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

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SCHEDULE FOR FALL 2019 NYU TAX POLICY COLLOQUIUM

(All sessions meet from 4:00-5:50 pm in Vanderbilt 202, NYU Law School)

1. Tuesday, September 3 – Lily Batchelder, NYU Law School.
2. Tuesday, September 10 – Eric Zwick, University of Chicago Booth School of Business.
3. Tuesday, September 17 – Diane Schanzenbach, Northwestern University School of Education and Social Policy.
4. Tuesday, September 24 – Li Liu, International Monetary Fund.
5. Tuesday, October 1 – Daniel Shaviro, NYU Law School.
6. Tuesday, October 8 – Katherine Pratt, Loyola Law School Los Angeles.
7. Tuesday, October 15 – Zachary Liscow, Yale Law School.
8. Tuesday, October 22 – Diane Ring, Boston College Law School.
9. Tuesday, October 29 – John Friedman, Brown University Economics Department.
10. Tuesday, November 5 – Marc Fleurbaey, Princeton University, Woodrow Wilson School.
11. Tuesday, November 12 – Stacie LaPlante, University of Wisconsin-Madison, Wisconsin School of Business.
12. Tuesday, November 19 – Joseph Bankman, Stanford Law School.
13. Tuesday, November 26 – Deborah Paul, Wachtell, Lipton, Rosen, and Katz.
14. Tuesday, December 3 – Joshua Blank, University of California at Irvine Law School, and Ari Glogower, The Ohio State University, Moritz College of Law.

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

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

Abstract. We investigate whether and to what extent the adoption of an intellectual property box increases innovative activity and the extent to which different types of firms benefit financially. Our quasi-experimental setting isolates the cause-effect relationship between the installation of an IP box regime and measures of firm innovation and effective tax rates. Our results indicate an overall increase in innovative activity as proxied by patent applications, grants, and highly-skilled employment, at the expense of patent quality. We also provide evidence that firms with patents, on average, enjoy 7.2% to 7.9% lower effective tax rates, with the greatest financial benefits accruing to multinational firms compared to domestic firms. Within multinational firms, those without income-shifting opportunities appear to benefit more than other multinationals with income shifting opportunities.

INTRODUCTION

We investigate whether and to what extent the adoption of an intellectual property box (IP box) affects firm-level innovative activity and estimated tax benefits. As corporations increasingly operate in multiple countries, competition between countries for investment that will increase the tax base and tax revenue intensifies. Intellectual property box regimes are a relatively new tax policy tool that some countries use to promote investment in innovative activity and to attract or retain mobile income and research and development (R&D) activities within the country. In theory, IP boxes reduce the effective tax burden on successful R&D investments (Evers, Miller, and Spengel 2015). Recent literature provides some evidence in multi-country settings that the introduction of an IP box regime is positively associated with firms' investment in fixed assets (Chen, De Simone, Hanlon, and Lester 2017) and patent applications at the country-level (Bradley, Dauchy, and Robinson 2015). However, recent literature cannot isolate specific elements of an IP box that drive any increase in activity and is silent on important indicators of firms' innovative activity, such as patent grants, patent quality or highly-skilled labor. Our study attempts to fill this gap.

IP box regimes are politically controversial because it is unclear whether they are effective in fostering innovation, yet they increase potential tax avoidance. Proponents of IP box regimes justify significant reductions in statutory tax rates for intellectual property as a necessary policy measure to increase domestic innovation that is perceived to suffer from underinvestment. In contrast, opponents, including some non-governmental organizations (NGOs) or countries without IP boxes, see IP boxes as mechanisms that allow countries to engage in harmful tax competition and to attract mobile capital. For example, former German Minister of Finance

Wolfgang Schäuble criticized patent boxes as *"going against the European spirit."*[1] In response to the controversy, the Organization for Economic Cooperation and Development (OECD) countries recently agreed upon implementing Base Erosion and Profit Shifting (BEPS) Action 5 that limits the tax benefit of IP boxes to income of innovation developed only within the country ("modified nexus approach"). However, some NGOs, such as Tax Justice Network, regard the implementation of the BEPS Action 5 *"as a step into the right direction,"* but doubt that such constraints are sufficient to prevent perceived abuse of IP boxes.[2]

While prior research provides evidence that IP box regimes attract patents with high earnings potential (Alstadsaeter et al. 2018; Schwab and Todtenhaupt 2019), limit tax-motivated income shifting out of the country (Chen et al. 2017), and increases tax-motivated income shifting into the country (Koethenbuerger et al. 2018), there is little evidence on whether and to what extent IP box regimes increase firms' innovative activity.[3] The answer to this question is important to determine if IP box regimes constitute a viable policy tool to foster innovative activity. Yet, it is difficult to answer in a multi-country setting because non-tax factors vary, as do the IP box regimes. Establishing causal effects of regulatory intervention and estimating their size effects is crucial for better-informed policy debates (Leuz and Wysocki 2016). We identify a setting with strong internal validity to assess the extent to which the introduction of an IP box regime affects firm-level patent applications, patent grants, patent quality, highly-skilled employees, and effective tax rates for domestic and multinational firms (MNEs).

[1] https://uk.reuters.com/article/uk-europe-taxes/germany-calls-on-eu-to-ban-patent-box-tax-breaks-idUKBRE9680KY20130709. Germany and Austria introduced anti-avoidance rules that include limiting the deductibility of royalty payments to affiliates that benefit from an IP box regime inconsistent with OECD requirements.

[2] https://www.corporatetaxhavenindex.org/PDF/7-Patent-Boxes.pdf.

[3] In contrast, Bradley et al. (2015) find no significant re-attribution effects of patent ownership.

