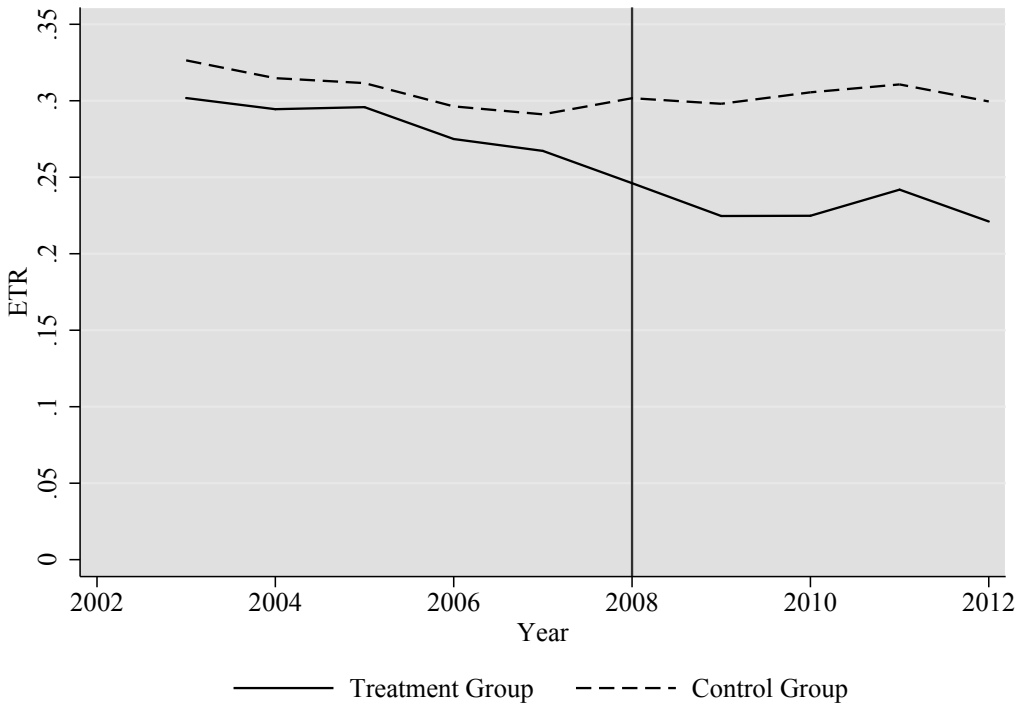
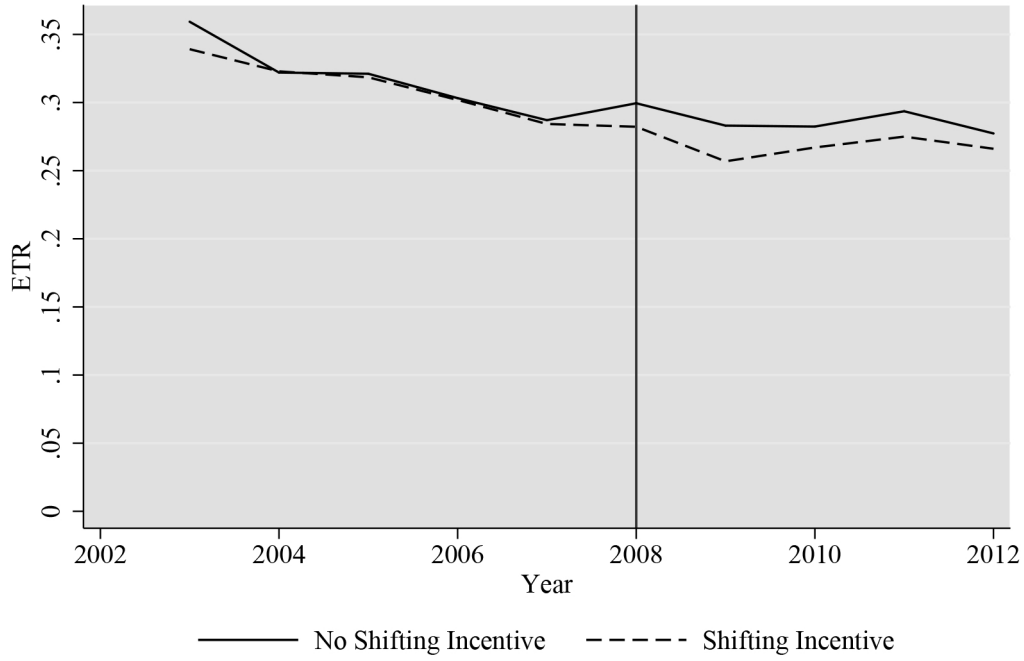


