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The Effect of Intellectual Property Boxes on Innovative Activity & Effective Tax Rates

Abstract. We investigate whether the adoption of an intellectual property box increases innovative activity and what type of firms benefit. We examine the adoption of the intellectual property box in Belgium because it allows us to cleanly identify the impact on innovative activity and effective tax rates. Our results indicate an overall increase in innovative activity as proxied by patent grants, the efficiency with which firms apply for and receive patents, and employment. We also provide evidence that, while firms with patents on average enjoy lower effective tax rates, the greatest financial benefits accrue to multinational firms without income shifting opportunities, followed by domestic firms. Multinational firms with income shifting opportunities do not significantly benefit from the intellectual property box.

1. Introduction

Intellectual property (IP) box regimes, or patent boxes, are a relatively new tool that some countries use to promote innovative activity and to attract or retain mobile income and research and development (R&D) activities within the country. While tax benefits vary across regimes, in theory, IP boxes reduce the effective tax burden on successful R&D investments (Evers, Miller, and Spengel 2015). However, it is difficult to empirically evaluate the effectiveness of IP boxes due to the heterogeneity in the characteristics and scope of IP box regimes across jurisdictions.[1] We overcome this limitation by identifying a quasi-experimental setting around the adoption of an IP box regime in Belgium to investigate two research questions. First, do IP box regimes increase firms' innovative activity? Second, what type of firms benefit financially from the introduction of the IP box regime?

Governments routinely use tax expenditures to foster innovative activities. For example, in 2013 U.S. taxpayers spent approximately $11.3 billion to fund the U.S. R&D tax credit (IRS, 2013). Prior empirical research suggests that one dollar of tax revenue spent on the R&D tax credit induces firms to invest anywhere from $ 1 to $ 2.96 in R&D activities (Berger, 1993; Klassen, Pittman, and Reed, 2004). Given that U.S. firms invested approximately $ 502.9 billion in R&D activities in 2013 (OECD, 2015), this suggests that the U.S. R&D tax credit induces anywhere between 2.2% and 6.6% of total corporate R&D investment. With respect to IP boxes, Merrill et al. (2012) estimate the cost of a U.S. version of an IP box regime at $9 billion (if enacted in the same form as in the U.K.) to $11 billion (if enacted in the same form as Belgium) per year. Given the heterogeneous nature of IP box regimes across countries, however, it is

[1] See Section 2 for an explanation of the institutional setting and a discussion of recent literature that provides limited evidence on the effectiveness of IP box regimes.

unclear whether and to what extent IP boxes increase innovative activities (e.g., Alstadsæter, Barrios, Nicodeme, Skonieczna, and Vezzani, 2018; Bradley, Dauchy, and Robinson; 2015; Chen, De Simone, Hanlon, and Lester, 2016). It is also unclear which firms benefit from these regimes. Because governments are potentially sacrificing large amounts of tax revenue in exchange for vague and uncertain benefits, it is important to understand whether an IP box affects firms' innovative activities and which firms receive benefits from the IP box.

In contrast to contemporaneous research on IP boxes that examines multiple countries, we focus on one country because it allows us to cleanly identify targeted innovative activity and resulting tax benefits around the adoption of the IP box. We exploit the Belgian IP box regime applicable for fiscal years ending after December 31, 2007, for numerous reasons. First, the tax benefits conferred by the Belgian IP box are only for gross income from new patents and exclude income from other forms of IP such as trademarks, know-how, or other secretly held innovation.[2] Second, in contrast to most other forms of IP, we can observe firms' patent applications, grants, holdings, and quality before and after the tax rate change. Third, the Belgian IP box decreases the tax rate on gross patent income by approximately 80%, from 33.99% to 6.8%, with no other tax rate changes in 2007 and 2008.[3] Fourth, Belgium maintains strict reporting requirements providing comfort that our sample captures substantially all firms that benefit from this law change. Fifth, this IP box applies to revenues for patents exploited after the IP box adoption earned by any domestic firm or subsidiary of a foreign parent that demonstrates nexus in Belgium.[4] Finally, both public and private Belgian firms are required to disclose detailed

[2] A "new" patent is one that did not lead to the sale of a patented product or service to an unrelated party prior to January 1, 2007. Therefore, the patent can exist before this date as long as it was not "exploited" prior to this date.
[3] See Eynatten (2008). We address other potential law changes in our robustness tests and alterative empirical specifications using year fixed effects. Also, we are also not aware of any regulatory changes in the patent filing process in our sample period in either Belgium or Germany.
[4] We use "nexus" to mean that the firm meets the requirements of an R&D certified center. This is different than the "modified nexus" approach adopted by the OECD (2016).

information about their workforce in publicly available financial statements allowing us to examine this important proxy of firm activity (Dierynck, Landsman, and Renders, 2012). Therefore, the Belgian IP box provides a strong quasi-experimental setting.

We investigate the effect of the adoption of the Belgian IP box on Belgian firms' innovative activity using a difference-in-difference specification with German firms as our comparison group.[5] We use six proxies for innovative activity, including patent applications, patent grants, patent efficiency (the ratio of patent applications or grants to patent stock), the number of employees, and patent quality. Our sample period extends from 2003 to 2012, and our results are consistent with innovative activity increasing after the adoption of an IP box. Relative to German firms, the results for our balanced panel of Belgian firms suggest that while patent applications do not change, patent grants increase by 0.7%, the number of employees increases by 6.7% and patenting efficiency (i.e., the ratio of patent applications (grants) to patent stock) improves. Belgian firms change from a 1.8 (3.8)% smaller patent application (grant) ratio before the IP box to a 2.3% higher (1.3% smaller) ratio after the adoption of the IP box. Patent quality is the only proxy that decreases after the adoption of the IP box. This pattern is substantially robust across both a balanced and unbalanced sample of firm-years, within patent-intensive industries and larger firms, as well as within domestic and multinational firm years respectively.

We also examine the effect of the Belgian IP box on effective tax rates to estimate the tax benefits conferred through an IP box. Relative to German firms, we find that Belgian firms on average reduce their effective tax rates by approximately 5.6 (4.6) percentage points after the adoption of the Belgian IP box for our balanced (unbalanced) sample. This pattern holds across

[5] Germany is a neighboring country and does not have an IP box. We discuss the merits of using German firms as a control group in Section 3.

patent-intensive industries, larger firms, as well as within domestic and multinational firm years respectively.

We run additional tests on our Belgium only sample to further investigate detailed employment changes around the adoption of the IP box as well as cross-sectional variation in the conferred tax benefits, as measured by decreases in effective tax rates. We find that overall employment increases on average, as before, but the increase appears concentrated in blue-collar workers employed by domestic firms in existence during the entire sample period (balanced panel) and highly-skilled workers concentrated in firms created (or entering Belgium) after the adoption of the IP box (unbalanced panel). In addition, tax benefits are largest for multinational firms that do not have an opportunity to shift income out of the country, followed by domestic firms. In contrast, multinational firms with income shifting opportunities do not enjoy significant tax benefits. We conduct several robustness tests to support the appropriateness of the difference-in-difference methodology and rule out other explanations.

Our research makes several contributions. First, it contributes to the IP literature by identifying a strong setting. Theoretical evidence suggests IP boxes increase returns to successful R&D, leading to more innovation (Evers et al., 2015). The size of the effect is challenging to quantify, however, and likely varies across countries due to the heterogeneous nature of IP regimes. In cross-country IP box studies, it is difficult to isolate how specific elements of any one IP box affect innovative activity. Cross-country studies also suffer from typical confounds such as culture, correlated omitted tax law changes, and other related law changes. From a policy perspective, evidence from multiple regimes is difficult to interpret when deciding on the structure of an IP box because it is not clear which aspect of any regime is driving the results. We identify a strong setting that allows us to investigate the direct impact of an IP box regime on

patenting activity in a country with a substantial tax benefit for one type of IP revenue (patents). Our results suggest that adopting a substantial tax benefit on gross patent income is related to an increase in innovative activities at the expense of patent quality.

Second, our study answers calls from policymakers and academics to assess whether a given R&D tax incentive achieves its objective and which firms benefit the most from it (Merrill, 2016; Guenther, 2017). As discussed in Section 2, one reason Belgium adopted the IP box was to foster technical innovation and increase R&D leading to commercial applications (Belgische Kamer Van Volksvertegenwoordigers, 2007). Our results suggest an overall increase in innovative activity as proxied by patent grants, the efficiency with which firms apply for and receive patents, and employment. Consistent with more revenue from newly commercialized patents after the adoption of the IP box in Belgium, our results also show a significant decrease in effective tax rates for firms operating in Belgium relative to Germany.

Third, our study examines the types of firms that reap the benefits of IP box tax incentives. Using only the Belgian firms, we measure the tax benefits accruing to firms by examining cross-sectional differences between domestic and multinational firms, and separately between multinationals with different income shifting opportunities. We provide evidence that, while firms with patents on average enjoy lower effective tax rates after the adoption of the IP box, multinational firms without income shifting opportunities receive the greatest tax benefits, followed by domestic firms. We find that multinational firms with income shifting opportunities do not benefit from the Belgian IP box, even in patent-intensive industries where prior research suggests otherwise (Guenther, 2017).

Collectively, our results indicate that the Belgian IP box increased innovative activity, but the quality of that activity declined. Our results also indicate that multinational firms without

other income shifting opportunities enjoy the biggest tax benefits from the IP box, followed by domestic firms, and other multinationals. This suggests that the desired effects of an IP box differs across types of firms and are difficult to anticipate because multinationals are able to decrease their effective tax rate via other channels. Our findings are useful for policymakers and academics considering incentives for technological innovations as well as the cost and benefits of tax policy.

Our paper proceeds as follows. In the next section, we provide institutional details on the Belgian IP box regime and derive our hypotheses. In Section 3, we present the research design, including our identification strategy. Section 4 includes our sample selection process and data summary, while Section 5 presents results. We conclude in Section 6.

2. Institutional background and hypothesis development

2.1 Institutional background

Intellectual property box regimes are a tax policy tool used to increase innovative activities and attract and retain investment related to research and development from abroad (Bradley et al., 2015; Brannon and Hanlon, 2015; Evers et al., 2015; Chen et al., 2016). Unlike input-based R&D tax incentives such as R&D tax credits, IP boxes target successful R&D activities that generally result in commercially viable products by providing a reduction in the tax rate applicable to IP income. Across the 17 countries currently using IP boxes, the scope of tax benefits with respect to qualified IP ranges from patents only to an array of IP, such as patents, trade secrets, trademarks, know-how, and domains. Table 1 provides an overview of the different IP box regimes.[6]

[6] See Evers et al. (2015) for a more comprehensive overview and calculations of effective tax rates of IP box regimes in various countries.

We examine the Belgian IP box because it offers a relatively clean research setting. Belgium adopted an IP box regime to meet three goals.[7] First, to foster technical innovation and increase R&D leading to commercial applications (Belgische Kamer Van Volksvertegenwoordigers, 2007, p. 37-38). Second, to prevent the erosion of its (mobile) tax base due to its relatively high statutory tax rate of 33.99%; and third, to compete with its neighboring countries, the Netherlands and Luxembourg, that adopted IP boxes in 2007 and 2008 respectively (Eynatten, 2008; Eynatten and Brauns, 2010; Bradley et al., 2015; Evers et al., 2015). In structuring its IP box to meet these goals, Belgium created relatively strong incentives for firms to engage in innovative activity in Belgium. Incentives include an 80% deduction on gross patent income (royalties, sales income, and notional royalties) less costs of acquired IP for patents commercialized after January 1, 2007, resulting in an effective tax rate of 6.8% on patent income.[8]

The Belgian IP box also applies relatively strong substance requirements compared to other IP boxes and applies to any domestic firm or subsidiary of a foreign parent that can demonstrate R&D activities within Belgium (Eynatten and Brauns, 2010; Faulhaber, 2017). To qualify for the IP box, firms must run a "qualifying research center" (Eynatten, 2008), which is a division of a firm capable of operating autonomously (Merrill et al., 2012). Intangibles developed abroad also qualify for the Belgian IP box as long as the qualified research center belongs to a Belgian legal entity (Eynatten, 2008). As a result, the Belgian IP box regime

[7] In accordance with the OECD's BEPS project, the Belgian Council of Ministers modified its IP Box on December 2, 2016 (effective from July 1, 2016 going forward) to include more categories of income, maintain validity of the IP box income deduction if a company is involved in a merger or acquisition, allow unused deductions to carry forward; increase the deduction to 85%; and replace the qualifying R&D center requirement with a nexus ratio.
[8] Belgium continues to allow firms to deduct related R&D expenses against other ordinary income as well.

provides a significant tax incentive to both domestic firms and multinationals or their subsidiaries that commercialize a patent within Belgium.

2.2. Hypotheses development

2.2.1 The effect of IP box regimes on innovative activity

Tax incentives are important policy tools to boost socially desired innovation and compensate firms for negative externalities triggered by the public good character of intangible assets. The public good character of intangible assets prevents firms from reaping the full benefits of their innovative activities. Ideas and inventions eventually spill over to competitors through high-skilled labor exchanges across firms, penetrable internal information systems, or business secrets falling outside the scope of patent laws and copyrights. Hence, firms cannot internalize the full benefits of their innovative activities pushing private returns to R&D below socially desired returns (Arrow, 1962; Hall, 1996). The public good character of intangible assets also prevents firms from disseminating value-relevant information on their innovative activities to the capital markets increasing the cost of R&D capital (Hall, 2010). For example, Koh and Reeb (2015) document that some firms do not report R&D expenses, although these firms are actively filing patents. Recent research further suggests that trade secrecy results in a decrease in corporate transparency (Glaeser, 2018) and transparency increases firms' innovative effort (Zhong, 2018). As a result, knowledge spillovers and higher costs of R&D capital drive a wedge between investments in tangible and intangible assets leading to underinvestment in innovative activities of firms.

Several countries provide a myriad of input tax incentives (e.g., tax credits) for expenditures on research and development to help close the gap between investment in tangible and intangible assets (OECD, 2016). A substantial body of research on input tax incentives

shows that these incentives increase firms' R&D spending across different countries, such as the U.S. (Cordes, 1989; Berger, 1993; Finley, Lusch, and Cook, 2015), Canada (Klassen et al., 2004), Norway (Cappelen, Raknerud, and Rybalka, 2012), Italy (Carboni, 2011), the Netherlands (Lokshin and Mohnen, 2012), and various OECD countries (Bloom, Griffith, and van Reenen, 2002). However, evidence on IP boxes is still emerging.