We exploit the Belgian IP box regime applicable for fiscal years ending after December 31, 2007 for several reasons discussed in Section II, but primarily because the tax benefits conferred by the Belgian IP box are only for gross income from new patents. It excludes income from other forms of IP, such as trademarks, know-how, or secretly held innovations that are difficult to discern in available data.[4] This unique attribute allows us to distinguish between firms with and without access to the Belgian IP box to better gauge causal effects. In contrast to contemporaneous research that examines heterogeneous IP boxes across countries, our research design exhibits strong internal validity allowing us to estimate the extent to which an IP box affects innovative activity. This is important because governments are potentially sacrificing large amounts of tax revenue in exchange for vague and uncertain benefits.[5,6]

We investigate the effect of the adoption of the Belgian IP box using four proxies for innovative activity, including patent applications, patent grants, patent quality, and the number of highly-skilled employees. We compare the patent activities of Belgian firms with access to the IP box to the patent activities of a sample of comparable German, Swedish, and French firms without access to the IP box (first difference) around its adoption in Belgium in 2008 (second difference). Our research design allows us to compare firms that are similar in most respects (e.g., patent-activity, exposure to EU institutions that govern patent activities) yet differ in their access to the IP box, increasing our confidence that we capture a causal effect of the introduction of the Belgian IP box.[7] We find that patent applications in Belgium increased from 0.4 to 1.8

[4] 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. The patent can exist before this date as long as it was not "exploited" prior to this date.
[5] We arguably provide lower bound estimates relative to IP boxes with reduced tax rates on multiple forms of IP not visible in publicly available data.
[6] The Belgian IP box required R&D nexus as of its introduction in 2008. This requirement is comparable to contemporary IP boxes that adopt the OECD BEPS Action 5 requirements.
[7] Our tests satisfactorily support the parallel trends assumption of a constant difference in outcome before the introduction of the IP box across treated and non-treated firms.

percent, and patent grants increase from 0.4 to 5.1 percent relative to firms in control countries after the adoption of the IP box, while patent quality decreases. This pattern is substantially robust across all comparisons of Belgian and control firms with and without entropy balancing.

We investigate our fourth proxy for innovative activity, highly-skilled employment changes, and the extent to which different types of firms benefit financially from the IP box within our Belgium only sample because the institutions that control employment and tax rules are not entirely harmonized across European countries and exhibit some changes during our sample period.[8] Specifically, we compare the number of jobs requiring university degrees (highly- skilled employees) of Belgian firms with access to the IP box to highly-skilled employees of Belgian firms without access to the IP box (first difference) around the introduction of the IP box (second difference). We find a substantial increase in highly-skilled employment after the adoption of the IP box in Belgium, controlling for overall employment levels. Within our sample firms, the mean (median) number of highly-skilled employees before the reform is 17.6 (6) and increases to 32.6 (8). This evidence is consistent with an increase in innovative activity after the adoption of the IP box.

For our second research question regarding the types of firms that benefit from the IP box, we examine effective tax rates to estimate the tax benefits conferred through the Belgian IP box. We use firms' *unconsolidated* ETRs as a comprehensive measure at the single entity level that captures the full tax benefits of IP boxes *after* income shifting takes place. ETRs based on unconsolidated financials capture any tax base effects (such as the introduction of the IP box regime) as tax payments in the European Union are determined at the single-entity level and based on unconsolidated financial data (Watrin et al. 2014). Across the sample period within our

[8] See Section 3.1 for a discussion of our identification strategy.

Belgian firms, we find that those firms subject to the IP box enjoy an average 7.2 to 7.9 percent (2.2 to 2.4 percentage points) decline in effective tax rates. This translates into an estimated tax revenue loss of approximately 0.63 percent or €67,917,685 for Belgium.[9] The benefits are largest for multinational firms relative to domestic firms. Within multinational firms, substantially bigger benefits accrue to firms that do not have income-shifting opportunities, relative to those that do.

Overall our results suggest that the Belgian IP box regime increases firms' level of innovative output and is associated with significantly lower ETRs, especially for subsidiaries of multinational firms that have an incentive to shift income into Belgium. While our results are from a single country, they are generalizable to other IP box regimes because all other IP boxes include tax benefits for patents. Our results arguably capture the lower bound effect on the magnitude of the response to the adoption of an IP box for two reasons. First, we require firms in our sample to have observations in each year of the sample period, so we do not capture the activity of new firms in Belgium after the reform. Second, unlike Belgium, other IP boxes apply preferential tax rates to multiple forms of IP.

Our research makes several contributions. First, it contributes to the tax literature by identifying a strong setting to test the effect of a relatively new tax policy tool. Theoretical evidence suggests IP boxes increase returns to successful R&D, leading to more innovation (Evers et al. 2015). The effect is challenging to detect empirically in a meaningful way in cross-country studies due to the heterogeneous nature of IP regimes, and typical confounds such as culture, correlated omitted tax law changes and other related law changes. Cross-country studies of the impact of tax rules are also affected by tax system characteristics, including the strength of

[9] As discussed below, this is a lower bound estimate of the impact of the Belgian IP box.

enforcement, that vary with components of managerial compensation (Atwood, Drake, Myers, and Myers 2012). Therefore, cross-country studies make it difficult to isolate whether and to what extent the specific elements of any IP box affect innovative activity, limiting their ability to inform policy. This is important because policy continues to evolve even in the absence of empirical data about the effect of a particular IP box (OECD 2015; Leuz and Wysocki 2016). Our setting allows us to investigate the impact of an IP box regime on patenting activity in a country with a substantial tax benefit for one type of IP revenue (patents). We show that a substantial tax benefit for 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 (Merrill 2016; Guenther 2017; Wilde and Wilson 2018). As discussed in Section 2, one reason Belgium adopted the IP box was to foster technological innovation and increase R&D leading to commercial applications (Belgische Kamer Van Volksvertegenwoordigers 2007). Our results arguably capture the lower bound effect on the magnitude of the response to the adoption of an IP.[10] Regardless, our results suggest an overall increase in innovative activity as proxied by patent applications, patent grants, and jobs requiring a university degree, consistent with IP boxes attracting mobile capital and increasing innovative activities of existing firms.