Figure 2: *Development of GAAP ETR over time in a subsample of MNEs with and without income shifting incentive.*

(a) *Development of GAAP ETR over time for control group in MNE-only subsample. Introduction of patent box regime in 2008 is indicated.*



(b) *Development of GAAP ETR over time for treatment group in MNE-only subsample. Introduction of patent box regime in 2008 is indicated.*

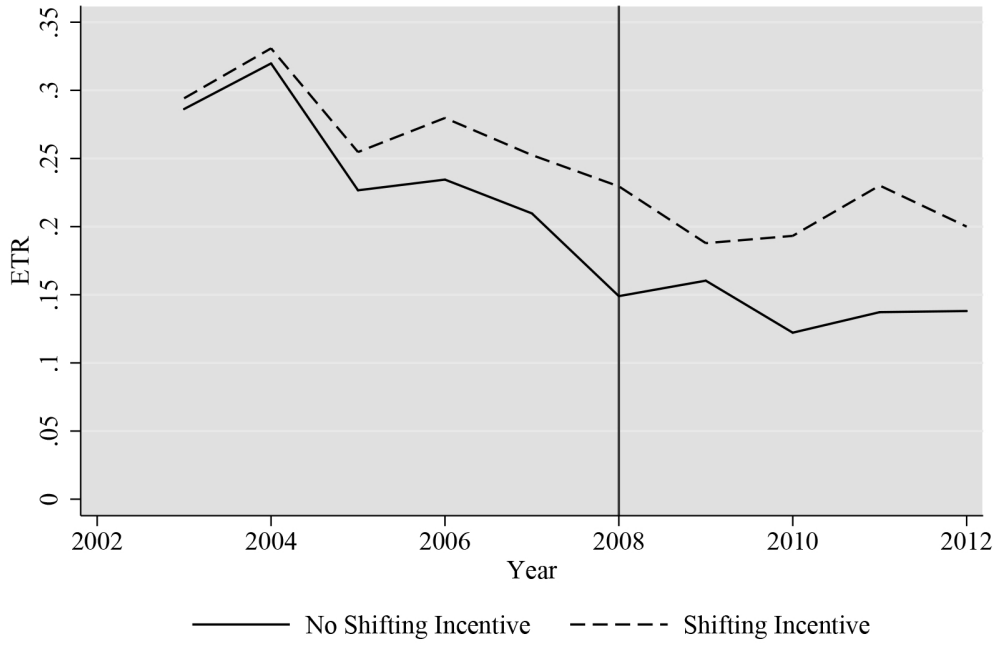


Table 1: *Variable Definitions*

Variable	Description
Capital Intensity	Ratio of tangible fixed assets to total assets of firm i in the prior period t-1. Source: Orbis database, variables Tangible fixed assets / Total Assets.
Cash ETR	Cash effective tax rate (cash taxes paid / profit (loss) before tax) of firm i in year t. Source: Belgian National Bank - Annual statements of Belgian firms, variables taxation paid, gain(loss) before taxes.
ETR	GAAP effective tax rate (tax expense / profit (loss) before tax) of firm i in year t. Source: Orbis database variables Taxation, P/L before tax.
Intangibility	Ratio of intangible fixed assets to total assets of firm i in year t. Source: Orbis database, variable Intangible fixed assets.
Industry	Industry classification of firm i according to the NACE Rev. 2 classification in the European Community. Source: Orbis database, Eurostat.
Inventory	Ratio of current assets to total assets of firm i in the period t. Source: Orbis database, variables Current assets stocks / Total Assets.
Leverage	Debt ratio of firm i (long-term debt/total assets) in year t. Source: Orbis database, variables Long term debt /Total Assets.
MNE	Indicator variable for firm either having a foreign parent or shareholder (participation requirement in both cases, greater 50%). Based on the 2006 ownership structure data derived from Orbis. Source: Orbis database, own calculations.
ln(Patent Applications)	Natural logarithm of the number of patent applications of firm i in year t. We set the logarithm to zero in case the logarithm is not defined. Source: PATSTAT database, own calculations.
ln(Patent Grants)	Natural logarithm of the number of patent grants of firm i in year t. We set the logarithm to zero in case the logarithm is not defined. Source: PATSTAT database, own calculations.
ln(Patent Stock)	Natural logarithm of the number of granted patents held by firm i in year t. We combine all worldwide patents that were granted in the last 19 years preceding the fiscal year (patents grant normally a legal protection of 20 years). We set the logarithm to zero in case the logarithm is not defined. Source: PATSTAT database, own calculations.