IP box regimes provide output-oriented tax incentives that condition the incentive on the success of the innovative activity. Because the commercialization and timing of future returns of R&D investments are uncertain, any tax benefits granted by an IP box regime are uncertain or risky (Holmstrom, 1989; Hall and Lerner, 2010). Therefore, risk-averse managers may not respond to uncertain tax benefits despite seemingly large tax incentives. Recent research provides some support for this conjecture. Evers et al. (2015) derive effective tax burdens on marginal R&D investments for several IP box regimes across Europe and show, analytically, that IP box regimes can significantly decrease the effective tax burdens on marginal R&D investments, but significant variation in tax burdens across countries exists. Chen, et al., (2016) empirically assess the introduction of IP box regimes across several countries and find an increase in total employment, but no increase in fixed asset investment after the introduction of the IP boxes.[9] Other research across multiple jurisdictions finds that an IP box increases the responsiveness of patent applications to tax rates on patent income, but only when inventors and patent owners are located in the same host country (Bradley, et al., 2015). Alstadsæter et al. (2018) find that IP boxes attract high-value patents primarily for R&D intensive firms, whereas Merrill (2016) suggests IP boxes are effective only for firms with relatively immobile R&D activity. Given the heterogeneous nature of IP box benefits across countries, it is difficult to

[9] Employment encompasses both R&D and non-R&D related activities.

identify whether IP boxes significantly affect innovative activity or benefit any particular firms within a country.

As discussed above, the Belgian IP box provides generous incentives for innovative activity, an 80% tax rate reduction on IP income as well as a deduction for R&D expenditures incurred to create the patent against ordinary income taxed at 33.99%. Evers et al. (2015) estimate that the combined effect of these provisions makes Belgium one of the most attractive IP box regimes with the second lowest tax rate on IP in 2008. Furthermore, using country-level data, Bradley et al. (2015) find that the responsiveness of patent applications to tax rates on patent income is increasing in the "generosity" of the tax rate on patent income as well as the favorable treatment of R&D expenses. Brannon and Hanlon (2015) also provide survey evidence within a single jurisdiction (the U.S.) suggesting firms would consider increasing innovative activity upon implementation of an IP box. Therefore, while the nature of successful innovative activities (riskiness, timeliness) coupled with some recent empirical evidence that implies uncertainty as to whether IP boxes increase innovative activities per se, Belgium provides a relatively strong setting where we expect to find a relation between an IP box regime and innovative activity. Our first hypothesis, stated in the alternative, is as follows:

> *H1: Firms subject to the Belgian IP box increase their innovative activities after the introduction of the Belgian IP box regime.*

Firm-level characteristics also likely affect how firms respond to IP box regimes. Multinational firms choose from a broad range of possible locations to carry out R&D investment and exploit successfully developed intangible assets. Prior research suggests that multinational enterprises (MNEs) distort the location of R&D activity and the location of intangible assets toward low tax jurisdictions (Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012). Therefore, IP box regimes commonly tie their benefits to substance requirements

regarding the R&D activity and/or the exploitation of the resulting intangible asset to prevent an artificial dispersion of the location of the R&D activity and the location of the intangible asset. Hence, we expect possible differences in responses to the introduction of IP box regimes between domestic-only firms and MNEs because MNEs are presumably more flexible in separating the location of the R&D from the location of the intangible. However, we have no expectation regarding the sign or magnitude of the difference. In our tests of the effect of IP boxes on innovative activities, therefore, we separately examine domestic and multinational firms.

2.2.2 The effect of IP box regimes on Effective Tax Rates

Governments use tax policy to induce certain behavior creating potential cross-sectional differences in the types of firms that benefit from each policy. We argue that intangible intensive firms, domestic firms, and firms with fewer alternative tax shields benefit more from an IP box when they hold eligible IP. IP boxes generally provide an incremental tax incentive to develop successful intangible assets. For example, in Belgium, R&D investments are tax deductible at the ordinary tax rate of 33.99% while income from successful IP assets is taxed at the preferential 6.8% tax rate.[10] Evers et al. (2015) estimate effective tax burdens on marginal R&D investments and show that one additional dollar spent on R&D yields an average effective tax rate of -1.88% for the Belgian IP box. Therefore, we expect firms with successful IP assets to reap the tax benefits of the IP box regime ceteris paribus.

> *H2a: Firms subject to the Belgian IP box decrease their effective tax rate after the introduction of the Belgian IP box regime.*

[10] Income from successful IP in Belgium includes royalty income from all patents held by Belgian firms, regardless of the location of the patent. See Figure 1 for an illustration.

Further, we expect cross-sectional differences in the extent to which firms benefit from the IP box tax rates across domestic and multinational firms. Intangible assets are mobile and feature high degrees of private information on their true value, providing firms with significant opportunities to avoid taxes (Dischinger and Riedel, 2011; Klassen and Laplante, 2012, Griffith, Miller, and O'Connell, 2014). Recent research suggests that low-tax countries attract intangible assets such as patents (Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012; Ernst, Richter, and Riedel, 2014) or trademarks (Heckemeyer, Olligs, and Overesch, 2016). Weichenrieder and Mintz (2008) also find that firms set up cross-country group structures allowing them to exploit tax loopholes, while other research shows that multinational firms shift income to low-tax countries (Huizinga and Laeven, 2008; Klassen and Laplante, 2012). Multinational firms appear to be responsive to tax rate differentials across countries, shift income to, and locate intangibles in low tax rate countries as part of their tax planning process. In contrast, domestic firms are unable to exploit tax rate differentials across countries or other IP box regimes. We argue that domestic firms' tax rates are relatively more responsive on average than MNEs' tax rates to the introduction of an IP box. Our next hypothesis, stated in the alternative, is as follows:

> *H2b: Domestic firms subject to the Belgian IP box decrease their effective tax rates relatively more than MNEs or subsidiaries of MNEs subject to the Belgian IP box regime.*

Tax avoidance is costly, but it is difficult to determine if it is relatively more costly for some firms. 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 (Lohse and Riedel, 2013). Shifting intangible assets to and setting up special entities in low-tax countries triggers a variety of costs including administrative costs, regulatory costs (e.g., potential penalties for misconduct), additional interest on subsequent tax payments or double taxation. Recent research provides evidence that firms are sensitive to a variety of increasing

costs of tax avoidance including, for example, transfer pricing documentation (Beer and Loeprick, 2015); anti-avoidance rules (Dischinger and Riedel, 2011; Lohse and Riedel, 2013) and financial constraints (Dyreng and Markle, 2016). 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; Rego, 2003).

We also expect cross-sectional differences in the extent to which firms benefit from the IP box tax rates across firms with relatively more income shifting opportunities. Not all subsidiaries of multinationals have similar tax avoidance opportunities. If, for example, the subsidiary of the multinational enterprise has no opportunities to shift income out of the country, the subsidiary should benefit from the introduction of an IP box regime in the same way as a domestic firm. Therefore, we further hypothesize:

> *H2c: MNEs or subsidiaries of MNEs subject to the Belgian IP box, but no opportunities to shift income out of the country, decrease their ETRs relatively more than MNEs or subsidiaries of MNEs subject to the Belgian IP box with income shifting opportunities after the introduction of the Belgian IP box regime.*

3. Research design

3.1 Identification strategy

We exploit the unique institutional setting of the Belgian IP box because, unlike other IP box regimes that provide tax benefits for both observable and unobservable intangible assets, the Belgian IP box regime limits tax benefits to income derived from patents only. Patents are observable in archival data. To examine the effect of IP boxes on innovative activities and ETRs, we employ a difference-in-difference design and identify Belgian firms (*BE*) as treatment firms because they are potentially able to benefit from the IP box regime.

We select German firms as control firms because Germany is geographically adjacent to Belgium, shares economic and institutional similarities (e.g., bank financing), and importantly

does not have an IP box (Andrews, Criscuolo, and Menon, 2014; Hsu, Tian, Xu, 2014). Both countries are also members of the Euro Zone, have a similar composition of industries (Andrews et al., 2014), and show a similar pattern of economic development within the sample period.[11]

Belgium cut its tax rate on newly-commercialized patent-related income from 33.99% to 6.8% on January 1, 2008, and we assume that eligible firms act rationally and opt into the IP box regime once they hold patents. We compare innovative activities and ETRs in the pre-reform period (pre-2008) versus the post-reform period (post-2007) for Belgian and German firms as the primary tests of our hypotheses. We assume that absent the introduction of the IP box regime, innovative activities and ETRs of Belgian and German firms evolve similarly (parallel trends assumption).[12] Applying a difference-in-difference design helps overcome drawbacks of comparing differences in activities before and after the reform across all firms, and allows us to strengthen causal inferences and derive implications about the effect of the implementation of an IP box.

3.2 Innovative activity and tax benefits

We use five patent-related metrics derived from the innovation economics literature, as well as an aggregate measure of employment, to measure firms' innovative activities (Hall, Thoma, and Torrisi, 2007; Hall et al., 2014). We calculate each proxy for each firm-year in our sample. Patents grant the right to exclude others from making, using or selling an invention and, therefore, reflect an investment in innovation. Patent applications are a common proxy for innovative activities (Hall et al., 2007; Hall, Helmers, Rogers, and Sena, 2014; Alstadsæter et al.,

[11] Retrieved from: Eurostat, http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00115&plugin=1). All of Belgium's other adjacent neighbors, the Netherlands, Luxembourg, and France introduced IP boxes prior to, or concurrent with, Belgium making them poor choices for a control sample.

[12] We investigate the parallel trends assumptions in three ways (Roberts and Whited, 2012): growth rates in dependent variables between treatment and control firms in the periods preceding 2008, placebo reforms, and placebo treatment tests. Overall, these tests confirm the parallel trend assumption (see Section 5.4 for details).

2018, Bradley et al., 2015).[13] Not every patent application results in a commercially exploitable patent, so we use patent grants as an alternative proxy for successful innovative activities (Hall et al., 2007; Hall et al., 2014). Following prior literature, we use the natural logarithm of each of these measures to account for the skewness of the underlying patenting metrics *ln(Patent Applications)* and *ln(Patent Grants)* (Hall et al., 2007; Alstadsæter et al., 2018; Balsmeier, Fleming, and Manso, 2017).[14] We also use two ratios, patent applications, and patent grants to patent stock, to examine the efficiency of innovative activities (Ciftci and Cready 2011; Hirshleifer, Hsu, and Li 2013). Patenting efficiency is an important indicator of innovative activity. If we assume patent stock is a measure of a firm's ability to successfully obtain patents, the efficiency ratios capture changes in the rate that firms are filing for or receiving patents relative to their ability. We define *Pat App Ratio* (*Pat Grant Ratio*) as the ratio of *Patent Applications (Patent Grants)* to patent stocks, which is the aggregated number of patents granted to firm *i* from year *t-19* through year *t*.[15] Our fifth proxy is *Patent Quality*. We acknowledge that patent quality is a poor proxy for the level of innovative activity. However, we include it to provide an indication of the quality of innovative activity induced by an IP box. We follow Lanjouw and Schankerman (2004), Hall et al., (2007), and Ernst et al., (2014) and use a composite quality indicator accounting for three factors of patents held (forward citations, family size, and technological scope of the patent) to proxy for the quality of innovative activities.[16] Our

[13] R&D expenditures are also used to proxy for innovative activities, but our data does not provide sufficient observations to use this proxy.
[14] We set the logarithm to zero when the logarithm is not defined. See Appendix A for further details.
[15] Patent stock is proxy for the firm's total number of patents available for commercial exploitation. We do not include patent stock as a proxy for innovative activity because we are primarily interested in the underlying innovative activities that are captured more directly by patent applications and grants.
[16] This measure adds the number of patent classes and family size to forward citations (Hall et al., 2007). It extends Hall, Jaffe, and Trajtenberg (2005) and is widely used in the finance and economics literature (e.g., Hsu, Tian, and Xu, 2014). Our results are similar to this literature, with an average *Patent Quality* below 0 and varying between -3.00 and +1.67 (Hall et al., 2007; Ernst et al., 2014). We weight each patent by its relative quality and aggregate it on an annual basis. At an aggregate level, Ernst et al. (2014, 712) calculate a median of -0.2494 for a European

last proxy for innovative activity is the level of employment because labor is an important *input* factor for innovative activities. We calculate *ln (Employees)* as the natural logarithm of the number of employees for firm *i* in year *t* (Andrews et al., 2014).[17] Appendix A provides definitions and the data sources for all variables.

We use effective tax rates to proxy for tax benefits because they capture the lower tax rate applicable to newly commercialized patents in Belgium, which is the only tax change to occur in Belgium during the sample period. Specifically, we calculate *Adj_ETR* as the GAAP effective tax rate (*GAAP ETR*) of firm *i* in year *t* (ratio of tax expenses and profit before taxes) and subtract the statutory tax rate of the respective country (Dyreng, Hoopes, and Wilde, 2016).[18] We use *Adj_ETR* instead of *GAAP ETR* because Germany lowered its statutory tax rate in 2008 from 38.36% to 29.51% (KPMG 2018) and *Adj_ETR* attempts to account for this statutory tax rate change.[19]

3.3. Empirical specification

3.3.1 The effect of the IP box on firms' innovative activities (H1) and tax benefits (H2)

We estimate the following model to address whether Belgian firms increase innovative activities around the adoption of the IP box regime relative to German firms:

$$Innovative\ Activity_{it} = \alpha + \lambda_1 Reform_t + \lambda_2 BE_i + \lambda_3 Reform_t \times BE_i + \theta\ Controls_{it} + FE + \varepsilon_{it}. \quad (1)$$

In model (1), *Innovative Activity* is one of the six proxies for innovative activities, *ln(Patent*

sample which is higher than the median in our combined sample (-0.466). While the level of median (and mean) is different in our sample, the distribution is similar.

[17] Prior literature also uses the cost of employees (e.g., Dischinger and Riedel, 2011), but we do not have this data for our German firms.

[18] See appendix A for variable definitions.

[19] The lower corporate tax rate in Germany decreases the chance that we find a significant increase in innovative activities in Belgium relative to Germany because lower statutory tax rates are associated with increased patenting activities (Karkinsky and Riedel, 2012). We conduct additional tests without German firms and report results in Section 5.3.