Third, we show that ultimate tax benefits conferred by IP box regimes are not necessarily concentrated in affiliates of MNEs that benefit from income shifting, but also extend to domestic firms. However, multinational firms without incentives to shift income out of Belgium appear to receive the greatest tax benefits of the IP box, followed by other multinational firms, and then

[10] See Section 5.5 for additional discussion and descriptive data on innovative activity of new firms in Belgium after the introduction of the IP box.

domestic firms. Our evidence is consistent with income shifting opportunities not only stressing the public budget but potentially rendering some fiscal measures void. Overall, our findings are useful for policymakers and academics considering incentives for technological innovations as well as the cost and benefits of tax policy.

INSTITUTIONAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

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 concerning qualified IP ranges from patents only to an array of IP, such as patents, trade secrets, trademarks, know-how, and domains. Appendix B provides an overview of the different IP box regimes.[11]

We examine the Belgian IP box because it offers a relatively clean research setting. Belgium adopted an IP box regime to meet three goals.[12] First, to foster technological innovation and increase R&D leading to commercial applications (Belgische Kamer Van Volksvertegenwoordigers 2007, 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

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

[12] 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.

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, including 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. Appendix C provides numerical examples for the theoretical effect of the Belgian IP box on firms' effective tax rates.

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

Hypotheses Development

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 that prevent 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). 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.

While 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), the evidence on IP boxes is still emerging. A substantial body of research on input tax incentives shows that these incentives increase firms' R&D spending across a variety of different countries (e.g., Berger 1993; Bloom, Griffith, and van Reenen 2002; Klassen et al. 2004; Finley, Lusch, and Cook 2015). IP box regimes, however, 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.[13] 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 identify whether IP boxes significantly affect innovative activity on average or benefit any particular firms within a country.

As discussed above, the Belgian IP box provides generous incentives for innovative activity, an 80percent 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:

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

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

2.2.2 The effect of IP box regimes on Effective Tax Rates

Intellectual property 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 percent, while the preferential 6.8 percent tax rate applies to income from successful IP assets.[14] 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 percent for the Belgian IP box. Despite the uncertainty of the effectiveness of IP box incentives to increase innovative activity, 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.

Governments use tax policy to induce certain behavior creating potential cross-sectional differences in the types of firms that benefit from each policy. 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 (Bradley, Robinson, and Ruf 2018).

[14] 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.

Firms also 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, tax avoidance activities appear to benefit from scale effects as larger firms can spread costs for tax avoidance across larger sales bases (Mills, Erickson, and Maydew 1998; Rego 2003).

Further, intangible assets are mobile and feature high degrees of private information regarding 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 or trademarks (Dischinger and Riedel, 2011; Karkinsky and Riedel 2012; Ernst, Richter, and Riedel 2014; 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). An IP box changes the costs and benefits of engaging in R&D activity. 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. The Belgian IP box alters the costs and benefits of engaging in innovative

activity, and we expect multinational entities to respond by earning more revenue from patents in Belgium if the IP box benefit exceeds the costs of placing the innovative activity in Belgium.

In contrast, domestic firms are unable to exploit tax rate differentials across countries or other IP box regimes, but the costs and benefits of engaging in innovative activity in Belgium are affected by the Belgian IP box as well. Whether domestic firms respond also depends on the size of the benefit conferred by the IP box relative to any incremental costs. Therefore, it is an empirical question as to whether domestic or multinational firms benefit more from the implementation of an IP box. Our next hypothesis, stated in the null, is as follows:

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

We 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. We assume that each firm in our sample is maximizing their tax planning opportunities, but not all subsidiaries of multinationals have similar opportunities. Even with the introduction of an IP box, some firms continue to receive bigger benefits from income shifting and have no incentive to utilize the IP box. Alternatively, if a firm has no incentive to shift income (or receives no benefit), it is more likely to take advantage of a new tax-saving opportunity such as an IP box. In the latter case, the IP box is not competing with the tax planning benefit of income shifting. 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.*

1. 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 test the effect of an IP box on firms' innovative activities, we investigate responses in patenting activities and skilled employment to the introduction of an IP box. We benchmark patenting activities of Belgian firms relative to a control group of German, Swedish, and French firms before and after the reform. This difference-in-difference design has several advantages. First, German, Swedish, and French firms did not have access to the benefits of the Belgian IP box and did not adopt IP boxes during our sample period, so the Belgian IP box does not directly affect the patenting activities of the control firms. Second, the European Patent Convention, adopted in 1973, harmonized patent laws across our countries of interest and installed a central European Patent Office (EPO). During the sample period, the institutions that govern patenting activities are comparable across Belgium, Germany, Sweden, and France (Dischinger and Riedel 2011; Hall, Thoma, and Torrisi 2007). Third, using control firms from multiple countries enhances the generalizability of our results. Lastly, pre-reform time-trends of patenting activities across these countries are comparable, which mitigates concerns that our results pick up a time trend affecting the treatment, but not the control group.[15] Therefore, comparing the relative change in patenting activities of Belgian firms subject to the IP box to a group of control firms not subject to the Belgian IP box in different countries provides us with a suitable setting to test our predictions.

[15] See Section 5.2 for a detailed discussion on parallel trends assumptions.