Reform	Indicator variable indicating the year of the introduction of the IP box. For the year of the introduction and the following years (2008 onwards), the variable takes a value of 1, otherwise 0.
Return on Assets	Return on assets of firm i (profit (loss) before interest and tax) / total assets in year t. Source: Orbis database, variables (P/L before interest and tax /Total Assets).
Shifting	Indicator variable that takes a value of 1 if the statutory tax rate of a foreign subsidiary or parent is lower than the Belgian statutory tax rate, and 0 otherwise.
Size	Natural logarithm of total assets of firm i in year t. Source: Orbis database, variable Total Assets.
Treat	Indicator variable for the eligibility of firm i for the IP box. The variable takes a value of 1 if the firm owns at least one patent in the Reform year (2008 onwards). Source: own calculations
Treatment(year)	Indicator variable for the eligibility of firm i for the IP box. The variable takes a value of 1 if the firm owns at least one patent in the placebo reform year (2005/2006/2007 onwards). Source: own calculations.
TreatmentRandom	Randomly assigned placebo treatment indicator variable for the eligibility of firm i for the IP box. We randomly assign half of our sample firms as treatment and the other half as control firms. Source: own calculations.

Table 2: *Balancing tests*

Covariate	Year	Mean		t-test		Var. Ratio
		Treatement Group	Control Group	t-value	p-value	
Size	2005	8.773	8.749	0.220	0.823	1.020
	2006	8.872	8.880	0.080	0.938	1.000
	2007	8.963	8.976	0.140	0.891	0.980
Leverage	2005	0.571	0.572	0.060	0.951	**0.800**
	2006	0.551	0.557	0.410	0.684	**0.770**
	2007	0.534	0.538	0.260	0.798	**0.760**
Intangibility	2005	0.020	0.018	0.310	0.757	**0.590**
	2006	0.023	0.022	0.220	0.824	**0.770**
	2007	0.022	0.024	0.370	0.709	**0.680**
ROA	2005	0.122	0.127	0.540	0.587	**0.730**
	2006	0.127	0.122	0.610	0.545	0.860
	2007	0.123	0.118	0.660	0.508	0.980
Capital Intensity	2005	0.185	0.199	1.090	0.277	**0.580**
	2006	0.185	0.195	0.870	0.383	**0.600**
	2007	0.181	0.195	1.230	0.218	**0.610**
Inventory	2005	0.155	0.155	0.040	0.971	**0.690**
	2006	0.163	0.166	0.270	0.788	**0.650**
	2007	0.166	0.168	0.170	0.862	**0.660**

This table presents balancing tests for our matched sample for each covariate and year we take into account to find a comparable match for each treated firm in our control group. We use a propensity score matching based on a widely used caliper of 0.1. Reported mean and t-statistics are after matching. Bold if variance ratio outside [0.84; 1.19].