Applications), ln(Patent Grants), Pat App Ratio, Pat Grant Ratio, Patent Quality, and *ln(Employees)* of firm *i* in year *t* described above. *Reform* is an indicator variable equal to one for all years after the introduction of the IP box regime (2008 onwards) and zero otherwise. *BE* is an indicator variable equal to one if firm *i* is located in Belgium and zero otherwise. *Controls* is a vector of control variables, including *Size*, because larger firms are likely to have more innovative activity and benefit from scale effects (Ciftci and Cready, 2011), and *Leverage* to account for firms' financial constraints (Hall et al., 2007; Balsmeier et al., 2017). We include fixed effects, *FE*, at the industry level to capture any additional unobservable industry factors.[20] Due to the inclusion of firms in multiple years, we report robust standard errors clustered at the firm level to mitigate concerns of understated standard errors (Petersen, 2009). Appendix A presents detailed definitions of each variable, including the source of data. The coefficient on the interaction between *Reform* and *BE*, λ_3, captures any incremental innovative activities of Belgian firms relative to German firms after the introduction of the Belgian IP box regime. A positive and significant λ_3 suggests the Belgian IP box increased innovative activities in Belgium consistent with our first hypothesis.

To address whether Belgian firms enjoy tax benefits around the adoption of the IP box regime relative to German firms, we estimate the following OLS regression:

$$Adj\_ETR_{it} = \alpha + \beta_1 Reform_t + \beta_2 BE_{it} + \beta_3 Reform_t \times BE_{it} + \delta Controls_{it} + FE + \varepsilon_{it}. \qquad (2)$$

In model (2) all variables are as defined above, except for the control variables. The coefficient on the interaction between *Reform* and *BE*, β_3, captures the incremental change in the effective

[20] We also run all regressions with year, industry-year, and country-industry fixed effects and the results are substantially unchanged. While the inclusion of year fixed effects limits the ability to interpret any coefficients on *Reform*, it allows us to control for macroeconomic correlated omitted variables and reduces the impact of cross-sectional correlation on standard errors.

tax rate of Belgian firms relative to German firms after the introduction of the Belgian IP box regime. In model (2), we include *Size* because larger firms have greater tax planning opportunities (Rego 2003) or higher political costs (Zimmerman, 1983; Gupta and Newberry, 1997); *Leverage* to account for the deductibility of interest expense (Chen, Chen, Cheng, and Shevlin, 2010; Dyreng, Hanlon, and Maydew, 2008); *Intangibility* to account for the ease of shifting income in the presence of intangible assets (Rego, 2003; Dyreng et al., 2008); *ROA,* return on assets, because successful firms likely pay relatively more taxes (Gupta and Newberry, 1997; Rego, 2003; Chen et al., 2010); *Capital Intensity* because higher capital expenditures allow for depreciation expenses (Gupta and Newberry, 1997); and *Inventory* because inventory is a substitute for capital investments (Gupta and Newberry, 1997).

To investigate cross-sectional differences in response to the IP box, we estimate models (1) and (2) for domestic and MNE firms separately. As depicted in Figure 1, MNEs are firms that have subsidiaries in foreign countries or are part of a multinational group headquartered in a foreign country. Domestic firms have neither parents nor subsidiaries in foreign countries. For Hypothesis 1, we do not make any predictions about differences between domestic and multinational firms. For Hypothesis 2a, we expect β_3 to be negative for the entire sample. Consistent with Hypothesis 2b, we expect β_3 to be less pronounced for multinational enterprises if these firms respond relatively less to the introduction of the IP box regime.

To investigate Hypothesis 2c, we bifurcate multinational firms according to their income shifting opportunities and estimate model (2) separately for firms with and without shifting opportunities. To test whether MNEs without other income shifting opportunities decrease their effective tax rates relatively more than MNEs with income shifting opportunities, we modify model (2) by including a triple interaction ($Reform_{it} \times BE_{it} \times Shift_{it}$) in a fully specified model

and estimate this regression in the sub-sample of multinational firms. *Shift* equals one if the firm is a multinational enterprise with an opportunity to shift income out of their respective country and zero otherwise. We construct *Shift* following Huizinga and Laeven (2008) and Markle (2016) to capture the incentives and opportunities to shift income among countries in which the multinational operates.[21] The coefficient on $Reform_{it} \times BE_{it} \times Shift_{it}$ captures the moderating effects of income shifting opportunities on Belgian MNEs' use of the Belgian IP box. If Belgian MNEs with an incentive to shift income out of the country respond relatively less to the introduction of the IP box regime, we expect the coefficient on the triple interaction to be positive and significant.

4. Data and sample

Our primary sample comprises Belgian industrial firms from 2003 to 2012. We choose a ten-year sample period including five years before and after the introduction of the Belgian IP box regime in 2008 because patenting is a lengthy 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, at which time it appears in the database. Therefore, we end the sample period in 2012 to ensure comparability across sample years. A ten-year sample period should reliably capture firms' innovative activities and effective tax rate changes.

We construct our sample from unconsolidated financial, employment, and ownership data from Bureau van Dijk's *ORBIS* database, and the Worldwide Patent Statistical Database

[21] Due to data constraints we can only compute this measure based on the statutory tax rates of the immediate parent or subsidiary of the Belgian firm, so we model income shifting opportunities between Belgium or Germany and the jurisdiction in which the parent and/or subsidiary of the MNE is located. We obtain our data from unconsolidated financial statements that reflect profits of a MNE's parent/subsidiary after any income shifting, which likely affects effective tax rates. We recognize that using the tax rate differential of the parent and subsidiary captures the incentive to shift income with noise, Markle (2016) suggests that income shifting involving the parent country is especially relevant for firms in territorial tax systems.

(*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, patent grants, and patent citations.[22] We use Bureau van Dijk's reverse search algorithm, taking into account the firm's name, city, and country of residence, to merge the patent data into our sample.[23]

We document our sample selection procedure in Table 2. We begin with 4,643,000 Belgian and 13,672,830 German firm-year observations.[24] We exclude firm-years with missing values for total assets, industry classification, and control variables, as well as negative or zero total assets, or profit before tax.[25] For our primary tests, our unbalanced panel consists of 4,056,540 (1,143,169 Belgian and 2,913,371 German) firm-year observations of 618,647 distinct (234,616 Belgian and 384,031 German) firms. Our balanced panel consists of 493,150 (244,450 Belgian and 248,700 German) firm-year observations of 49,315 (24,445 Belgian and 24,870 German) distinct firms. We winsorize all continuous covariates at the 1st and 99th percentile to accommodate for potential outliers. We winsorize *Adj_ETR* at zero and one, before subtracting the statutory tax rate, to account for outliers in the distribution of effective tax rates within a country (Dyreng, at al., 2008; Dyreng et al., 2016).

5. Results

5.1 Descriptive statistics

[22] The database covers patent applications of European Patent Convention (EPC) member states and other major patent offices in the world like the United States Patent and Trademark Office (USPTO). For more information, see https://www.epo.org/searching-for-patents/business/patstat.html#tab-1.
[23] We are able to merge over 80% of Belgian firms in *PATSTAT* to firms retrieved from *ORBIS*.
[24] Initial sample sizes appear large because reporting requirements induce all types and sizes of businesses to report financial information.
[25] We require this step to calculate effective tax rates (Dyreng et al., 2008).

Table 3 presents descriptive statistics for the balanced sample of our primary tests including Belgian and German firms. Approximately 1.1% (10.4%) of Belgian (German) firm-year observations in this sample apply for patents. The combined average is approximately 5.8% and is consistent with findings of the innovation economics literature (Andrews et al., 2014; Hall et al., 2014; Bradley et al., 2015).[26] The German firm-years also contain significantly more patent applications and grants and are of higher quality. *Adj_ETR* is more negative for German firms, reflecting a bigger difference between German firms' effective and statutory tax rates across the sample period.[27]

Table 4 presents Pearson correlations for the balanced sample of our primary test. Correlation coefficients significant at the 1% level are marked bold in each panel. As expected, the correlation among the proxies for innovative activities (*Patent Applications, Patent Grants, Patent App Ratio, Patent Grant Ratio, Patent Quality*, and *Employees*) are high in both panels. The correlation coefficients of *Size, Inventory, Capital Intensity*, and *MNE* are negatively correlated with *Adj_ETR* whereas the coefficients of *Size* and *Leverage* are positively correlated.[28] *Adj_ETR* exhibits a significant but relatively small correlation with five of six variables proxying for innovative activities, *Patent Applications, Patent Grant, Patent App Ratio, Patent Grant Ratio, Patent Quality*, and *Employees* suggesting the effect of an increase in innovative activity on effective tax rates might be too small to capture in the data.

5.2 Primary tests

[26] Prior literature documents great variation of innovation activities among countries (Andrews et al., 2014).
[27] A *t*-test between Belgian and German firms indicate differences that are significant at the 1% level. We address potential concerns about the comparability of treatment and control groups in Section 5.4.
[28] We attribute the positive coefficient for *Leverage* to the notional interest regime that was enacted in Belgium in 2006, reducing the benefit of using high leverage to reduce tax payments. To mitigate concerns that our results are driven by the adoption of the notional interest regime, we conduct placebo reform tests in Section 5.4 and results indicate that reduced effective tax rates are not attributed to the adoption of notional interest regime.

We report our results in Tables 5 – 9 using a balanced and an unbalanced sample to provide information about whether any change in activity originates from firms that existed during the entire sample period or from all available firms. We also report results across omestic and MNEs to document potential differences in responses to tax policy across groups of firms.[29]

5.2.1 The effect of the IP box on firms' innovative activities

We first test whether the Belgian IP box affects innovative activities of firms using the specification presented in model (1). In Table 5, we report results from both balanced (Panels A and C) and unbalanced (Panels B and D) panels of firm-years. In Panel A columns (1), (3), (5), (7), (9), (11), we initially report results excluding control variables. The constant term in these columns represents the average level of activity in German firms before the adoption of the Belgian IP box.[30] Across both balanced and unbalanced observations, the coefficients on the innovative activities of Belgian firms relative to German firms, *BE*, are negative and significant consistent with German firms engaging in more innovative activity on average (Andrews et al., 2014).

The interaction term of *Reform* and *BE* (β_3) provides an indication of any incremental innovative activity of Belgian firms during the reform period. Results from Table 5 generally suggest that, relative to firms in Germany, innovative activities increase while patent quality decreases. Specifically, from the balanced panel in Panel A we see that in Belgium relative to Germany, patent grants increase by 0.7 % (Column 4), application and grant ratios increase by 4.2% and 2.5% (Columns 6 and 8 respectively), and employment increases by 6.7% (Column

[29] We also run all tests on subsamples of large firms (where SIZE > 5 meaning total assets exceed €10 mil) and patent-intensive industries as defined by Andrews et al. (2014). These tests indicate that our primary results are not driven by these subsamples of firms.

[30] The intercept does not have a direct interpretation once we include control variables because the regression extrapolates values by setting all independent variables to zero.

10).[31] Patent quality, meanwhile, decreases but the size of the decrease is difficult to interpret economically given the proxy comprises three disparate components. This pattern is robust for both domestic and MNE firms (Panel C).[32]

We also report results separately for domestic and MNEs in Panel C (balanced) and Panel D (unbalanced). We make no prediction regarding the level of patent activity in domestic firms versus MNEs. The results in Panels C and D suggest that Belgian MNEs have relatively more patent applications and grants after 2007 compared to domestic firms.[33] In contrast, the results in columns (5) to (8) in Panel C indicate that domestic firms experience an increase in the number of applications and grants relative to their patent stocks as reflected in significantly positive patent application and grant ratios. Moreover, the results suggest that domestic firms increase employment relatively more than MNEs.

5.2.2 The effect of the IP box on firms' Effective Tax Rates

Next, we test whether and to what extent firms benefit from the Belgian IP box using the specification presented in model (2). In Table 6, we report results from both a balanced (Panels A) and unbalanced (Panels B) panel of firm-years. Across both balanced and unbalanced observations, the coefficients on the interaction of $Reform \times BE$ representing the incremental effect of the adoption of the IP box on Belgian firms relative to German firms' adjusted ETRs are negative and significant. These results are consistent with Hypothesis 2a which suggests that

[31] We calculate the effect for patent grants and employment using a log-level transformation with a difference in difference specification as $100(\exp(\beta_3) -1)\%$ change in the post period for the treated firms. For a coefficient of 0.007, this results in a $100(\exp(0.007)-1) = 0.7$ % change. For the efficiency ratios, the interpretation of the coefficients follows a level-level transformation (Wooldridge, 2015, p. 44).
[32] In untabulated results, we find that this pattern holds for larger firms and firms within patent-intensive industries.
[33] In untabulated tests using a triple interaction, we confirm that the difference is statistically significant.

Belgian firms benefit from the adoption of the IP box by enjoying lower ETRs relative to German firms.

In Hypothesis 2b we predict that Belgian domestic firms experience a bigger reduction in taxes than Belgian MNEs. Results for the balanced (unbalanced) sample, reported in columns (2) and (3) ((7) and (8)), suggest otherwise. Specifically, domestic firms' effective tax rates decrease by approximately 5.4% (4.5%), while MNEs decrease by 8.3% (9.7%). We recognize our estimate of the ETR reduction appears large, but the Belgian IP box provides for a substantial 80% reduction in effective tax rates on IP income. Informal discussions with practitioners with knowledge of the Belgian IP box indicate our estimate is on the higher end of the spectrum for the average firm, but not unreasonable.[34] However, these results are inconsistent with Hypothesis 2b.

To test Hypothesis 2c, we examine multinational firms with different income shifting incentives, and we expect firms without incentive to shift income out of Belgium to respond more to the introduction of an IP box regime than their counterparts with an incentive to shift income out of Belgium. We split observations of MNEs into MNEs without and with shifting opportunities in columns (4) and (5) and estimate model (1) for these two groups separately. We report a coefficient of -0.019 (-0.076) in column 4 (9) for MNEs without shifting opportunities and -0.092 (-0.101) in column 5 (10) for MNEs with shifting opportunities, inconsistent with Hypothesis 2c.[35] We report the results of the formal test of Hypothesis 2c in Table 6, Panels C and D. For the balanced (unbalanced) sample of firms, our results suggest that MNEs with

[34] To further corroborate our findings, we interact *Reform x BE x MNE* in untabulated tests and find an insignificant difference between MNEs and domestic firms for *Adj_ETR* levels (i.e., *Reform* x *BE* + *Reform* x *BE* x *MNE* = 0; P >F = 0.001).