We select firms located in Germany and France as control firms because they are geographically adjacent to Belgium, and share cultural similarities. Germany also shares economic and institutional similarities (e.g., bank financing) with Belgium and does not have an IP box during the sample period (Andrews, Criscuolo, and Menon 2014; Hsu, Tian, and Xu 2014). Alternatively, France adopted an IP box in 2000 and maintained it during the entire sample period. Germany and France also exhibit similar productivity measured as GDP per capita and gross domestic spending on R&D measured as a percentage of R&D expenditure of GDP compared to Belgium.[16] Given Germany and France are both substantially larger than Belgium, we also use Swedish firms as control firms. Sweden is similar to Belgium in size, GDP, and the resources dedicated to research and development activities at a macro level (Andrews et al. 2014). Finally, all of the countries in our study also show a similar pattern of economic development across our sample period.[17]

To test the effects of the introduction of an IP box on firms' highly-skilled employees (our fourth proxy for innovative activities) and effective tax rates, we compare employment and tax rates for patenting firms relative to non-patenting firms *within* Belgium before and after the reform. We perform these analyses using a set of Belgian control firms instead of firms from other countries because the institutions that govern taxes and employment are not entirely harmonized across European countries as are applicable patent laws. All Belgian firms are similarly affected by Belgian tax and employment rules, significantly improving the validity of the parallel trends assumption.[18] We define treated (control) firms as Belgian firms that hold (do

[16] Retrieved from: OECD Data, data.oecd.org.
[17] Retrieved from: OECD Data, https://data.oecd.org/chart/5uDA and Eurostat, http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00115&plugin=1.
[18] See Section 5.2. The parallel trends assumption is questionable for ETRs and employment when comparing across Germany, Sweden, France and Belgium prior to the adoption of the Belgian IP box. Also, detailed employment data is not available for Germany, Sweden or France.

not hold) an eligible patent in the pre-period (before 2008). Assigning the treatment status based on pre-reform characteristics ensures that the introduction of the IP box does not affect the firm's treatment assignment (Angrist and Pischke 2008, 241).

Belgium cut its tax rate on newly-commercialized patent-related income from 33.99 percent to 6.8 percent on January 1, 2008, and we assume that eligible firms act rationally and opt into the IP box regime if the benefits exceed the costs. We compare innovative activities and ETRs in the pre-reform period (pre-2008) versus the post-reform period (post-2007) for Belgian and control firms to test our hypotheses. We assume that absent the introduction of the IP box regime, innovative activities, and ETRs of treatment and control firms evolve similarly (parallel trends assumption). We test this assumption in Figures 2 to 5 and Table 5 (see Section 5.2 for details). 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 activities and tax benefits

We use three patent-related metrics derived from the innovation economics literature, as well as highly-skilled 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. Our first proxy is patent applications, a common proxy for innovative activities (Hall et al. 2007; Hall, Helmers, Rogers, and Sena 2014; Alstadsæter et al. 2018; Bradley et al. 2015).[19] 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

[19] R&D expenditures are also used to proxy for innovative activities, but our data does not provide sufficient observations to use this proxy.

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).[20] Our third proxy is *Patent Quality*. We acknowledge that patent quality does not map as well into the level of innovative activity as other proxies, but indicates the quality of innovative activity induced by an IP box. Following Lanjouw and Schankerman (2004), Hall et al. (2007), and Ernst et al. (2014), we 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.[21] Our last proxy for innovative activity is the level of highly-skilled employment because it is an important *input* factor for innovative activities. We calculate *ln (Uni Degree - BE)* as the natural logarithm of the number of employees with a university degree for firm *i* in year *t* (Andrews et al. 2014).[22]

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 corporate income tax change to occur in Belgium during the sample period. Specifically, we calculate the GAAP effective tax rate (*GAAP ETR*) of firm *i* in year *t* as the ratio of tax expenses to profit before taxes. Appendix A provides definitions and data sources for all variables.

3.3. Empirical specification

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

[20] We set the logarithm to zero when the logarithm is not defined. See Appendix A for further details.
[21] We add the number of patent classes and family size to forward citations (Hall et al., 2007), and then weight each patent by its relative quality and aggregate on an annual basis. This measure 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 ranging from -4.99 to +1.59 (Hall et al. 2007; Ernst et al. 2014).
[22] Prior literature also uses the cost of employees (e.g., Dischinger and Riedel 2011), but we do not have this data.

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

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

In equation (1), *Innovative Activity* is one of the four proxies for innovative activities, patent applications (*ln(Patent Applications))*,patent grants (*ln(Patent Grants))*, patent quality (*Patent Quality*), or highly-skilled employees (*ln(Uni Degree-BE))* 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. *X* equals *BE* for the first three innovative activity proxies, patent applications, patent grants and patent quality, and *BE_PAT* for the last innovative activity, highly-skilled employees. *BE* is used for the cross-country sample and is an indicator variable equal to one if firm *i* is located in Belgium and zero otherwise. *BE_PAT* is used for the Belgian-only sample and is an indicator variable equal to one if the firm is located in Belgium and holds at least one patent in the Pre-Reform period (before 2008). *Controls* is a vector of control variables, including *Size*, because larger firms are likely to have more innovative activity and benefit from scale effects and *Leverage* to account for firms' financial constraints (Hall et al. 2007; Balsmeier et al. 2017).

We include country-industry fixed effects, *FE*, in equation (1) to control for unobserved, time-invariant heterogeneity in patent activities across countries and industries (Dischinger and Riedel 2011; Karkinsky and Riedel 2012).[23] Differences in patent intensity between industries with similar R&D intensity are caused by the underlying technologies that differ across industries but are similar for firms within industries (Arundel 2001; Arundel and Kabla 1998).

[23] Our results remain unchanged when we add country and industry fixed effects separately. We include industry fixed effects instead of country-industry fixed effects when examining employment because our sample is limited to Belgian firms only.