Table 3: *Descriptive Statistics*

Panel A: Full Sample

	Full Sample						Treatment Group						Control Group					
	N	Mean	Std. Dev.	Q1	Median	Q3	N	Mean	Std. Dev.	Q1	Median	Q3	N	Mean	Std. Dev.	Q1	Median	Q3
ETR	1,143,208	0.304	0.232	0.167	0.293	0.374	6,206	0.258	0.208	0.082	0.276	0.349	1,137,002	0.305	0.232	0.167	0.294	0.375
Cash ETR	73,366	0.317	0.215	0.194	0.322	0.382	3,265	0.263	0.205	0.089	0.282	0.356	70,101	0.320	0.215	0.199	0.324	0.384
Size	1,143,208	5.954	1.488	4.913	5.823	6.799	6,206	8.715	1.769	7.472	8.938	10.615	1,137,002	5.939	1.472	4.913	5.817	6.783
Leverage	1,143,208	0.578	0.273	0.372	0.606	0.794	6,206	0.558	0.252	0.377	0.580	0.751	1,137,002	0.578	0.273	0.372	0.606	0.794
Intangibility	1,143,208	0.025	0.092	0.000	0.000	0.576	6,206	0.029	0.083	0.000	0.002	0.017	1,137,002	0.025	0.092	0.000	0.000	0.576
ROA	1,143,208	0.146	0.163	0.038	0.092	0.190	6,206	0.111	0.124	0.031	0.072	0.146	1,137,002	0.147	0.163	0.038	0.092	0.190
Capital Intensity	1,143,208	0.301	0.264	0.076	0.227	0.477	6,206	0.188	0.178	0.051	0.140	0.271	1,137,002	0.302	0.264	0.077	0.228	0.479
Inventory	1,143,208	0.095	0.167	0.000	0.000	0.125	6,206	0.155	0.159	0.006	0.117	0.246	1,137,002	0.095	0.167	0.000	0.000	0.124
Patent Applications	1,143,208	0.003	0.082	0.000	0.000	0.000	6,206	0.480	0.974	0.000	0.000	0.693	1,137,002	0.000	0.000	0.000	0.000	0.000
Patent Grants	1,143,208	0.001	0.057	0.000	0.000	0.000	6,206	0.277	0.718	0.000	0.000	0.000	1,137,002	0.000	0.000	0.000	0.000	0.000
Patent Stock	1,143,208	0.008	0.152	0.000	0.000	0.000	6,206	1.540	1.343	0.693	1.386	2.079	1,137,002	0.000	0.000	0.000	0.000	0.000

Panel B: Matched Sample

	Full Sample						Treatment Group						Control Group					
	N	Mean	Std. Dev.	Q1	Median	Q3	N	Mean	Std. Dev.	Q1	Median	Q3	N	Mean	Std. Dev.	Q1	Median	Q3
ETR	8,531	0.275	0.187	0.158	0.296	0.351	4,229	0.271	0.182	0.160	0.295	0.349	4,302	0.278	0.192	0.154	0.298	0.353
Cash ETR	4,953	0.284	0.198	0.148	0.302	0.360	2,510	0.279	0.192	0.148	0.300	0.358	2,443	0.289	0.205	0.152	0.305	0.364
Size	8,531	8.935	1.594	7.763	9.175	10.663	4,229	8.945	1.581	7.784	9.167	10.663	4,302	8.925	1.608	7.727	9.179	10.658
Leverage	8,531	0.536	0.253	0.344	0.562	0.738	4,229	0.531	0.240	0.356	0.554	0.713	4,302	0.540	0.265	0.329	0.569	0.759
Intangibility	8,531	0.021	0.069	0.000	0.000	0.008	4,229	0.022	0.065	0.000	0.001	0.013	4,302	0.020	0.072	0.000	0.000	0.003
ROA	8,531	0.114	0.118	0.036	0.079	0.153	4,229	0.116	0.113	0.038	0.081	0.155	4,302	0.113	0.122	0.033	0.077	0.151
Capital Intensity	8,531	0.189	0.188	0.044	0.129	0.274	4,229	0.182	0.162	0.055	0.143	0.262	4,302	0.196	0.210	0.034	0.117	0.297
Inventory	8,531	0.160	0.170	0.004	0.111	0.255	4,229	0.159	0.154	0.023	0.127	0.246	4,302	0.160	0.185	0.000	0.089	0.264
Patent Applications	8,531	0.239	0.711	0.000	0.000	0.000	4,229	0.478	0.949	0.000	0.000	0.693	4,302	0.000	0.000	0.000	0.000	0.000
Patent Grants	8,531	0.136	0.511	0.000	0.000	0.000	4,229	0.273	0.700	0.000	0.000	0.000	4,302	0.000	0.000	0.000	0.000	0.000
Patent Stock	8,531	0.769	1.214	0.000	0.000	1.386	4,229	1.548	1.329	0.693	1.386	2.079	4,302	0.000	0.000	0.000	0.000	0.000

This table presents descriptive statistics of our main variables for our full sample in Panel A and our matched sample in Panel B. We present descriptive statistics of our main variables also separately for our treatment and control group used.