[35] Untabulated results for large firms show similar inferences. For patent-intensive firms, we find that MNEs without an income shifting opportunity benefit to the same or greater degree than MNEs with an income shifting opportunity.

income shifting opportunities (column 2 (4)) decrease their effective tax rates more than MNEs without shifting opportunities. However, the F-tests at the bottom of Panels C and D reveal that the difference is not significant (P > F = 0.279 for the balanced panel; P > F = 0.117 for the unbalanced panel).

One issue with using Germany as our control group is that Germany decreased its statutory tax rate from 38.36% to 29.51% in 2008 (KPMG, 2018). This potentially weakens our identification because an underlying assumption is that control firms receive no treatment, but a decrease in tax rates affects firms' incentives. We attempt to correct for this problem by adjusting GAAP ETRs by the statutory tax rate but recognize this remedy is not perfect. Therefore, we perform additional tests excluding the German firms.

5.3. Additional tests

5.3.1 The effect of the IP box on firms' innovative activities

We perform additional tests of our hypotheses using the sub-sample of Belgian firm-years for three reasons. First, it allows us to explore additional policy implications by examining cross-sectional differences in the tax benefit conferred by the Belgian IP box. Second, we exploit detailed Belgian labor data that is not available for German firms to further investigate the effect of the Belgian IP box on specific types of employment activity. This addresses a main policy goal of IP box adoption, attracting high-skilled labor (e.g., OECD, 2015; Bradley et al., 2015; Evers et al., 2015). Third, we recognize that the tax rate change in Germany weakens our identification.

For our additional tests, we match the subsample of Belgian firms to workforce data (using the VAT Tax Identification Number) obtained from the National Bank of Belgium to construct the following additional proxies for activity: total employees, workers, managers, and

employees with university degrees. These data reflect individuals legally employed in Belgium. We identify firm-years with patent applications after 2007 as firms that are most likely to benefit from the IP box and refer to them as our "patenting" firms (*PAT*).[36]

We report descriptive statistics for our Belgian *PAT* and *non-PAT* sample in Table 7. Panel A describes the sample selection. In Panel B, patent applications, grants, and patent quality are significantly different between the groups consistent with a successful partitioning of the data.[37] The mean *GAAP ETR* for the *PAT* = 1 (*PAT* = 0) group is 27.6% (30.6%). Firms that apply for patents in the post-reform period are larger, more likely to be multinational firms, have higher *Leverage* ratios, lower *ROA* and *Capital Intensity* ratios, more *Inventory* and comparable *Intangibility* ratios. In Panel C, we report correlation coefficients. The relatively high correlation between *ln(Employees)* obtained from *ORBIS* and used in our primary tests and each of the employee-related proxies obtained directly from the Belgian National Bank provide some comfort regarding the consistency of the employment data across sources.

Using our Belgian sub-sample, we test our first hypothesis using a slightly modified version of model (1) as follows:

$$\textit{Innovative Activity\_BE}_{it} = \alpha + \lambda_1 \textit{ Reform} + \lambda_2 \textit{ PAT}_i + \lambda_3 \textit{ Reform} \times \textit{PAT}_i + \theta \textit{ Controls}_{it} + FE + \varepsilon_{it}. \quad (3)$$

In model (3), *Innovative Activity* is one of four proxies for employment-related innovative activities: *ln(Employees – BE)* is the natural logarithm of the total number of employees; *ln(Workers-BE)* equals the natural logarithm of the number of blue-collar workers;

[36] We choose the definition of *PAT* in the *post*-reform period because it allows us to draw implications about beneficiaries of the IP box not only for the balanced but also for the unbalanced panel. Although this definition might induce a bias to our results, we estimate all regressions of our additional tests using the firms that apply for patents in the *pre*-reform period and find substantially similar results.

[37] A *t*-test between *PAT* and Non-*PAT* firms indicate differences that are significant at the 1% level, respectively.

ln(Management – BE) is the natural logarithm of the number of managers*;* and *ln(Uni Degree – BE)* is the natural logarithm of the number of total employees with university degrees.[38] *Reform* and control variables are identical to the variables used in our primary tests. *PAT* is an indicator variable equal to one for Belgian firms that file for at least one patent in the post-reform period. We use industry fixed effects to capture any additional unobservable industry factors and cluster standard errors at the firm level (Petersen, 2009).

Table 8 Panel A shows that for our balanced sample, the overall number of employees increases by approximately 6.3% (coefficient 0.061). Domestic firms appear to drive this increase relative to MNEs, and the increase is concentrated on the blue-collar workers (*ln(Workers-BE)*). Results for our unbalanced sample, Panel B, however only show an increase in employees with university degrees, and this increase occurs for both domestic and MNE firms.[39] Combined, this pattern suggests that the intent of the IP box to increase activity is generally fulfilled as overall employment increases on average for *PAT* firms. However, the increase is somewhat nuanced as it is concentrated in blue-collar workers employed by domestic firms in existence across the entire sample period and in highly-skilled jobs employed by both domestic and MNEs that were not in existence throughout the sample period. This evidence suggests a demand for different types of employees depending on the age and reach of the firm.

To investigate the effect of the IP box on Belgian firms' effective tax rates, we split the sample into domestic and multinational firms and MNEs with and without income shifting

[38] In our additional tests, we do not estimate model (3) using proxies that directly measure changes in patent-related activities because we use patent applications as the basis for our definition of *PAT*. By definition, firms that apply for patents in the post-period increase their patenting activities and therefore patent-related measures do not provide additional information about this form of innovative activities. Hence, we focus on innovative activities that are indirectly related to patenting activities and different forms of employment that are associated with patenting activities.

[39] In untabulated results, we find that the most pronounced increase in *ln(Uni Degree – BE)* occurs for domestic firms in patent-intensive industries.

opportunities and test Hypotheses 2a to 2c using a slightly modified version of model (2) as follows:

$$GAAP\ ETR_{it} = \alpha + \beta_1\ Reform_t + \beta_2\ PAT_{it} + \beta_3\ Reform_t \times PAT_{it} + \delta\ X_{it} + FE + \varepsilon_{it}, \qquad (4)$$

where *GAAP ETR* is the effective tax rate (tax expense/profit before tax) of firm *i* in year *t*, and all other variables are as defined with respect to model (2).

In Table 9, we first report the results for all Belgian firms as an additional test of H2a but recognize that we should see results here given the way we define *PAT*. Consistent with our main analysis and identifying firms that successfully commercialized patents after 2007, results in column (2) indicate a 2.2 percentage-point reduction in GAAP ETRs. The highest benefit of the IP box appears to accrue to domestic firms (column 4) that enjoy a GAAP ETR reduction of approximately 2.1 (3.5) percentage points for the balanced (unbalanced) sample versus MNEs (column 6) in both balanced and unbalanced samples, which do not experience a significant decrease in ETRs. These results are consistent with Hypothesis 2b.[40]

In columns 8 and 10 of Table 9, Panel A and B, we examine MNEs with and without income shifting opportunities to test Hypothesis H2c. For our balanced sample, we find that the GAAP ETR of firms without income shifting opportunities decreases by a significant 9.7 percentage points. We do not find a significant reduction for firms with shifting opportunities. These results are consistent with Hypothesis 2c suggesting that firms without income shifting opportunities benefit relatively more from the IP box than firms with income shifting opportunities. We test this difference using a fully interacted model with a triple interaction (*Reform x PAT x Shift*) and report results in Panels C and D of Table 9. The negative and

[40] In untabulated tests, we confirm that these differences are statistically different using seemingly unrelated estimation (Prob > chi2 = 0.000). An F-test comparing the two coefficients of *Reform* x *PAT* and *Reform* x *PAT* x *MNE* supports our results.

significant coefficient in Panel C supports our conclusion for the balanced sample that firms without income shifting opportunities benefit relatively more than those with income shifting opportunities. For our unbalanced sample, reported in Panel D, we find a similar pattern of coefficients but the difference between firms with and without income shifting opportunities is not significant. Therefore, the results of the tests of Hypothesis 2c are mixed. In our additional tests, we find that Belgian firms with access to the IP box appear to decrease their effective tax rates after the introduction of the Belgian IP box on average, and this relation is driven by domestic firms relative to MNEs consistent with Hypothesis 2b. However, we also find that MNEs without income shifting opportunities enjoy significantly more tax benefits than MNEs with income shifting opportunities, consistent with Hypothesis 2c. These results contrast with those reported in Table 7 where Germany serves as the control group.

We interpret these findings not as inconsistent but rather as different perspectives on the types of firms that benefit from an IP box. From a policy perspective, this suggests that the desired effects of R&D tax incentives are especially difficult to anticipate for two reasons. First, the tax incentive not only changes the relative tax burden of Belgian and German firms but also among different types of firms operating in Belgium. Second, firms are able to decrease their effective tax rate via other channels. Specifically, our results indicate that profit shifting opportunities not only stress the public budget, but potentially also render fiscal measures void.

5.4 Robustness tests

Difference-in-difference estimation requires that treatment and control firms exhibit parallel trends in the outcome variable in the period before the treatment (Roberts and Whited, 2012). We conduct several additional tests to examine this assumption. First, we calculate the percentage growth rate of our dependent variables in the period preceding the IP Box adoption in

Belgium (e.g., Roberts and Whited, 2012). Statistically indistinguishable average growth rates across treatment and control groups support the parallel trend assumption. Second, we use a falsification test by changing the post-reform period, which also allows us to rule out other explanations for our results (Almeida, Campello, Laranjeira, and Weisbrenner, 2011; Roberts and Whited, 2012). We re-estimate our models assuming placebo reforms in 2005, 2006 and 2007. If the parallel trends assumption is satisfied, we expect the coefficients on the interaction of *Reform20XX x BE* (β_3) to be insignificant. Third, we conduct placebo tests where we randomly assign the treatment indicator variable for the eligibility of firm *i* for the IP box, *TreatmentRandom*, to half of our sample firms and use the other half as control firms (Roberts and Whited, 2012). We re-estimate our models using an interaction term of *Reform* and *TreatmentRandom*. An insignificant coefficient (β_3) for the interaction term of *Reform* and *TreatmentRandom* supports the parallel trend assumption.

Table 10 presents the results of the three parallel trend assumption tests. Panel A presents the results for our sample used for primary tests of Hypothesis 1. One out of three tests supports the parallel trend assumption for *ln(Patent Applications)* and *ln(Employees)*. Two out of three tests support the parallel trends assumption for *ln(Patent Grants)*, *Pat App Ratio*, and *Pat Grant Ratio*. All three tests support the parallel trends assumption for *Patent Quality*. In Panel B, we repeat the same three tests using the sub-sample of Belgian firms used in our additional tests and proxies for employment activities. Two out of three tests support the parallel trends assumption for *ln(Employees - BE)* and *ln(Workers - BE)*. All three tests support the parallel trends assumption for *ln(Management - BE)* and *ln(Uni Degree - BE)*. Panel C presents the results for robustness tests for Hypothesis 2. We find support for the parallel trend assumptions in all our

three tests for the sample used for our primary and additional tests.[41] Overall, the results presented in Table 10 suggest that our tests meet the parallel trends assumptions necessary for a valid difference-in-differences estimation.

To mitigate concerns about the comparability of treatment and control firms, we use two statistical techniques: propensity score matching (Imbens, 2015) and entropy balancing (Hainmueller, 2012). For both techniques, we match treatment and control group on all covariates in the three years prior to the IP box adoption and re-estimate all models.[42] Inferences remain for all specifications in both matching techniques except for one test.[43] Finally, we re-estimate our difference-in-difference specification adding linear and quadratic time trends, and industry-by-year indicator variables (Autor, 2003). Our inferences remain unchanged.

6. Conclusion

We investigate the effect of the adoption of the Belgian IP box regime on innovative and effective tax rates. In contrast to contemporaneous research on IP boxes that examines multiple countries, we focus on the adoption of an IP box in one country because it allows us to cleanly identify targeted innovative activity and the resulting tax benefits. We deploy a difference-in-difference research design with Belgian firms as the treatment group, and German firms as the control group because Germany does not have an IP box.

Our results suggest that, relative to firms in Germany, patent grants increase by 0.7 %, while patent applications remain at a similar level. Patenting efficiency, proxied by the ratio of patent applications (grants) to patent stock, improves, while the number of employees increases

[41] Inferences are unchanged when we repeat the parallel trends tests for our unbalanced sample.
[42] Propensity score matching creates an equal number of firms in the treatment and the control group. Entropy balancing provides weighted sample means of the control group that are nearly identical to the sample means of the treated observations (Hainmueller, 2012).
[43] Results hold across all proxies for activity for our main tests and are less pronounced for our additional tests. Inferences from all tests for effective tax rates remain unchanged.

by 6.7%. However, patent quality declines. This pattern is robust across both a balanced and unbalanced sample of firm-years, within patent intensive industries, as well as within domestic and multinational firm years respectively. Within our Belgian sample, we also find that the increase in employment appears concentrated in blue-collar workers employed by domestic firms in existence during the entire sample period (balanced panel) and highly-skilled workers concentrated in firms created (or entering Belgium) after the adoption of the IP box.

We also examine the types of firms that benefit from the Belgian IP Box. Relative to German firms, we find that Belgian firms on average reduce their effective tax rates by approximately 5.6 (4.6) percentage points after the adoption of the Belgian IP box for our balanced (unbalanced) sample. This pattern also holds across patent-intensive industries, larger firms, as well as within domestic and multinational firm years respectively. In addition, we find cross-sectional variation in the types of firms that enjoy tax benefits of the IP box within our Belgian sample. Effective tax rate savings are most pronounced for Belgian multinationals that do not have an opportunity to shift income out of the country, followed by domestic firms. In contrast, multinationals with an income shifting opportunity do not experience significant reductions in ETRs after the introduction of the IP box regime.

Our research makes several contributions. We identify a strong setting that allows us to investigate the direct impact of an IP box regime on patenting activity and the types of firms that reap the financial benefits of the IP box. Our results suggest an overall increase in innovative activity, at the expense of patent quality. We also provide evidence that, while firms with patents on average enjoy lower effective tax rates after the adoption of the IP box, it is useful to consider income shifting opportunities when identifying firms that benefit from the IP box.