For example, firms operating in the petroleum and chemical industry rely significantly more on patent protection relative to firms operating in the telecommunications industry, even though R&D intensity is similar because chemical formulas are easily delineated, making them relatively easy to patent. Meanwhile, complex technological innovation in the telecommunication industry is difficult to define and to patent. We also include year fixed effects, *FE*, in equation (1) to control for unobserved, macro-level heterogeneity in patent activities across time.[24]

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. Importantly, the coefficient on the interaction between *Reform* and *X*, λ_3, captures any incremental innovative activities of Belgian firms relative to control 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 our second hypothesis, whether and to what extent firms subject to the Belgian IP box enjoy tax benefits around the adoption of the IP box regime relative to control firms, we estimate the following OLS regression:

$$ETR_{it} = \alpha + \beta_1 Reform_t + \beta_2 BE\_PAT_{it} + \beta_3 Reform_t \times BE\_PAT_{it} + \delta Controls_{it} + FE + \varepsilon_{it}. \quad (2)$$

All variables in equation (2) are as defined above, except for the control variables. The

[24] The inclusion of year fixed effects changes the interpretation of the coefficient on *Reform*, but it allows us to control for macroeconomic correlated omitted variables (such as the global financial crisis) and reduces the impact of cross-sectional correlation on standard errors. In robustness tests, we also run all regressions without year fixed effects and the results are substantially unchanged. We do not include firm fixed effects because firms' patenting activities change relatively slowly over time, making them highly correlated with a firm's fixed effect. We want to capture differences in patenting activities between firms, so including firm fixed effects is akin to throwing the baby out with the bathwater (Hall, Jaffe, and Trajtenberg 2005).

coefficient on the interaction between *Reform* and *BE_PAT*, $\beta_{3,}$ captures the incremental change in the effective tax rate of patenting Belgian firms relative to control firms after the introduction of the Belgian IP box regime. In equation (2), we include *Size* because larger firms have greater tax planning opportunities (Rego 2003) and 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 increase depreciation expenses (Gupta and Newberry 1997); *Inventory* because it is a substitute for capital investments (Gupta and Newberry 1997), and total Belgian employees (*ln(Employees - BE)*) to control for overall employment trends in Belgium.

To investigate cross-sectional differences in response to the IP box, hypotheses H2b and H2c, we estimate equation (2) for domestic and MNE firms separately. As depicted in Appendix B, 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 2a, we expect β_3 to be negative. For Hypothesis 2b, if β_3 is less (more) pronounced for multinational enterprises, it suggests MNEs respond relatively less (more) to the introduction of the IP box regime. To test whether MNEs decrease their effective tax rates relatively more than domestic firms, we modify equation (2) by including a triple interaction ($Reform_t \times BE\_PAT_{it} \times MNE_i$) in a fully specified model. The coefficient on $Reform_t \times BE\_PAT_{it} \times MNE_{\text{i}}$ captures the incremental change in effective tax rates of MNEs compared to domestic firms that make use of the Belgian IP box.

To investigate Hypothesis 2c, we bifurcate multinational firms according to their income-shifting opportunities and estimate equation (2) separately for firms with and without shifting opportunities. To test whether MNEs without income-shifting opportunities decrease their effective tax rates relatively more than MNEs with income shifting opportunities, we modify equation (2) by including a triple interaction ($Reform_t \times BE\_PAT_{it} \times Shift_{it}$) in a fully specified model and estimate this regression in the sub-sample of multinational firms. *Shift* equals one if the firm is a MNE with an opportunity to shift income out of Belgium 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 where the multinational operates.[25] The coefficient on $Reform_t \times BE\_PAT_{it} \times Shift_{it}$ 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 significantly positive.

2. Data and sample

Our sample comprises Belgian, German, Swedish, and French industrial firms from 2003 to 2014. We choose a 12-year sample period, including five years before and seven years 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.[26]

[25] Data constraints require us to 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 and the jurisdiction where the parent and/or subsidiary of the MNE is located. Using the tax rate differential of the parent and subsidiary captures the incentive to shift income with noise. However, Markle (2016) suggests that income shifting involving the parent country is especially relevant for firms in territorial tax systems such as Belgium.

[26] Our sample period ends in 2013 for *ln(Uni Degree-BE)* because that is the last year that the data is available.

We construct our sample from unconsolidated financial, employment, and ownership data from Bureau van Dijk's *ORBIS* database, and the Worldwide Patent Statistical Database (*PATSTAT*) (Autumn 2017 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.[27] 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.[28] For sample firms located in Belgium, we match workforce data (using the VAT Tax Identification Number) obtained from the National Bank of Belgium to construct our last proxy for innovative activity, *ln(Uni Degree-BE)*. These data reflect individuals legally employed in Belgium.

We document our sample selection procedure in Table 1. We begin with 2,637,596 Belgian, 7,335,961 German, 1,939,173 Swedish, and 8,120,717 French firm-year observations. Reporting requirements in these countries induce all types and sizes of businesses to report financial information, resulting in large initial sample sizes. However, variation across countries in the extent of financial reporting required contributes to uneven attrition in our sample selection (see, e.g., Dischinger and Riedel 2011; Beuselinck, Deloof, and Vanstraelen 2015; Bethmann, Jacob, and Müller 2018). For example, we lose a disproportionate number of German firms when we drop firms missing total assets. We require firms to be present in each of the twelve years of our sample period to further mitigate noise from reporting requirement differences.[29] We also exclude firm-years missing industry classification and control variables,

[27] 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.
[28] We are able to merge over 80% of Belgian firms in *PATSTAT* to firms retrieved from *ORBIS*.
[29] This requirement also implies that our results are a lower bound estimate of the impact of the IP box given it excludes new firms entering the market after imposition of the Belgian IP box. In Section 5.5, we provide additional information about firms entering the sample after 2007.

as well as negative or zero total assets, or profit before tax.[30] For our cross-country tests of hypothesis H1, our sample consists of 757,284 firm-year observations of 63,107 distinct firms. We further split the 240,396 Belgian firm-years into 2,280 (238,116) firm-years with (with-out) patents before the introduction of the IP box for the within Belgium tests of hypotheses H1 and H2. We winsorize all continuous covariates at the 1st and 99th percentile and *GAAP ETR* at zero and one to accommodate for potential outliers (Dyreng et al. 2008).