Table 4: *Pearson Correlations Full Sample*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) ETR	1										
(2) Cash ETR	**0.865**	1									
(3) Size	**-0.057**	**-0.141**	1								
(4) Leverage	**0.075**	**0.195**	**0.0645**	1							
(5) Intangibility	**0.022**	0.002	**-0.048**	**0.113**	1						
(6) ROA	**-0.069**	**-0.079**	**-0.3037**	**-0.181**	**0.007**	1					
(7) Capital Intensity	0.002	**-0.053**	**-0.0075**	**0.226**	**-0.117**	**-0.219**	1				
(8) Inventory	**-0.038**	**0.022**	**0.1627**	**0.104**	**-0.086**	**-0.190**	**-0.215**	1			
(9) Patent Applications	**-0.017**	**-0.063**	**0.1262**	**-0.008**	**0.009**	**-0.015**	**-0.028**	**0.018**	1		
(10) Patent Grant	**-0.012**	**-0.052**	**0.0867**	**-0.005**	**0.010**	**-0.010**	**-0.018**	**0.010**	**0.707**	1	
(11) Patent Stock	**-0.011**	**-0.044**	**0.0686**	**-0.005**	**0.010**	**-0.008**	**-0.015**	**0.007**	**0.656**	**0.896**	1

This table provides Pearson correlations for the full sample. Bold letters denotes statistical significance at the 5 percent level.

Table 5: *Effect of the IP box on firms' ETRs*

Panel A: Full Sample						
	GAAP ETR			Cash ETR		
	(1)	(2)	(3)	(4)	(5)	(6)
Reform x Treatment	-0.032***	-0.030***	-0.045***	-0.026**	-0.028***	-0.018*
	(0.007)	(0.007)	(0.007)	(0.011)	(0.010)	(0.010)
Reform x Treatment x MNE	0.010	0.001	0.020	0.024	0.014	-0.002
	(0.014)	(0.014)	(0.014)	(0.018)	(0.018)	(0.017)
Size		-0.004***	-0.012***		-0.025***	-0.027***
		(0.001)	(0.000)		(0.003)	(0.001)
Leverage		-0.012***	0.068***		0.016**	0.135***
		(0.002)	(0.001)		(0.008)	(0.005)
Intangibility		-0.097***	-0.053***		0.060	0.023
		(0.005)	(0.003)		(0.039)	(0.031)
ROA		-0.303***	-0.176***		-0.368***	-0.203***
		(0.002)	(0.002)		(0.013)	(0.010)
Capital Intensity		-0.017***	-0.039***		-0.027**	-0.053***
		(0.002)	(0.001)		(0.012)	(0.007)
Inventory		0.006	-0.047***		0.018	-0.022***
		(0.004)	(0.002)		(0.014)	(0.008)
Observations	1,143,208	1,143,208	1,143,208	73,366	73,366	73,366
Adj. R-squared	0.003	0.028	0.036	0.037	0.061	0.113
Firm fixed effects	Yes	Yes	No	Yes	Yes	No
Industry fixed effects	No	No	Yes	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Matched Sample						
	GAAP ETR			Cash ETR		
	(1)	(2)	(3)	(4)	(5)	(6)
Reform x Treatment	-0.018*	-0.016	-0.016	-0.028*	-0.027*	-0.016
	(0.011)	(0.011)	(0.011)	(0.015)	(0.015)	(0.015)
Reform x Treatment x MNE	-0.007	-0.012	-0.010	0.028	0.018	0.006
	(0.022)	(0.022)	(0.022)	(0.028)	(0.028)	(0.027)
Size		-0.015*	-0.011***		-0.050***	-0.039***
		(0.008)	(0.002)		(0.012)	(0.006)
Leverage		0.051***	0.126***		0.059**	0.128***
		(0.020)	(0.013)		(0.025)	(0.018)
Intangibility		0.071	-0.029		0.110	-0.046
		(0.070)	(0.067)		(0.079)	(0.090)
ROA		-0.151***	-0.021		-0.325***	-0.176***
		(0.033)	(0.025)		(0.046)	(0.036)
Capital Intensity		0.055*	-0.001		-0.018	-0.010
		(0.030)	(0.018)		(0.050)	(0.030)
Inventory		0.071*	0.009		0.048	0.024
		(0.039)	(0.022)		(0.049)	(0.029)
Observations	8,531	8,531	8,531	4,953	4,953	4,953
Adj. R-squared	0.029	0.038	0.089	0.050	0.075	0.163
Firm fixed effects	Yes	Yes	No	Yes	Yes	No
Industry fixed effects	No	No	Yes	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the regression results of regression model 1. Panel A reports results for the full sample. Panel B reports results for the matched sample. *Reform* is an indicator variable taking value one for years 2008 onwards and zero otherwise. *Treatment* is an indicator variable equal to one if a firm holds at least one patent in the post-reform period and equal to zero, otherwise. *MNE* is an indicator variable if the firm is held by an foreign shareholder or owns at least one foreign subsidiary. Standard errors clustered at the firm-level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 6: *Effect of income shifting incentives*