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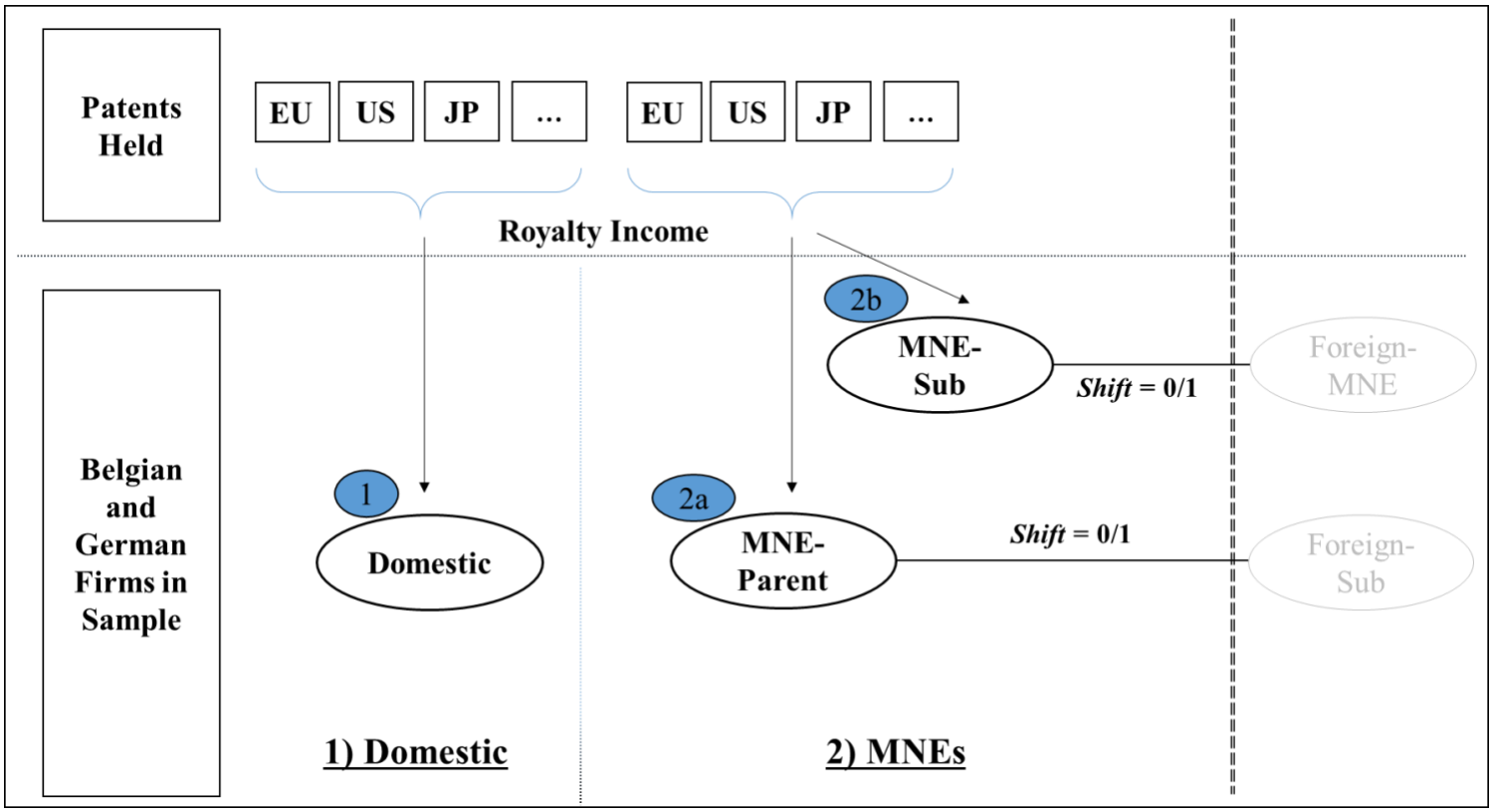
Appendix A: Variable definitions

Variable	Definition and Source
Adj_ETR	*GAAP ETR* less the statutory tax rate of firm *i* in year *t*. The statutory tax rate for Belgian is 33.99% for the entire sample period. For Germany, the statutory tax rate prior to 2008 is 38.36% and 29.51% from 2008 onwards. Source: ORBIS database variables Taxation, P/L before tax, Total Assets; KPMG Corporate tax rates table (KPMG, 2018).
BE	Indicator variable indicating the location of firm *i*. The variable takes a value of one if the firm is located in Belgium, and zero otherwise. Source: ORBIS database.
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.
GAAP 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, variables Intangible fixed assets, Total Assets.
Industry	Industry classification (two digit) 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, > 50%). Based on the 2006 ownership structure data. Source: ORBIS database.
ln(Employees)	Natural logarithm of the number of employees of firm *i* in year *t* Source: ORBIS database
ln(Employees- BE)	Natural logarithm of the number of employees of firm *i* in year *t*. Source: Belgian National Bank - Annual statements of Belgian firms.
ln(Management – BE)	Natural logarithm of the number of management staff employed by firm *i* in year *t*. Source: Belgian National Bank - Annual statements of Belgian firms.
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.
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.
ln(Uni Degree – BE)	Natural logarithm of the number of employees with university education in firm *i* in year *t*. Source: Belgian National Bank - Annual statements of Belgian firms.
ln(Workers – BE)	Natural logarithm of the number of workers employed by firm *i* in year *t*. Source: Belgian National Bank - Annual statements of Belgian firms.
PAT	Indicator variable for the eligibility of firm *i* for the Belgian IP box. The variable takes a value of one if the firm is located in Belgium and applies for at least one patent in the Post-Reform period (after 2007). Source: PATSTAT database.
Patent Application Ratio	Ratio of the number of *Patent Applications* to *Patent Stock* of firm *i* in year *t*. Source: PATSTAT database.
Patent Grant Ratio	Ratio of the number of *Patent Grants* to *Patent Stock* of firm *i* in year *t*. Source: PATSTAT database.
Patent Quality	Composite Quality Index of firm *i* in year *t* as a measure for patent quality derived from a principal component analysis. Following Lanjouw and Schankerman (2004), Hall et al. (2007) and Ernst et al. (2014), the index takes into account received (forward) citations, family size and number of technological classes as factors of patent quality. We weight each patent by its relative quality and aggregate it on an annual basis. Source: PATSTAT database.
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 when the logarithm is not defined (Hall et al. 2007). Source: PATSTAT database.

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 one, otherwise zero.
Reform(year)	Indicator variable taking value one for placebo reform years 20XX onwards and zero otherwise.
ROA(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.
Shift	Indicator variable that takes a value of one if the statutory tax rate of a foreign subsidiary or parent is lower than the Belgian statutory tax rate, and zero otherwise.
Size	Natural logarithm of total assets of firm *i* in year *t*. Source: ORBIS database, variable Total Assets.
Treat(year)	Indicator variable for the eligibility of firm *i* for the IP box. The variable takes a value of one if the firm applies at least for one patent in the placebo reform year (2005/2006/2007 or before). Source: PATSTAT database.
Treatment Random	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.

Figure 1: Firms included in Primary Tests of H1 and H2: Belgian and German Firms



MNEs are firms that have subsidiaries in foreign countries (MNE-Parent) or are part of a multinational group headquartered in a foreign country (MNE-Sub). *Shift* is an indicator variable that takes a value of one if the statutory tax rate of a foreign subsidiary or parent is lower than the Belgian statutory tax rate, and zero otherwise. Domestic firms have neither parents nor subsidiaries in foreign countries. Combined with data from the *PATSTAT* database, we can observe all worldwide patent applications and grants that proxy for activity.

Table 1: Overview IP Boxes (Sources: EY (2014); Alstadsæter et al., (2018); Evers et al., (2015))

		BE	CH (NW)	CY	ES	FR	HU	ITA	LIE	LUX	MT	NL	PT	UK
Statutory CIT (%) 2015		33.99	12.66	12.5	28	34.43[a)]	19	31.4	12.5	29.22	35	25	29.5	20
Year of IP Box Introduction (modified)		2008	2011	2012	2008	2000	2003 (2012)	2015	2011	2008	2010	2007 (2010)	2014	2013
IP Box Rate (%)		6.8	8.8	2.5	12	15.5	9.5	15.7[b)]	2.5	5.84	0	10 (5)	14	10[c)]
Eligible IP	Patents	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Trademarks	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No
	Designs & models	No	Yes	Yes	Yes[d)]	No	Yes[e)]	Yes	Yes	Yes	No	Yes[f)]	Yes[e)]	No
	Copyrights	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes[g)]	Yes[h)]	Yes [f)g)]	No	No
	Domain names	No	Yes	No	No	No	No	No	Yes	Yes	No	No	No	No
	Trade secrets	No	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes[f)]	No	No
	Know-how	No[i)]	Yes	Yes	No	Yes[i)]	Yes	No	No	No	No	Yes[f)]	No	No
Existing/ Acquired IP	Existing IP	No[k)]	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes
	Acquired IP	Yes[l)]	Yes	Yes	No	Yes[l)]	Yes	Yes	Yes	Yes	Yes	No	No	Yes[l)]
Location of R&D	Group	Yes[m)]	Yes	Yes	Yes [n)]	Yes	Yes	Yes	Yes	Yes	Yes	Yes[o)]	Yes	Yes[q)]
	Abroad	Yes [m)]	Yes	Yes	Yes [n)]	Yes	Yes	No	Yes	Yes	Yes	No	Yes[p)]	Yes[q)]
R&D expenses	Deductibility at statutory CIT	Yes	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No

BE = Belgium; CH (NW) = Switzerland (Kanton Nidwalden); CY= Cyprus; ES = Spain; FR = France; HU = Hungary; ITA = Italy; LIE = Liechtenstein; LUX = Luxembourg; MT = Malta; NL = Netherlands; PT = Portugal; UK = United Kingdom.

a) FRA: A 3.3% social contribution is levied on the part of the corporate income tax that exceeds EUR 763,000, resulting in an overall maximum tax rate of 34.43%. Also, a temporary 10.7% surtax is levied on companies with a turnover over EUR 250 million.

b) ITA: The percentage of profits derived from IP that will be excluded from taxation will be 30% in the first year, 40% in the second year and then 50% for the remaining three years.

c) The UK system is phased in starting from financial years after 31 March 2013. Companies can apply an appropriate percentage of profits (starting with 60% for 2013 and increasing linearly by 10 percentage points to 100% for financial years starting from March 31 2017).

d) Only models.

e) Only industrial IP.

f) Only when obtained R&D certificate.

g) Only software.

h) Only artistic works.

i) BE: IP box tax rate only applicable if know-how substantially connected to patents; FRA: Associated industrial/manufacturing processes that can be viewed as an essential element for the patent or patentable invention.

k) If patent not commercialized.

l) BE: If fully or partially improved: UK: If further developed and actively managed.

m) If in a qualifying R&D center. See E&Y (2014) and Belgische Kamer Van Volksvertegenwoordigers (2007).

n) LUX: If self-developed patents: ES: If self-developed IP.

o) Applicable to patents developed within a group when managed and coordinated in the Netherlands.

p) Double tax relief limited to 50%.

q) If self-developed and active ownership.

Table 2: Sample Selection - Primary Tests of H1 and H2: Belgian and German Firms

Step	Description	No. of observations dropped	No. of observations remaining
1	All firm-years listed in *ORBIS* from 2003-2012 (10 years)		18,315,830
2	Less: firm-years with missing industry classification and data for total assets	(11,396,530)	6,919,300
3	Less: firms with negative or zero total assets	(6,802)	6,912,498
4	Less: firm-years with missing data for control variables	(2,438,926)	4,473,572
5	Less: firms with negative or zero profit before tax	(417,032)	
6	**Unbalanced Sample**		**4,056,540**
7	Less: firms with missing observations for balanced panel	(3,563,390)	
8	**Balanced Sample**		**493,150**

This table contains the sample selection procedure for our primary tests for both the balanced and unbalanced samples. The number of firm-year observations in the unbalanced panel are increasing over our sample period. For the unbalanced panel of our primary tests that includes Belgian and German firms, the number of observations increase from 112,048 in 2003 to 528,491 in 2012.

Table 3: Descriptive Statistics – Primary Tests of H1 and H2 (Balanced Panel Belgian and German firms)

	Full Sample						Belgium (Treatment Group)						Germany (Control Group)						
	N	Mean	Std. Dev.	Q1	Median	Q3	N	Mean	Std. Dev.	Q1	Median	Q3	N	Mean	Std. Dev.	Q1	Median	Q3	Diff. Mean
ln(Patent Applications)	493,150	0.043	0.345	0.000	0.000	0.000	244,450	0.004	0.096	0.000	0.000	0.000	248,700	0.081	0.473	0.000	0.000	0.000	***
ln(Patent Grants)	493,150	0.030	0.270	0.000	0.000	0.000	244,450	0.002	0.066	0.000	0.000	0.000	248,700	0.056	0.372	0.000	0.000	0.000	***
Pat App Ratio	27,383	0.248	0.365	0.000	0.000	0.500	1,798	0.240	0.410	0.000	0.000	0.437	25,585	0.249	0.362	0.000	0.000	0.500	
Pat Grant Ratio	27,383	0.165	0.275	0.000	0.000	0.315	1,798	0.134	0.284	0.000	0.000	0.000	25,585	0.167	0.274	0.000	0.000	0.325	***
ln(Employees)	260,757	3.011	1.870	1.609	2.639	4.127	146,287	2.099	1.240	1.099	1.792	2.833	114,470	4.177	1.892	2.773	4.094	5.380	***
Patent Quality	27,383	-0.403	0.700	-0.796	-0.466	-0.002	1,798	-0.694	0.861	-1.157	-0.602	-0.105	25,585	-0.383	0.683	-0.778	-0.459	0.002	***
GAAP ETR	360,893	0.285	0.183	0.182	0.291	0.358	244,450	0.306	0.170	0.222	0.301	0.356	116,443	0.241	0.201	0.060	0.250	0.364	***
Adj_ETR	360,893	-0.056	0.183	-0.158	-0.046	0.013	244,450	-0.034	0.170	-0.118	-0.039	0.016	116,443	-0.103	0.199	-0.277	-0.087	0.008	***
Size	493,150	7.379	1.998	5.958	7.001	8.454	244,450	6.708	1.492	-0.118	-0.039	0.016	248,700	8.038	2.202	6.399	7.741	9.472	***
Leverage	493,150	0.506	0.268	0.286	0.511	0.725	244,450	0.481	0.256	5.694	6.503	7.496	248,700	0.530	0.278	0.302	0.537	0.763	***
Intangibility	426,709	0.017	0.060	0.000	0.000	0.004	244,450	0.017	0.064	0.272	0.488	0.688	182,259	0.018	0.053	0.000	0.002	0.010	***
ROA	391,040	0.121	0.138	0.034	0.089	0.171	244,450	0.150	0.135	0.000	0.000	0.000	146,590	0.072	0.129	0.008	0.047	0.116	***
Capital Intensity	488,549	0.303	0.263	0.082	0.224	0.471	244,450	0.271	0.241	0.058	0.113	0.197	244,099	0.334	0.280	0.092	0.255	0.532	***
Inventory	493,030	0.370	0.354	0.007	0.264	0.714	244,450	0.101	0.160	0.073	0.199	0.416	248,580	0.635	0.286	0.418	0.703	0.885	***
MNE	493,150	0.045	0.207	0.000	0.000	0.000	244,450	0.028	0.165	0.000	0.007	0.152	248,700	0.062	0.240	0.000	0.000	0.000	***
Shift	22,140	0.797	0.402	1.000	1.000	1.000	6,820	0.813	0.390	0.000	0.000	0.000	15,320	0.790	0.407	1.000	1.000	1.000	***

This table presents descriptive statistics for Belgian and German firms used for our Primary Tests of H1 and H2. We present descriptive statistics of our main variables separately for our treatment and control groups. The treatment group contains all Belgian firms and the control group contains all German firms. *** *, **, and *** denote the significance level of a t-test of the means of the Treatment and Control Group at the 10%, 5%, and 1% levels, respectively. Variables are defined in Appendix A.