5. Results

5.1 Descriptive statistics

Table 2, Panel A presents descriptive statistics for our sample. Approximately 1.2 percent of Belgian, 27.2 percent of German, 6.6 percent of Swedish, and 3.1 percent of French firm-year observations in this sample hold patents in the pre-reform period. These cross-country differences are due, in part, to the relatively smaller number of German firms remaining in our sample after deleting firms with missing assets, as explained in Step 2 of Table 1. The combined average is approximately 3.3 percent and is consistent with findings of the innovation economics literature (Andrews et al. 2014; Hall et al. 2014; Bradley et al. 2015).[31] In comparing the Belgian firms to control firms, Belgian firms have fewer patent applications, and their patents are of lower quality. Belgian firms also appear to be smaller and more highly levered than control firms. To mitigate concerns that these differences affect our results, we provide extensive tests of the parallel-trend assumptions and also present results using an entropy-balanced sample.[32]

Table 2, Panel B reports descriptive statistics for our Belgian firms that hold (do not hold) patents in the pre-reform period, *BE_PAT* = 1 (*BE_PAT* = 0). The mean *GAAP ETR* for the

[30] We require firm years with positive profits before tax to calculate effective tax rates (Dyreng et al. 2008).
[31] Prior literature documents substantial variation in innovation activities among countries (Andrews et al. 2014).
[32] We also run all tests using propensity score matching. Our results remain unchanged.

BE_PAT = 1 (*BE_PAT* = 0) group is 27.7 percent (30.4 percent), relative to the statutory tax rate of 33.99 percent effective in Belgium during the sample period. Firms that hold patents in the pre-reform period also employee more highly skilled workers, are larger, more likely to be multinational firms, have higher *Leverage* ratios, lower *ROA* and *Capital Intensity* ratios, more *Inventory* and comparable *Intangibility* ratios.

Table 3, Panel A (Panel B) presents Pearson correlations for our full sample (Belgian-only sample), with those coefficients that are significant at the 1 percent level marked bold. As expected, the correlation among the proxies for innovative activities in Panel A (*Patent Applications, Patent Grants,* and *Patent Quality*) are significantly positive. *Size, Capital Intensity,* and *Inventory* are positively correlated with both patent applications and patent grants, while *Leverage*, *Intangibility*, *MNE* and *Shift* are negatively correlated.

For our Belgian sample reported in Panel B of Table 3, our fourth proxy for innovative activity, highly-skilled employment, *ln(Uni Degree – BE)*, is significantly and positively related to *Size*, *Intangibility*, *MNE*, and *ln(Employees - BE).* It is also negatively related to *ROA*, *Capital Intensity,* and *Inventory. GAAP ETR* exhibits a significant but relatively small correlation with all of the variables.[33] Of note, *GAAP ETR* is negatively (positively) correlated with *BE_PAT* (*ln(Uni Degree - BE))*, suggesting the effect of an increase in innovative activity on effective tax rates might be too small to capture in the data.

Collectively, the descriptive statistics indicate significant differences in covariates between treatment and control firms, both across countries and within Belgium. We use entropy balancing, matching on the distribution of each covariate before 2008, to alleviate concerns

[33] The positive relation between *Leverage* and *GAAP ETR* is partially attributed to the Allowance for Corporate Equity regime in Belgium.

about the comparability across groups.[34] Unlike other matching techniques, it allows us to match the distribution of our covariates to the first, second, and third moments (Hainmueller 2012; McMullin and Schonberger 2018). Table 4, Panel A (Panel B) provides evidence that the distributions of the covariates are similar after entropy balancing for observations of treatment and control firms across countries (within Belgium), except for German firms.[35] The covariate means for the German firms remain significantly different after entropy balancing due to inherent differences in *Size*, for which we control.

5.2 Parallel Trends Assumption

A critical requirement for our identification strategy is that patenting activities and ETRs of Belgian and control firms evolve similarly before the introduction of the IP box in 2008. To provide detailed and sufficient evidence that this parallel trends assumption holds, we replace the interaction term in equations (1) and (2) with $Year_t \times X_i$ to show relative *annual* changes in patent activities and ETRs for treatment and control firms in the pre-reform period. If the parallel trends assumption holds, we expect the interaction term $Year_t \times X_i$ to be statistically and economically zero in the pre-reform period (Roberts and Whited 2012; Angrist and Pischke 2008).

We provide both graphical and statistical evidence that the parallel trends assumption holds. Figures 2, 3 and 4 provide graphical evidence indicating the Belgian firms' patenting activities *relative* to firms located in Germany, Sweden, and France exhibit little, if any, obvious relation before 2008 in eight out of nine cases, consistent with patenting activities evolving

[34] We repeat all tests balancing on *Size* and *Leverage*. Our results remain unchanged.
[35] Differences between the descriptive statistics reported in Tables 2 and 4 result from matching the distribution of our covariates to the first, second and third moments of the covariates prior to 2008.

uniformly across our countries of interest.[36] Figure 5 provides similar evidence for our Belgian-only sample for our fourth proxy of innovative activity, highly-skilled employees, in Panel A, and GAAP ETRs in Panel B.[37]

We corroborate our graphical evidence with statistical evidence in Table 5 of the yearly pre-reform coefficients of the interaction$Year \times BE$ of regression equation (1) for the entropy-balanced sample. A significant coefficient suggests differences between treatment and control firms before the adoption of the IP box. In Panel A, there are no significant differences for patent quality and only one significant difference out of nine for patent grants (France in 2005). For patent applications, however, we find significant differences every year of the pre-reform period between Belgium and Germany, and in 2005 between Belgium and France, suggesting significantly fewer patent applications in Belgium relative to these control country-years. For Sweden, there are no significant differences. Overall, we interpret this evidence as consistent with a parallel trend assumption holding.