Panel A: Full Sample						
	GAAP ETR			Cash ETR		
	(1)	(2)	(3)	(4)	(5)	(6)
Reform x Treatment	-0.075***	-0.083***	-0.090***	-0.073*	-0.093**	-0.077**
	(0.027)	(0.028)	(0.028)	(0.039)	(0.039)	(0.035)
Reform x Treatment x Shifting	0.061**	0.063**	0.073**	0.084**	0.093**	0.061
	(0.031)	(0.032)	(0.032)	(0.042)	(0.042)	(0.040)
Size		-0.009	-0.016***		-0.040***	-0.034***
		(0.007)	(0.002)		(0.007)	(0.003)
Leverage		0.021	0.115***		0.019	0.111***
		(0.014)	(0.010)		(0.016)	(0.012)
Intangibility		0.073	0.056		0.116	0.101
		(0.074)	(0.062)		(0.078)	(0.069)
ROA		-0.231***	-0.089***		-0.381***	-0.201***
		(0.020)	(0.018)		(0.027)	(0.024)
Capital Intensity		-0.002	-0.013		0.013	0.008
		(0.025)	(0.015)		(0.030)	(0.018)
Inventory		0.005	-0.010		0.039	-0.027
		(0.028)	(0.016)		(0.033)	(0.018)
Observations	19,153	19,153	19,153	12,952	12,952	12,952
Adj. R-squared	0.032	0.045	0.081	0.036	0.070	0.115
Firm fixed effects	Yes	No	Yes	Yes	Yes	No
Industry fixed effects	No	Yes	No	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Matched Sample						
	GAAP ETR			Cash ETR		
	(1)	(2)	(3)	(4)	(5)	(6)
Reform x Treatment	-0.156***	-0.170***	-0.206***	-0.132	-0.151*	-0.176**
	(0.058)	(0.059)	(0.055)	(0.082)	(0.085)	(0.069)
Reform x Treatment x Shifting	0.154**	0.169***	0.194***	0.155*	0.174*	0.186**
	(0.063)	(0.065)	(0.060)	(0.088)	(0.090)	(0.075)
Size		-0.034*	-0.023***		-0.038*	-0.037***
		(0.019)	(0.009)		(0.022)	(0.010)
Leverage		0.076**	0.148***		0.055	0.133***
		(0.036)	(0.027)		(0.043)	(0.029)
Intangibility		0.187*	0.258**		0.161	0.243*
		(0.102)	(0.124)		(0.125)	(0.137)
ROA		-0.152**	0.010		-0.303***	-0.120*
		(0.076)	(0.063)		(0.089)	(0.069)
Capital Intensity		0.044	-0.033		0.113	0.007
		(0.073)	(0.057)		(0.097)	(0.068)
Inventory		-0.080	0.032		-0.017	0.081
		(0.102)	(0.058)		(0.113)	(0.065)
Observations	1,628	1,628	1,628	1,402	1,402	1,402
Adj. R-squared	0.058	0.071	0.167	0.038	0.060	0.140
Firm fixed effects	Yes	No	Yes	Yes	No	Yes
Industry fixed effects	No	Yes	No	No	Yes	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the regression results of regression model 2. Panel A reports results for the full sample. Panel B reports results for the matched sample. *Reform* is an indicator variable taking value one for years 2008 onwards and zero otherwise. *Treatment* is an indicator variable equal to one if a firm holds at least one patent in the post-reform period and equal to zero, otherwise. *Shift* is an indicator variable equal to one if the firm has an incentive to shift income out of the country and zero if not. Standard errors clustered at the firm-level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 7: *Effects on patenting activities*