Table 4: Pearson Correlations - Primary Tests of H1 and H2 (Balanced Panel Belgian and German firms)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) ln(Patent App.)	1															
(2) ln(Patent Grants)	**0.958**	1														
(3) Patent App Ratio	**0.710**	**0.622**	1													
(4) Patent Grant Ratio	**0.691**	**0.742**	**0.834**	1												
(5) ln(Employees)	**0.312**	**0.289**	**0.238**	**0.252**	1											
(6) Patent Quality	**0.273**	**0.257**	**0.110**	**0.147**	**0.239**	1										
(7) GAAP ETR	**-0.028**	**-0.024**	**0.034**	**0.035**	**-0.095**	**-0.032**	1									
(8) Adj_ETR	**-0.029**	**-0.027**	0.016	**0.008**	**-0.085**	**-0.034**	**0.990**	1								
(9) Size	**0.242**	**0.220**	**0.192**	**0.179**	**0.807**	**0.278**	**-0.133**	**-0.126**	1							
(10) Leverage	**-0.041**	**-0.037**	**-0.042**	**-0.033**	**-0.027**	**-0.071**	**0.064**	**0.057**	**0.017**	1						
(11) Intangibility	**0.066**	**0.061**	**0.113**	**0.109**	**0.151**	**0.164**	**0.023**	**0.022**	**0.007**	**0.061**	1					
(12) ROA	**-0.040**	**-0.035**	0.001	0.010	**-0.193**	**-0.025**	**0.052**	**0.052**	**-0.277**	**-0.171**	**0.014**	1				
(13) Capital Intensity	**0.021**	**0.020**	**0.032**	**0.034**	**0.170**	**0.089**	**-0.058**	**-0.056**	**0.226**	**0.058**	**-0.005**	**-0.217**	1			
(14) Inventory	**0.081**	**0.072**	**-0.021**	-0.005	**0.364**	**-0.018**	**-0.095**	**-0.107**	**0.142**	**0.070**	**-0.058**	**-0.198**	**-0.354**	1		
(15) MNE	**0.096**	**0.082**	**0.041**	**0.025**	**0.205**	**0.090**	**-0.007**	**-0.007**	**0.229**	0.002	**0.019**	**-0.03**	**-0.060**	**0.094**	1	
(16) Shift	-0.006	0.001	**0.042**	**0.062**	**-0.025**	**-0.118**	**0.041**	**-0.023**	**-0.091**	**0.069**	-0.008	0.003	0.007	**-0.033**	.	1

This table provides Pearson correlations for the balanced sample of Belgian and German firms. Bold letters denote statistical significance at the 1% level.

Table 5: Effect of the IP box on innovative activities – Primary Tests of H1

Panel A: Balanced Panel Belgium and Germany

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	*ln(Patent Applications)*		*ln(Patent Grants)*		*Pat App Ratio*		*Pat Grant Ratio*		*ln(Employees)*		*Patent Quality*	
Reform	-0.009***	-0.018***	-0.014***	-0.021***	-0.073***	-0.076***	-0.074***	-0.076***	-0.798***	-0.173***	-0.026***	-0.036***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.005)	(0.005)	(0.004)	(0.004)	(0.012)	(0.007)	(0.008)	(0.009)
BE	-0.070***	-0.027***	-0.053***	-0.022***	-0.031	-0.018	-0.048***	-0.038***	-2.619***	-1.083***	-0.211***	-0.173**
	(0.003)	(0.002)	(0.002)	(0.001)	(0.022)	(0.021)	(0.015)	(0.014)	(0.022)	(0.013)	(0.074)	(0.072)
Reform x BE	**0.010*** **	**-0.000**	**0.014*** **	**0.007*** **	**0.050** **	**0.041***	**0.031** **	**0.025***	**0.865*** **	**0.065*** **	**-0.266*** **	**-0.293*** **
	(0.001)	**(0.001)**	**(0.001)**	**(0.001)**	**(0.022)**	**(0.022)**	**(0.014)**	**(0.014)**	**(0.012)**	**(0.008)**	**(0.057)**	**(0.057)**
Size		0.041***		0.029***		0.035***		0.025***		0.668***		0.094***
		(0.002)		(0.001)		(0.002)		(0.002)		(0.004)		(0.008)
Leverage		-0.058***		-0.042***		-0.019		-0.009		0.105***		-0.101
		(0.004)		(0.003)		(0.014)		(0.010)		(0.019)		(0.073)
Constant	0.037***	-0.250***	0.031***	-0.175***	0.200**	-0.125*	0.168**	-0.067	3.838***	-2.301***	-0.639**	-1.490***
	(0.005)	(0.013)	(0.004)	(0.010)	(0.093)	(0.074)	(0.074)	(0.060)	(0.053)	(0.048)	(0.285)	(0.254)
Observations	493,150	493,150	493,150	493,150	27,383	27,383	27,383	27,383	260,757	260,757	27,383	27,383
Adj. R-squared	0.044	0.091	0.036	0.075	0.026	0.064	0.030	0.064	0.363	0.752	0.029	0.071
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Unbalanced Panel Belgium and Germany

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Reform	-0.005***	-0.006***	-0.005***	-0.006***	-0.059***	-0.056***	-0.057***	-0.055***	-0.818***	-0.312***	-0.043***	-0.038***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.006)	(0.004)	(0.003)	(0.003)
BE	-0.015***	-0.010***	-0.011***	-0.008***	0.016	-0.002	-0.006	-0.017**	-1.611***	-1.009***	-0.020	-0.061*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.011)	(0.011)	(0.008)	(0.008)	(0.009)	(0.005)	(0.032)	(0.032)
Reform x BE	**0.005*** **	**0.006*** **	**0.005*** **	**0.006*** **	**0.039*** **	**0.033** **	**0.005**	**0.002**	**0.792*** **	**0.250*** **	**-0.176*** **	**-0.191*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.013)**	**(0.013)**	**(0.008)**	**(0.008)**	**(0.007)**	**(0.004)**	**(0.027)**	**(0.027)**
Observations	4,056,540	4,056,540	4,056,540	4,056,540	122,784	122,784	122,784	122,784	1,446,860	1,446,860	122,784	122,784
Adj. R-squared	0.016	0.035	0.013	0.028	0.012	0.032	0.014	0.027	0.189	0.595	0.013	0.036
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5: Effect of the IP box on innovative activities – Primary Tests of H1 (continued)

Panel C: Balanced Panel Belgian and German Firms – Domestic Firms and MNEs												
Variables	*ln(Patent Applications)*		*ln(Patent Grants)*		*Pat App Ratio*		*Pat Grant Ratio*		*ln(Employees)*		*Patent Quality*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Domestic	MNEs	Domestic	MNEs	Domestic	MNEs	Domestic	MNEs	Domestic	MNEs	Domestic	MNEs
Reform	-0.015***	-0.066***	-0.018***	-0.072***	-0.072***	-0.094***	-0.074***	-0.089***	-0.186***	-0.152***	-0.030***	-0.060*
	(0.001)	(0.010)	(0.001)	(0.008)	(0.005)	(0.013)	(0.004)	(0.009)	(0.007)	(0.022)	(0.008)	(0.036)
BE	-0.020***	-0.206***	-0.017***	-0.154***	-0.011	-0.041	-0.037**	-0.041	-1.134***	-0.568***	-0.218***	0.056
	(0.002)	(0.020)	(0.001)	(0.016)	(0.023)	(0.051)	(0.015)	(0.035)	(0.014)	(0.051)	(0.082)	(0.142)
Reform x BE	**-0.002**	**0.033*** **	**0.005*** **	**0.044*** **	**0.048** **	**0.013**	**0.027***	**0.016**	**0.079*** **	**0.039**	**-0.279*** **	**-0.316** **
	(0.001)	**(0.011)**	**(0.001)**	**(0.008)**	**(0.024)**	**(0.054)**	**(0.016)**	**(0.033)**	**(0.008)**	**(0.028)**	**(0.063)**	**(0.138)**
Size	0.038***	0.074***	0.027***	0.054***	0.037***	0.027***	0.026***	0.021***	0.665***	0.685***	0.100***	0.030
	(0.002)	(0.009)	(0.002)	(0.007)	(0.002)	(0.007)	(0.002)	(0.005)	(0.004)	(0.015)	(0.007)	(0.039)
Leverage	-0.049***	-0.165***	-0.037***	-0.099***	-0.007	-0.089**	-0.009	-0.018	0.105***	-0.083	-0.018	-0.512
	(0.004)	(0.036)	(0.003)	(0.027)	(0.015)	(0.039)	(0.011)	(0.027)	(0.019)	(0.084)	(0.053)	(0.358)
Constant	-0.239***	-0.408***	-0.168***	-0.308***	-0.149**	-0.099	-0.080	-0.109	-2.254***	-1.829***	-1.571***	0.145
	(0.014)	(0.107)	(0.011)	(0.081)	(0.075)	(0.100)	(0.060)	(0.068)	(0.049)	(0.210)	(0.248)	(0.993)
Observations	471,010	22,140	471,010	22,140	22,660	4,723	22,660	4,723	244,087	16,670	22,660	4,723
Adj. R-squared	0.084	0.121	0.070	0.102	0.069	0.053	0.067	0.058	0.749	0.627	0.105	0.045
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel D: Unbalanced Panel Belgian and German Firms – Domestic Firms and MNEs												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Reform	-0.005***	-0.028***	-0.005***	-0.026***	-0.055***	-0.070***	-0.054***	-0.067***	-0.318***	-0.321***	-0.036***	-0.056**
	(0.000)	(0.003)	(0.000)	(0.002)	(0.003)	(0.008)	(0.002)	(0.005)	(0.004)	(0.015)	(0.004)	(0.023)
BE	-0.009***	-0.094***	-0.007***	-0.069***	-0.002	-0.014	-0.014*	-0.034*	-1.043***	-0.384***	-0.080*	-0.253***
	(0.000)	(0.008)	(0.000)	(0.006)	(0.012)	(0.027)	(0.009)	(0.018)	(0.005)	(0.028)	(0.042)	(0.097)
Reform x BE	**0.005*** **	**0.015*** **	**0.005*** **	**0.011*** **	**0.042*** **	**-0.004**	**0.004**	**-0.006**	**0.259*** **	**0.215*** **	**-0.311*** **	**-0.097**
	(0.000)	**(0.005)**	**(0.000)**	**(0.003)**	**(0.014)**	**(0.029)**	**(0.009)**	**(0.018)**	**(0.004)**	**(0.020)**	**(0.046)**	**(0.097)**
Observations	3,937,366	119,174	3,937,366	119,174	109,278	13,506	109,278	13,506	1,386,820	60,040	109,278	13,506
Adj. R-squared	0.031	0.081	0.024	0.065	0.031	0.029	0.026	0.032	0.587	0.573	0.036	0.038
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5: Effect of the IP box on innovative activities – Primary Tests of H1 (continued)

This table reports the results of our primary tests of Hypothesis 1 using model (1). Panel A (B) reports results for the (un)balanced panel of all Belgian and German firms. Panel C (D) reports results for a(n) (un)balanced panel bifurcated between domestic and multinational observations. *ln(Patent Applications)* is the natural logarithm of patent applications, *ln(Patent Grants)* the natural logarithm of patent grants. *Pat App Ratio* is the ratio of the number of *Patent Applications* and *Patent Stock*, where *Patent Stock* is the number of all granted patents in the last 19 years preceding the fiscal year. *Pat Grant Ratio* is the ratio of the number of *Patent Grants* and *Patent Stock*. *Ln(Employees)* is the natural logarithm of the number of employees. *Patent Quality* is the composite quality indicator developed by Lanjouw and Schankerman (2004). Variables are defined in Appendix A. We report robust standard errors clustered at the firm-level in parentheses. *, **, and *** denote significance of two-tailed tests at the 10%, 5%, and 1% levels, respectively.