We reach a similar conclusion when assessing the parallel trends assumption for the within Belgium tests of highly-skilled employees and GAAP ETRs. In Panel B of Table 5, none of the coefficients in the pre-reform period for highly-skilled employees or GAAP ETRs is significant, consistent with the parallel trends assumption.

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

Table 6 reports the results from tests of hypothesis H1 of the effect of the Belgian IP box on innovative activities. Relative to control firms, results in Panel A suggest that patent

[36] Figure 2, Panel A depicts significant decreases in patent applications for Belgian compared to German firms in the pre-reform period. Consistent with our predictions, however, we find a relative increase in the post-reform period.
[37] Figures 2 and 3 also show an increase in innovative activities after 2009, consistent with the lag in the innovation process of approximately 2.5 years from patent filing to grant / refusal. We find a comparable lagged effect for patent quality in Figure 4. The more pronounced increases for patent grants could arguably come from increased patent office efficiency rather than changes in innovative behavior. Given patent offices are harmonized across our sample countries, we rule out this alternative explanation.

applications and patent grants of Belgian firms significantly increase after the introduction of the IP box, while patent quality significantly deteriorates. For patent applications, we find positive and statistically significant coefficients on the interaction term $Reform \times BE$ (β_3) with Germany and France (Sweden and France) as control countries using the full (entropy-balanced) sample. Patent applications of Belgian firms increase after the introduction of the IP box by 1.8 percent, 0.6 percent, and 0.4 percent relative to German, Swedish, and French firms, respectively.[38] For patent grants, the coefficient on β_3 is significant across all control countries for both the full and entropy balanced sample, suggesting patent grants of Belgian firms increase by 5.1 percent, 0.9 percent, and 0.4 percent relative to German, Swedish and French firms after the introduction of the IP box.

While patent applications and grants of Belgian firms increase relative to control firms, patent quality decreases. By construction, recent patents are of lower quality relative to older patents. However, our results suggest that the quality of patents granted to Belgian firms is relatively lower than the quality of patents granted to German, Swedish, or French firms. We find negative and statistically significant coefficients on the interaction term $Reform \times BE$ (β_3) across all control countries using both the full and entropy-balanced samples. Given the proxy for patent quality comprises three disparate components, both the size of the coefficient and the corresponding economic effects are difficult to interpret. Overall, results from Panel A of Table 6 suggest that, relative to firms in non-reform countries, innovative activities of Belgian firms increase while the quality of that activity decreases.

[38] We calculate the effect for patent applications, patent grants, and highly-skilled employees using a log-level transformation with a difference in difference specification as 100(exp(β_3) -1)% change in the post period for the treated firms. For a coefficient of 0.018, this results in a 100(exp(0.018)-1) = 1.82 % change.

Next, we assess the effect of the IP box on Belgian firms' highly-skilled employees to address another main policy goal of IP box adoption, attracting highly-skilled labor (e.g., OECD 2015; Bradley et al. 2015; Evers et al. 2015). We restrict this analysis to a sub-sample of Belgian firms with detailed labor data because this data is not available to us in a comparable level of detail for Germany, Sweden, or France. Panel B in Table 6 reports the results from estimating equation (1) where we replace the treatment indicator BE with an indicator BE_PAT that equals one if the firm holds at least one patent before 2008, zero otherwise. This allows us to compare the level of highly-skilled employees of patenting firms with access to the IP box relative to firms that do not have access to the IP box before and after the reform.[39] β_3 is the coefficient of interest on the interaction term $Reform \times BE\_PAT$ that captures the relative change in highly-skilled employees levels after the introduction of the IP box.

Results in Panel B of Table 6 suggest that Belgian firms with access to the benefits of the IP box experience a significant increase in highly-skilled employees relative to non-patenting Belgian firms.[40] Both coefficients on the interaction term $Reform \times BE\_PAT$ (0.328 and 0.383) are highly significant at the one percent-level, suggesting that Belgian firms subject to the IP box experience an increase in the level of highly-skilled employees of 38.8 percent to 46.7 percent in the reform period relative to non-patenting firms. While seemingly large, for the 1,397 firms in our sample with available data, the mean (median) number of highly-skilled employees before the reform is 17.6 (6) and increases to 32.6 (8). Overall, we interpret our results in Table 6 as

[39] In the tests using the Belgium sub-sample, we do not estimate equation (1) using proxies that directly measure changes in patent-related activities because we use patents as the basis for our definition of *BE_PAT*.
[40] The coefficient on *BE_PAT* is significant for the entropy balanced specification (Panel B, Column 2). However, we do not find any significant difference for this coefficient in Table 5, Panel B. This provides comfort that the parallel trend assumption holds.

being consistent with hypothesis H1, the level of innovative activity increases after the adoption of the Belgian IP box.

5.4 The effect of the IP box on firms' effective tax rates

For our second hypothesis, we test whether and to what extent Belgian firms benefit financially from the IP box using the specification presented in equation (2). We compare effective tax rates of Belgian firms with access to the IP box (*BE_PAT* = 1) relative to Belgian firms without access to the IP box (*BE_PAT* = 0). We restrict our analysis to a sample of Belgian firms to ensure that both treatment and control firms are subject to identical tax laws. Table 7 reports results from the full and entropy-balanced sample, which suggests that on average Belgian firms with access to the IP box exhibit significantly lower ETRs relative to firms without access to the IP box. Across the full sample (column 1) and the entropy-balanced sample (column 6), the coefficients on the interaction $Reform \times BE\_PAT$ are negative and significant at the 1 percent-level consistent with hypothesis H2a. Based on our sample, Belgian firms with access to the IP box enjoy approximately 7.2 percent to 7.9 percent (2.2 to 2.4 percentage points) lower ETR relative to firms without access to the IP box. This effect suggests an annual loss in tax revenue for Belgium of about 0.63 percent or € 67,917,685.[41] As with the innovative activity tests of hypothesis H1, this is a lower bound estimate based on the firms in our balanced sample.[42]

Hypothesis H2b investigates whether Belgian domestic firms experience a different reduction in effective tax rates than MNEs. Results for the full sample (columns 2 and 3) and the

[41] Calculated as the product of the average profit of firms holding patents in the post-reform period (€ 16,248,250) and the ETR reduction (2.2 percentage points) yielding an average tax revenue loss per firm of € 357,461. For our sample of 190 eligible firms, this equates to an overall yearly loss for Belgium of approximately € 67,917,685, or 0.63% of the yearly average Belgian tax revenue in the post-period from corporate income and gains of € 10.860 billion.