Panel A: Full Sample						
	ln(Patent Applications)		ln(Patent Grants)		ln(Patent Stock)	
	(1)	(2)	(3)	(4)	(5)	(6)
Reform	-0.000	-0.001***	-0.002***	-0.002***	0.003***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
MNE		0.025***		0.016***		0.058***
		(0.006)		(0.004)		(0.011)
Reform x MNE	0.000	-0.002	-0.007**	-0.007***	0.017***	0.011
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.007)
Size	0.001***	0.004***	0.001***	0.002***	0.001***	0.010***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Leverage	-0.000	-0.002***	-0.000	-0.001***	-0.000	-0.007***
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Observations	1,143,208	1,143,208	1,143,208	1,143,208	1,143,208	1,143,208
Adj. R-squared	0.000	0.032	0.000	0.028	0.002	0.047
Firm fixed effects	Yes	No	Yes	No	Yes	No
Industry fixed effects	No	Yes	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Matched Sample						
	ln(Patent Applications)		ln(Patent Grants)		ln(Patent Stock)	
	(1)	(2)	(3)	(4)	(5)	(6)
Reform	-0.000	-0.047*	-0.044**	-0.110***	0.215***	0.199***
	(0.026)	(0.028)	(0.020)	(0.022)	(0.024)	(0.037)
MNE		-0.023		-0.012		-0.099
		(0.064)		-0.049		(0.105)
Reform x MNE	-0.023	-0.026	-0.029	-0.027	-0.012	-0.014
	(0.036)	(0.041)	(0.026)	(0.025)	(0.038)	(0.052)
Size	0.051***	0.070***	0.042***	0.046***	0.056***	0.116***
	(0.017)	(0.011)	(0.012)	(0.008)	(0.021)	(0.023)
Leverage	0.068	-0.084	0.005	-0.082*	-0.003	-0.210*
	(0.053)	(0.064)	(0.040)	(0.042)	(0.055)	(0.125)
Observations	8,531	8,531	8,531	8,531	8,531	8,531
Adj. R-squared	0.002	0.129	0.008	0.102	0.094	0.229
Firm fixed effects	Yes	No	Yes	No	Yes	No
Industry fixed effects	No	Yes	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the regression results of regression model 3. Panel A reports results for the full sample. Panel B reports results for the matched sample. *ln(Patent Applications)* is the natural logarithm of patent applications, *ln(Patent Grants)* the natural logarithm of patent grants, and *ln(Patent Stock)* the natural logarithm of patent stock. (Standard errors clustered at the firm-level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 8: *Placebo Reforms*