Table 6: Effect of the IP box on firms' ETRs – Primary Tests of H2

	Panel A: Balanced Panel – Belgian and German firms					**Panel B: Unbalanced Panel– Belgian and German firms**				
Test of	**H2a**	**H2b**		**H2c**		**H2a**	**H2b**		**H2c**	
Prediction (*Reform x BE*)	-	| - | > | - |		| - | > | - |		-	| - | > | - |		| - | > | - |	
	All Firms	Domestic	MNEs	MNEs– *Shift* = 0	MNEs– *Shift* = 1	All Firms	Domestic	MNEs	MNEs– *Shift* = 0	MNEs– *Shift* = 1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variables	*Adj_ETR*	*Adj_ETR*	*Adj_ETR*	*Adj_ETR*	*Adj_ETR*	*Adj_ETR*	*Adj_ETR*	*Adj_ETR*	*Adj_ETR*	*Adj_ETR*
Reform	0.042***	0.042***	0.047***	-0.005	0.053***	0.043***	0.043***	0.047***	0.039***	0.050***
	(0.001)	(0.001)	(0.005)	(0.018)	(0.006)	(0.001)	(0.001)	(0.003)	(0.010)	(0.003)
BE	0.100***	0.098***	0.145***	0.099***	0.147***	0.024***	0.024***	0.077***	0.084***	0.075***
	(0.003)	(0.003)	(0.013)	(0.029)	(0.015)	(0.001)	(0.001)	(0.009)	(0.020)	(0.009)
Reform x BE	**-0.056*** **	**-0.054*** **	**-0.083*** **	**-0.019**	**-0.092*** **	**-0.046*** **	**-0.045*** **	**-0.097*** **	**-0.076*** **	**-0.101*** **
	(0.002)	**(0.002)**	**(0.006)**	**(0.022)**	**(0.007)**	**(0.001)**	**(0.001)**	**(0.004)**	**(0.014)**	**(0.005)**
Size	-0.004***	-0.004***	-0.007***	-0.006*	-0.008***	-0.009***	-0.010***	-0.010***	-0.007***	-0.010***
	(0.000)	(0.000)	(0.002)	(0.003)	(0.002)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
Leverage	0.062***	0.064***	0.018*	-0.007	0.024**	0.049***	0.050***	0.027***	0.020	0.029***
	(0.002)	(0.002)	(0.011)	(0.020)	(0.012)	(0.001)	(0.001)	(0.006)	(0.012)	(0.007)
Intangibility	0.027***	0.022***	0.187***	0.240***	0.169***	-0.011***	-0.016***	0.194***	0.156***	0.207***
	(0.008)	(0.008)	(0.047)	(0.088)	(0.052)	(0.003)	(0.003)	(0.033)	(0.053)	(0.038)
ROA	-0.001	-0.009**	0.107***	0.179***	0.088***	-0.151***	-0.155***	-0.080***	-0.072***	-0.082***
	(0.004)	(0.004)	(0.020)	(0.032)	(0.023)	(0.002)	(0.002)	(0.011)	(0.021)	(0.012)
Capital Intensity	-0.008***	-0.008***	-0.001	-0.015	0.003	-0.039***	-0.040***	-0.003	-0.001	-0.004
	(0.003)	(0.003)	(0.018)	(0.032)	(0.020)	(0.001)	(0.001)	(0.011)	(0.023)	(0.013)
Inventory	0.037***	0.033***	0.083***	0.093***	0.080***	-0.016***	-0.019***	0.047***	0.059**	0.045***
	(0.004)	(0.004)	(0.018)	(0.035)	(0.020)	(0.002)	(0.002)	(0.011)	(0.023)	(0.012)
Constant	-0.180***	-0.175***	-0.151***	-0.105*	-0.155***	-0.085***	-0.082***	-0.020	0.004	-0.017
	(0.007)	(0.007)	(0.045)	(0.063)	(0.047)	(0.003)	(0.003)	(0.040)	(0.103)	(0.042)
Observations	340,471	324,406	16,065	3,303	12,762	1,415,471	1,371,966	43,505	8,875	34,630
Adj. R-squared	0.054	0.054	0.071	0.078	0.071	0.031	0.031	0.036	0.027	0.037
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Effect of the IP box on firms' ETRs – Primary Tests of H2 (continued)

Tests of H2c					
Variables	*Prediction*	**Panel C: Balanced Panel** *Adj_ETR*		**Panel D: Unbalanced Panel** *Adj_ETR*	
		(1)	(2)	(3)	(4)
Reform × *BE*	-	0.060***	-0.021	-0.076***	-0.073***
		(0.023)	(0.022)	(0.014)	(0.014)
Reform × *BE* × *Shift*	+	-0.065***	-0.071***	-0.026*	-0.028*
		(0.025)	(0.024)	(0.015)	(0.015)
Controls		No	Yes	No	Yes
Observations		16,065	16,065	43,505	43,505
Adj. R-squared		0.053	0.072	0.024	0.036
Industry FE		Yes	Yes	Yes	Yes
F-Test: (*Reform* × *BE* + *Reform* × *BE* × *Shift* = 0)		F = 0.560 P> F = 0.455	F= 1.170 P> F = 0.279	F= 2.91 P> F =0.088	F= 2.46 P> F = 0.117

This table reports the results of our primary tests of Hypotheses 2a to 2c using model (2) for Belgian and German firms. Panel A (B), column 1 (6) report the results for our tests of H2a, columns 2 and 3 (7 and 8) report the results for our tests of H2b for the balanced (unbalanced) panel. Panel A (B), columns 4 and 5 (9 and 10) report the results for our tests of H2c for the balanced (unbalanced) panel using model (2); panel C (D) report the results for our tests of H2c for the balanced (unbalanced) panel of Belgian and German multinationals using a fully specified model that includes a triple interaction. We do not present all coefficients included in the model. *Adj_ETR* is the GAAP effective tax rate (tax expense/profit (loss) before tax) of firm *i* in year *t* less the statutory tax rate of the respective country. *Reform* is an indicator variable taking value one for years 2008 onwards and zero otherwise. *BE* is an indicator variable equal to one if a firm is located in Belgium and equal to zero, otherwise. *MNE* is an indicator variable equal to one if the firm is owned by a foreign shareholder or the firm owns at least one foreign subsidiary. *Shift* is an indicator variable equal to one if the statutory tax rate of a foreign subsidiary or Belgian parent is lower than the Belgian statutory tax rate, and zero otherwise. Variables are defined in Appendix A. We report robust standard errors clustered at the firm-level in parentheses. *, **, and *** denote significance of two-tailed tests at the 10%, 5%, and 1% levels, respectively.

Table 7: Descriptive Statistics – Additional Tests of H1 and H2

Panel A: Sample Selection (Belgian Firms only)			
Step	Description	No. of observations dropped	No. of observations remaining
1	All firms listed in *ORBIS* from 2003-2012 (10 years)		4,643,000
2	Less: firm-years with missing industry classification and data for total assets	(1,569,510)	3,073,490
3	Less: firms with negative or zero total assets	(5,590)	3,067,900
4	Less: firm-years with missing data for control variables	(1,611,365)	1,456,535
5	Less: firms with negative or zero profit before tax	(313,366)	
6	**Unbalanced Sample**		**1,143,169**
7	Less: firms with missing observations for balanced panel	(898,719)	
8	**Balanced Sample**		**244,450**

This table contains the sample selection procedure for our additional tests for both the balanced and unbalanced samples of Belgian firms. The number of firm-year observations increases from 86,499 in 2003 to 157,005 in 2012.

Table 7: Descriptive Statistics – Additional Tests of H1 and H2 (continued)

Panel B: Descriptive Statistics (Belgian Firms only)

	Full Sample						*PAT* = 1						*PAT* = 0						
	N	Mean	SD.	Q1	Median	Q3	N	Mean	SD.	Q1	Median	Q3	N	Mean	SD.	Q1	Median	Q3	Diff. Mean
ln(Employees)	146,287	2.099	1.240	1.099	1.792	2.833	1,789	3.820	1.732	2.565	3.689	4.898	144,498	2.078	1.218	1.099	1.792	2.773	***
GAAP ETR	244,450	0.306	0.170	0.222	0.301	0.356	1,950	0.276	0.141	0.207	0.299	0.344	242,500	0.306	0.170	0.222	0.301	0.356	***
Adj_ETR	244,450	-0.034	0.170	-0.118	-0.039	0.016	1,950	-0.064	0.141	-0.133	-0.041	0.005	242,500	-0.034	0.170	-0.118	-0.039	0.017	***
Size	244,450	6.700	1.455	5.694	6.503	7.496	1,950	9.126	1.669	7.836	9.056	10.640	242,500	6.680	1.437	5.690	6.492	7.473	***
Leverage	244,450	0.481	0.256	0.272	0.488	0.688	1,950	0.502	0.227	0.335	0.514	0.679	242,500	0.481	0.256	0.272	0.488	0.688	***
Intangibility	244,450	0.017	0.068	0.000	0.000	0.000	1,950	0.016	0.048	0.000	0.001	0.009	242,500	0.017	0.068	0.000	0.000	0.000	
ROA	244,450	0.151	0.138	0.058	0.113	0.197	1,950	0.139	0.122	0.057	0.106	0.185	242,500	0.151	0.138	0.058	0.113	0.198	***
Capital Intensity	244,450	0.271	0.241	0.073	0.199	0.416	1,950	0.191	0.158	0.062	0.163	0.271	242,500	0.272	0.241	0.073	0.199	0.418	***
Inventory	244,450	0.100	0.156	0.000	0.007	0.152	1,950	0.162	0.150	0.026	0.138	0.246	242,500	0.099	0.156	0.000	0.007	0.151	***
MNE	244,450	0.028	0.165	0.000	0.000	0.000	1,950	0.174	0.380	0.000	0.000	0.000	242,500	0.027	0.161	0.000	0.000	0.000	***
Shift	6,820	0.813	0.390	1.000	1.000	1.000	340	0.844	0.363	1.000	1.000	1.000	6,480	0.811	0.391	1.000	1.000	1.000	
ln(Employees – BE)	128,508	2.106	1.214	1.099	1.946	2.833	1,733	3.721	1.646	2.565	3.638	4.754	126,775	2.084	1.192	1.099	1.946	2.773	***
ln(Workers – BE)	82,173	2.036	1.129	1.099	1.792	2.708	1,348	3.460	1.512	2.398	3.434	4.419	80,825	2.012	1.106	1.099	1.792	2.639	***
ln(Management – BE)	6,518	1.370	0.876	0.693	1.099	1.792	354	2.161	1.317	1.099	2.079	2.708	6,164	1.325	0.821	0.693	1.099	1.792	***
ln(Uni Degree- BE)	6,730	2.357	1.115	1.386	2.079	2.944	492	2.844	1.377	1.792	2.639	3.434	6,238	2.319	1.082	1.386	2.079	2.890	***

This table presents descriptive statistics of our main variables for Belgian firms used for our Additional Tests of H1 and H2. The treatment group (*PAT* = 1) comprises Belgian firms that file for at least one patent in the *Reform* period (2008 and onwards) when the Belgian IP box was adopted, while the control group (*PAT* = 0) contains all other Belgian firm years. .*** *, **, and *** denote the significance level of a t-test of the means of the Treatment and Control Group at the 10%, 5%, and 1% levels, respectively. Variables are defined in Appendix A.

Table 7: Descriptive Statistics – Additional Tests of H1 and H2 (continued)

Panel C: Pearson Correlations (Belgian Firms only)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) ln(Employees)	1														
(2) Patent Quality	**0.185**	1													
(3) GAAP ETR	**0.048**	**-0.033**	1												
(4) Adjusted ETR	**0.048**	**-0.033**	1	1											
(5) Size	**0.755**	**0.102**	**-0.054**	**-0.054**	1										
(6) Leverage	**0.149**	**0.064**	**0.166**	**0.166**	**0.147**	1									
(7) Intangibility	**-0.022**	**0.186**	**0.026**	**0.026**	**-0.091**	**0.110**	1								
(8) ROA	**-0.065**	**-0.071**	**-0.037**	**-0.037**	**-0.244**	**-0.123**	**0.043**	1							
(9) Capital Intensity	**-0.128**	**-0.066**	**0.025**	**0.025**	**-0.117**	**0.168**	**-0.085**	**-0.175**	1						
(10) Inventory	**0.079**	-0.015	**-0.040**	**-0.040**	**0.217**	**0.123**	**-0.101**	**-0.192**	**-0.208**	1					
(11) MNE	**0.303**	**0.134**	**0.013**	**0.013**	**0.300**	**0.048**	**-0.014**	-0.001	**-0.093**	**0.032**	1				
(12) Shift	**-0.041**	-0.026	-0.017	-0.017	**-0.041**	0.013	-0.005	-0.021	-0.013	0.011	.	1			
(13) ln(Employees –BE)	**0.971**	**0.199**	**0.049**	**0.049**	**0.745**	**0.137**	**-0.009**	**-0.056**	**-0.114**	**0.061**	**0.305**	**-0.050**	1		
(14) ln(Workers –BE)	**0.882**	**0.178**	**0.046**	**0.046**	**0.665**	**0.134**	**0.034**	**-0.038**	**-0.089**	**-0.030**	**0.251**	**-0.051**	**0.914**	1	
(15) ln(Management – BE)	**0.638**	**0.138**	**-0.108**	**-0.108**	**0.560**	**0.105**	**0.119**	**-0.113**	0.022	**-0.055**	**0.197**	-0.052	**0.642**	**0.580**	1
(16) ln(Uni Degree – BE)	**0.576**	**0.247**	**-0.010**	-0.010	**0.420**	**0.032**	**0.101**	**-0.083**	**-0.074**	**-0.057**	**0.155**	-0.040	**0.594**	**0.420**	**0.443**

This table provides Pearson correlations for the balanced sample of Belgian firms. Bold letters denote statistical significance at the 1% level.