Panel A: Full Sample						
	GAAP ETR			Cash ETR		
	(1)	(2)	(3)	(4)	(5)	(6)
Reform2005 x Treatment2005	-0.006			-0.012		
	(0.007)			(0.010)		
Reform2006 x Treatment2006		-0.016**			-0.014	
		(0.007)			(0.009)	
Reform2007 x Treatment2007			-0.027***			-0.022**
			(0.006)			(0.009)
Size	-0.004***	-0.004***	-0.004***	-0.025***	-0.025***	-0.025***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)
Leverage	-0.012***	-0.012***	-0.012***	0.015**	0.015**	0.015**
	(0.002)	(0.002)	(0.002)	(0.008)	(0.008)	(0.008)
Intangibility	-0.099***	-0.099***	-0.098***	0.059	0.060	0.060
	(0.005)	(0.005)	(0.005)	(0.039)	(0.039)	(0.039)
ROA	-0.303***	-0.303***	-0.303***	-0.368***	-0.368***	-0.368***
	(0.002)	(0.002)	(0.002)	(0.013)	(0.013)	(0.013)
Capital Intensity	-0.018***	-0.018***	-0.018***	-0.027**	-0.027**	-0.027**
	(0.002)	(0.002)	(0.002)	(0.012)	(0.012)	(0.012)
Inventory	0.006	0.007	0.007	0.018	0.018	0.018
	(0.004)	(0.004)	(0.004)	(0.014)	(0.014)	(0.014)
Observations	1,143,208	1,143,208	1,143,208	73,366	73,366	73,366
Adj. R-squared	0.028	0.028	0.028	0.061	0.061	0.061
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Matched Sample						
	GAAP ETR			Cash ETR		
	(1)	(2)	(3)	(4)	(5)	(6)
Reform2005 x Treatment2005	-0.009			-0.020		
	(0.010)			(0.014)		
Reform2006 x Treatment2006		-0.010			-0.011	
		(0.010)			(0.013)	
Reform2007 x Treatment2007			-0.014			-0.016
			(0.010)			(0.013)
Size	-0.015*	-0.015*	-0.015*	-0.050***	-0.050***	-0.050***
	(0.008)	(0.008)	(0.008)	(0.012)	(0.012)	(0.012)
Leverage	0.051***	0.051***	0.051***	0.058**	0.057**	0.057**
	(0.020)	(0.020)	(0.020)	(0.025)	(0.025)	(0.025)
Intangibility	0.067	0.068	0.069	0.110	0.110	0.109
	(0.070)	(0.070)	(0.070)	(0.078)	(0.078)	(0.078)
ROA	-0.150***	-0.149***	-0.149***	-0.329***	-0.329***	-0.330***
	(0.033)	(0.033)	(0.033)	(0.046)	(0.046)	(0.046)
Capital Intensity	0.057*	0.057*	0.057*	-0.025	-0.024	-0.025
	(0.030)	(0.030)	(0.030)	(0.050)	(0.050)	(0.050)
Inventory	0.072*	0.072*	0.073*	0.044	0.044	0.045
	(0.040)	(0.040)	(0.040)	(0.048)	(0.048)	(0.048)
Observations	8,531	8,531	8,531	4,953	4,953	4,953
Adj. R-squared	0.037	0.037	0.038	0.074	0.073	0.074
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the regression results of regression model 1 for different placebo reforms. Panel A reports results for the full sample. Panel B reports results for the matched sample. *Reform20XX* is an indicator variable taking value one for placebo reform years 20XX onwards and zero otherwise. *Treatment20XX* is an indicator variable equal to one if a firm holds at least one patent in the placebo-reform period and equal to zero, otherwise. Standard errors clustered at the firm-level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 9: *Placebo Treatments*

	Full Sample		Matched Sample	
	GAAP ETR	Cash ETR	GAAP ETR	Cash ETR
	(1)	(2)	(3)	(4)
Reform x TreatmentRandom	-0.000	-0.003	0.009	-0.001
	(0.001)	(0.004)	(0.009)	(0.013)
Size	-0.004***	-0.024***	-0.014*	-0.049***
	(0.001)	(0.003)	(0.008)	(0.012)
Leverage	-0.012***	0.015**	0.052***	0.057**
	(0.002)	(0.008)	(0.020)	(0.025)
Intangibility	-0.099***	0.058	0.064	0.112
	(0.005)	(0.039)	(0.070)	(0.078)
ROA	-0.303***	-0.368***	-0.149***	-0.331***
	(0.002)	(0.013)	(0.033)	(0.046)
Capital Intensity	-0.018***	-0.027**	0.058*	-0.025
	(0.002)	(0.012)	(0.030)	(0.050)
Inventory	0.006	0.018	0.071*	0.044
	(0.004)	(0.014)	(0.040)	(0.048)
Observations	1,143,208	73,366	8,531	4,953
Adj. R-squared	0.028	0.061	0.037	0.073
Firm fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes

This table reports the regression results of regression model 1 for placebo treatments. Panel A reports results for the full sample. Panel B reports results for the matched sample. *Reform* is an indicator variable taking value one for reform years 2008 onwards and zero otherwise. *TreatmentRandom* is an indicator variable that randomly assigns a treatment to a firm. Placebo Treatment and control groups are evenly distributed over our sample. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.