Table 8: Effect of the IP box on innovative activities – Additional Tests of H1

Panel A: Balanced Panel Belgium firms												
Variables	*ln(Employees - BE)*			*ln(Workers - BE)*			*ln(Management - BE)*			*ln(Uni Degree - BE)*		
	All	Dom.	MNEs	All	Dom.	MNEs	All	Dom.	MNEs	All	Dom.	MNEs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Reform	-0.110***	-0.102***	-0.109***	-0.106***	-0.103***	-0.085**	-0.044**	-0.055**	-0.039	0.635***	0.548***	0.841***
	(0.004)	(0.004)	(0.019)	(0.006)	(0.006)	(0.038)	(0.019)	(0.022)	(0.039)	(0.035)	(0.044)	(0.057)
PAT	0.210***	0.190**	0.210	0.127	0.106	0.096	0.360**	0.431*	0.241	0.237	0.281	0.234
	(0.068)	(0.075)	(0.144)	(0.078)	(0.086)	(0.178)	(0.165)	(0.227)	(0.210)	(0.159)	(0.212)	(0.204)
Reform x PAT	**0.061****	**0.087*****	**-0.065**	**0.054**	**0.100****	**-0.195****	**0.047**	**0.089**	**-0.016**	**0.083**	**0.112**	**-0.018**
	(0.026)	**(0.029)**	**(0.052)**	**(0.040)**	**(0.047)**	**(0.078)**	**(0.095)**	**(0.111)**	**(0.165)**	**(0.122)**	**(0.162)**	**(0.167)**
Size	0.637***	0.610***	0.735***	0.570***	0.553***	0.771***	0.273***	0.254***	0.357***	0.414***	0.378***	0.452***
	(0.006)	(0.007)	(0.027)	(0.008)	(0.008)	(0.044)	(0.016)	(0.019)	(0.037)	(0.020)	(0.022)	(0.042)
Leverage	0.352***	0.353***	0.400***	0.319***	0.332***	0.103	0.211**	0.188	0.217	0.316***	0.261**	0.500***
	(0.025)	(0.024)	(0.140)	(0.031)	(0.031)	(0.213)	(0.096)	(0.116)	(0.167)	(0.103)	(0.127)	(0.177)
Constant	-3.112***	-2.932***	-3.445***	-2.669***	-2.558***	-3.859***	-1.185***	-0.995***	-2.807***	-3.049***	-2.298***	-4.065***
	(0.072)	(0.073)	(0.260)	(0.081)	(0.081)	(0.445)	(0.160)	(0.147)	(0.385)	(0.314)	(0.346)	(0.426)
Observations	128,508	122,208	6,300	82,173	78,713	3,460	6,518	4,680	1,838	6,730	4,680	2,050
Adj. R-squared	0.613	0.579	0.591	0.556	0.530	0.533	0.345	0.352	0.282	0.306	0.291	0.325
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Unbalanced Panel Belgium firms												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Reform	-0.085***	-0.079***	-0.113***	-0.088***	-0.085***	-0.130***	-0.017	-0.010	-0.042	0.578***	0.501***	0.796***
	(0.002)	(0.002)	(0.015)	(0.003)	(0.003)	(0.025)	(0.012)	(0.013)	(0.028)	(0.023)	(0.028)	(0.038)
PAT	0.558***	0.512***	0.355***	0.375***	0.353***	0.092	0.604***	0.776***	0.278**	0.313***	0.377***	0.262*
	(0.051)	(0.057)	(0.097)	(0.059)	(0.067)	(0.124)	(0.118)	(0.170)	(0.141)	(0.092)	(0.116)	(0.148)
Reform x PAT	**0.002**	**0.006**	**0.023**	**-0.000**	**0.019**	**-0.059**	**0.018**	**0.044**	**0.013**	**0.271*****	**0.261*****	**0.218***
	(0.027)	**(0.031)**	**(0.050)**	**(0.034)**	**(0.038)**	**(0.078)**	**(0.076)**	**(0.110)**	**(0.105)**	**(0.074)**	**(0.095)**	**(0.112)**
Observations	465,520	449,454	16,066	299,313	290,631	8,682	16,680	12,553	4,127	16,679	11,923	4,756
Adj. R-squared	0.561	0.526	0.583	0.521	0.495	0.474	0.296	0.303	0.233	0.276	0.268	0.291
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: Effect of the IP box on innovative activities – Additional Tests of H1 (continued)

This table reports results of our additional tests of Hypothesis 1 using model (3) for Belgian firms. Panel A (B) reports results for the (un)balanced panel of Belgian firms. *ln(Employees - BE)* is the natural logarithm of the number of employees; *ln(Workers)* is the natural logarithm of the number of workers employed; *ln(Management)* is the natural logarithm of the number of management staff employed; and *ln(Uni Degree)* is the natural logarithm of the number of employees with a university education. *Reform* is an indicator variable taking value one for years 2008 onwards and zero otherwise. *PAT* is an indicator variable equal to one if a firm files for at least one patent in the post-reform period and equal to zero, otherwise. Variables are defined in Appendix A. We report robust standard errors clustered at the firm-level in parentheses. *, **, and *** denote significance of two-tailed tests at the 10%, 5%, and 1% levels, respectively.

Table 9: Effect of the IP box on firms' ETRs - Additional Tests of H2

Panel A: Balanced Panel Belgium firms										
Test of	**H2a**		**H2b**				**H2c**			
Prediction (Reform x PAT)	-		| - | > | - |				| - | > | - |			
	All Firms		Domestic		MNEs		MNEs – *Shift* = 0		MNEs – *Shift* = 1	
Variables	*GAAP ETR*		*GAAP ETR*		*GAAP ETR*		*GAAP ETR*		*GAAP ETR*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Reform	-0.020***	-0.011***	-0.019***	-0.010***	-0.043***	-0.028***	-0.036***	-0.013	-0.045***	-0.030***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.013)	(0.012)	(0.005)	(0.005)
PAT	-0.008	0.004	-0.009	0.004	-0.025	-0.008	-0.018	-0.012	-0.027	-0.008
	(0.007)	(0.007)	(0.007)	(0.007)	(0.019)	(0.017)	(0.030)	(0.031)	(0.022)	(0.019)
Reform x PAT	**-0.023*** **	**-0.022*** **	**-0.022*** **	**-0.021*** **	**-0.006**	**-0.007**	**-0.072** **	**-0.097*** **	**-0.001**	**-0.003**
	(0.007)	**(0.008)**	**(0.008)**	**(0.008)**	**(0.021)**	**(0.021)**	**(0.030)**	**(0.033)**	**(0.025)**	**(0.025)**
Size		-0.008***		-0.008***		-0.022***		-0.022***		-0.022***
		(0.001)		(0.001)		(0.003)		(0.005)		(0.003)
Leverage		0.121***		0.120***		0.142***		0.135***		0.146***
		(0.003)		(0.003)		(0.014)		(0.028)		(0.015)
Intangibility		-0.066***		-0.069***		0.256***		0.215*		0.271***
		(0.008)		(0.008)		(0.089)		(0.122)		(0.103)
ROA		-0.083***		-0.085***		-0.118***		-0.095**		-0.125***
		(0.004)		(0.004)		(0.028)		(0.039)		(0.032)
Capital Intensity		-0.030***		-0.029***		0.011		0.006		0.016
		(0.003)		(0.003)		(0.021)		(0.031)		(0.024)
Inventory		-0.038***		-0.037***		-0.024		0.039		-0.036
		(0.005)		(0.005)		(0.022)		(0.045)		(0.024)
Constant	0.271***	0.281***	0.270***	0.286***	0.329***	0.421***	0.346***	0.505***	0.330***	0.420***
	(0.006)	(0.007)	(0.006)	(0.007)	(0.002)	(0.024)	(0.002)	(0.044)	(0.002)	(0.026)
Observations	244,450	244,450	237,630	237,630	6,820	6,820	1,275	1,275	5,545	5,545
Adj. R-squared	0.013	0.046	0.013	0.046	0.042	0.126	0.058	0.134	0.038	0.125
Panel B: Unbalanced Panel Belgium firms										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Reform	-0.006***	-0.003***	-0.005***	-0.002***	-0.054***	-0.043***	-0.041***	-0.019*	-0.055***	-0.045***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.004)	(0.011)	(0.011)	(0.004)	(0.004)
PAT	-0.009	0.018***	-0.006	0.019***	-0.037***	-0.023*	-0.039	-0.030	-0.037**	-0.021
	(0.005)	(0.005)	(0.006)	(0.006)	(0.014)	(0.013)	(0.029)	(0.028)	(0.015)	(0.014)
Reform x PAT	**-0.036*** **	**-0.036*** **	**-0.035*** **	**-0.035*** **	**0.004**	**0.004**	**-0.016**	**-0.040**	**0.005**	**0.007**
	(0.006)	**(0.006)**	**(0.007)**	**(0.007)**	**(0.014)**	**(0.015)**	**(0.038)**	**(0.035)**	**(0.017)**	**(0.017)**
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,143,169	1,143,169	1,124,033	1,124,033	19,136	19,136	3,344	3,344	15,792	15,792
Adj. R-squared	0.010	0.031	0.011	0.031	0.033	0.066	0.030	0.064	0.032	0.066
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 9: Effect of the IP box on firms' ETRs - Additional Tests of H2 (continued)

Tests of H2c					
Variables	*Prediction*	**Panel C: Balanced Panel** *GAAP ETR*		**Panel D: Unbalanced Panel** *GAAP ETR*	
		(1)	(2)	(3)	(4)
Reform x PAT	-	-0.063**	-0.087***	-0.009	-0.037
		(0.031)	(0.034)	(0.040)	(0.035)
Reform x PAT x Shift	+	0.062	0.085**	0.013	0.044
		(0.041)	(0.042)	(0.045)	(0.041)
Controls		No	Yes	No	Yes
Observations		6,820	6,820	19,136	19,136
Adj. R-squared		0.042	0.126	0.033	0.066
Industry FE		Yes	Yes	Yes	Yes
F-Test: (*Reform x PAT* + *Reform x PAT x Shift* = 0)		F = 3.44 P> F = 0.064	F= 5.66 P> F = 0.018	F= 0.07 P> F = 0.790	F= 1.19 P> F = 0.278

This table reports the results of our additional tests of Hypotheses 2a to 2c using model (4) for Belgian firms. Panel A (B), columns 1 and 2 report the results for our tests of H2a, columns 3 to 6 report the results for our tests of H2b for the balanced (unbalanced) panel of Belgian firms. Panel A (B), columns 7 to 10 present the results for our tests of H2c for the balanced (unbalanced) panel of Belgian multinationals using model (4); panel C (D) report the results for our tests of H2c for the balanced (unbalanced) panel of Belgian multinationals using a fully specified model that includes a triple interaction. We do not present all coefficients included in the model. *GAAP ETR* is the GAAP effective tax rate (tax expense/profit (loss) before tax) of firm *i* in year *t*. *Reform* is an indicator variable equal to one for years 2008 onwards and zero otherwise. *PAT* is an indicator variable equal to one if a firm files for at least one patent in the post-reform period and equal to zero, otherwise. *Shift* is an indicator variable equal to one if the statutory tax rate of a foreign subsidiary or Belgian parent is lower than the Belgian statutory tax rate, and zero otherwise. Variables are defined in Appendix A. We report robust standard errors clustered at the firm-level in parentheses. *, **, and *** denote significance of two-tailed tests at the 10%, 5%, and 1% levels, respectively.

Table 10: Robustness Tests

Panel A: Balanced Panel Belgian and German firms – Primary Tests of H1						
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	*ln(Patent Applications)*	*ln(Patent Grants)*	*Pat App Ratio*	*Pat Grant Ratio*	*ln (Employees)*	*Patent Quality*
***Test 1**: Growth rates of dependent variables:*						
p-value (Growth Rate (BE (Treatment) – DE (Control))	0.009***	0.000***	0.000***	0.000***	0.009*	0.439
Conforming Parallel Trend?	*No*	*No*	*No*	*No*	*No*	*Yes*
***Test 2:** Coefficients estimated for Placebo Reforms*						
Reform2005 x BE	-0.005***	-0.002*	-0.018	-0.018	0.061***	-0.031
Reform2006 x BE	-0.005***	-0.001	0.005	0.002	0.064***	-0.066
Reform2007 x BE	-0.005***	-0.001	0.005	0.009	0.018**	-0.076**
Conforming Parallel Trend?	*No*	*Yes*	*Yes*	*Yes*	*No*	*Yes*
***Test 3:** Coefficients estimated for Placebo Treatment*						
Reform x TreatmentRandom	0.001	0.001	0.002	0.008	0.004	-0.026
Conforming Parallel Trend?	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Sum Test 1 – 3: Parallel Trend? (Conforming : Non-Conforming)	**1:2**	**2:1**	**2:1**	**2:1**	**1:2**	**3:0**

Table 10: Robustness Tests (continued)

Panel B: Balanced Panel Belgian firms only – Additional Tests of H1				
	(1)	(2)	(3)	(4)
Variables	*ln(Employees - BE)*	*ln(Workers - BE)*	*ln(Management - BE)*	*ln(Uni Degree - BE)*
***Test 1**: Growth rates of dependent variables:*				
p-value (Growth Rate (*PAT* = 1) – (*PAT* = 0))	0.254	0.459	0.232	0.712
Conforming Parallel Trend?	*Yes*	*Yes*	*Yes*	*Yes*
***Test 2:** Coefficients estimated for Placebo Reforms*				
Reform2005 x Treat2005	0.006	0.026	0.110	-0.047
Reform2006 x Treat2006	0.041**	0.061*	0.032	0.015
Reform2007 x Treat2007	0.045**	0.059*	0.015	-0.082
Conforming Parallel Trend?	*No*	*No*	*Yes*	*Yes*
***Test 3:** Coefficients estimated for Placebo Treatment*				
Reform x TreatmentRandom	-0.008	0.001	-0.032	-0.009
Conforming Parallel Trend?	*Yes*	*Yes*	*Yes*	*Yes*
Sum Test 1 – 3: Parallel Trend? (Conforming : Non-Conforming)	**2:1**	**2:1**	**3:0**	**3:0**

Table 10: Robustness Tests (continued)

Panel C: Balanced Panels –Tests of H2		
	Balanced Panel Belgian and German firms - *Primary Tests*	Balanced Panel Belgian firms only – *Additional Tests*
	(1)	(2)
Variables	*Adj_ETR*	*GAAP ETR*
Test 1: *Growth rates of dependent variables:*	Growth Rate (BE – DE)	(*PAT* = 1 – *PAT* = 0)
p-value	0.549	0.221
Conforming Parallel Trend?	*Yes*	*Yes*
Test 2: *Coefficients estimated for Placebo Reforms*		
Reform2005 x Treat2005	0.003	0.004
Reform2006 x Treat2006	0.002	0.005
Reform2007 x Treat2007	-0.010	-0.003
Conforming Parallel Trend?	*Yes*	*Yes*
Test 3: *Coefficients estimated for Placebo Treatment*		
Reform x TreatmentRandom	0.001	0.000
Reform x TreatmentRandom x Shift	0.006	0.005
Conforming Parallel Trend?	*Yes*	*Yes*
Sum Test 1 – 3: Parallel Trend? (Conforming : Non-Conforming)	**3:0**	**3:0**

This table provides tests of the parallel trends assumptions for H1 and H2. Test 1 reports *p*-values of the *t*-tests of differences in the growth rates of our dependent variables between the Treatment and Control firms in the period preceding the introduction of the Belgian IP box (2008). Test 2 uses placebo reforms for models (1), (2), (3), and (4). Panel A presents the results for robustness tests of H1 using the sample with Belgian and German firms, Panel B with Belgian firms only. Panel C presents results for robustness tests of H2. *Reform20XX* is an indicator variable equal to one for placebo reform years 20XX onwards and zero otherwise. *Treat20XX* is an indicator variable equal to one if a firm is in the treatment group (*BE* or *PAT*) in the placebo-reform period and equal to zero, otherwise. *Shift* is an indicator variable equal to one if the statutory tax rate of a foreign subsidiary or parent is lower than the Belgian statutory tax rate, and zero otherwise. Test 3 uses an indicator variable (*TreatmentRandom*) that randomly assigns a firm to the Treatment group. Placebo treatment and control groups are evenly distributed over our sample. Variables are defined in Appendix A. We include industry fixed effects in all specifications and report robust standard errors clustered at the firm-level in parentheses. *, **, and *** denote significance of two-tailed tests at the 10%, 5%, and 1% levels, respectively.

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