[42] Using an unbalanced sample of firms that include firms entering in the post-reform period, we estimate a tax revenue loss of approximately 4.82% or € 523,532,943.

entropy-balanced sample (columns 7 and 8) suggest that MNEs benefit from the IP box to a greater extent than domestic firms. Specifically, domestic firms exhibit at the maximum a marginal decrease in their effective tax rates (coefficient -0.009 ($p > 0.10$) for full sample, and -0.011 for entropy-balanced sample, $p < 0.10$), while the decrease in MNEs' effective tax rates ranges from 11.5 percent to 12.5 percent (3.5 to 3.8 percentage points) ($p < 0.01$).[43] In Panel B, we use a triple interaction to test whether the conferred tax benefits for MNEs are greater than for domestic firms. Consistent with H2b, we find a negative coefficient on the triple interaction $BE\_PAT_{it} \times MNE_{i}$ indicating that MNEs incrementally decrease their ETRs by 2.8 to 2.9 percentage points ($p < 0.10$) compared to domestic firms. These results suggest that MNEs appear to enjoy the tax benefits of the IP box more than domestic firms.

To provide a more nuanced picture of MNE's tax benefits, hypothesis H2c examines MNEs with different income shifting incentives. We expect firms that lack an incentive to shift income out of Belgium (*Shift* = 0) to respond more to the introduction of an IP box regime than their counterparts with an incentive to shift income out of Belgium (*Shift* = 1). We split observations of MNEs into MNEs without and with shifting opportunities in columns 4 and 5 (full sample) and columns 9 and 10 (entropy-balanced sample) and estimate equation (2) for these two groups separately. Overall, the results suggest that MNEs without shifting opportunities experience a higher incremental reduction in their ETRs compared to MNEs with shifting opportunities consistent with Hypothesis 2c. Specifically, MNEs without (with) shifting opportunities exhibit a significant incremental reduction in ETRs of 5.2 to 7.1 (3.7 to 4.4) percentage points, translating into a 17.1 percent to 23.4 percent (12.2 percent to 14.5 percent) decrease in ETRs. In Table 7, Panel C, we do not find a significant coefficient on $Reform_{t} \times$

[43] We evaluate this percentage change at the sample mean of ETRs.

$BE\_PAT_{it} \times Shift_{it}$ (coefficients 0.006 and -0.001, $p > 0.10$). While our estimates in Panel A indicate that MNEs without shifting opportunities experience larger incremental reductions in ETRs compared to their peers with shifting opportunities, we do not find statistical support for H2c.

Our estimate of the ETR reduction initially appears large. However, it depends on the magnitude of the patent-related income a firm earns because the Belgian IP box provides an 80 percent reduction in the tax rate on IP income. Variation in the magnitude of royalty rates is substantial, but 25 percent appears to be a decent "rule of thumb" (KPMG 2012). Therefore, in Appendix C, we illustrate the impact of the IP box on firms that have a 10 percent and 30 percent share of patent-related income. Given our results suggest that sample firms' share of patent-related income is around 30 percent of firms' overall pre-tax income, the calculations in Appendix C suggest our estimates of the effect of the IP box on firms ETRs are not unreasonable.[44]

Results in Table 7 suggest that firms subject to the Belgian IP box benefit financially, but MNEs benefit relatively more than domestic firms, and within MNEs, those without other income shifting incentives benefit the most. From a policy perspective, this implies that the desired recipients of these targeted tax incentives are especially difficult to anticipate because the tax incentive not only changes the relative tax burden of patenting and non-patenting firms but also among different types of firms operating in Belgium. Firms are also able to decrease their ETRs via other channels. Therefore, our results indicate that income shifting opportunities not only stress the public budget but potentially renders some fiscal measures void.

[44] Informal discussions with practitioners with knowledge of the Belgian IP box also indicate our estimate is not unreasonable.

5.5 Additional tests

Alternative explanations. To rule out alternative explanations for our results, we use two additional tests and report results in Table 8.[45] First, we conduct a falsification test that assumes the onset of treatment occurs one, two, and three years before the actual reform in 2008. A coefficient statistically indistinguishable from zero indicates that the observed change is more likely due to the treatment than an alternative force (Almeida, Campello, Laranjeira, and Weisbrenner 2011; Roberts and Whited 2012). We find a similar distribution of insignificant coefficients on the interaction of *Reform20XX x BE* (β_3), as in Table 5, consistent with the IP box affecting innovative activity.[46] Second, 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* and find no significant coefficient (β_3) for the interaction term of *Reform* and *TreatmentRandom*. Similar to the falsification test, these results are consistent with the IP box affecting innovative activity.

Unbalanced sample. In Table 9, we also investigate the characteristics of firms with innovative activities entering Belgium after 2007 that are not in our balanced sample. The results for the new firms in Panel C relative to those in Panels A (*BE* = 1) and B (*BE_PAT* =1) indicate that on average the new firms have significantly more highly-skilled employees (78 versus 29 and 66), significantly lower GAAP ETRs (18.9 percent versus 30.4 percent and 27.7 percent) and a significantly higher ratio of intangible to tangible assets (6.4 percent versus 1.7 percent and 1.3 percent). These characteristics are consistent with the IP box attracting new firms

[45] These tests also further test the parallel trends assumption.
[46] In contrast to our specification used in Table 5 that compares *yearly* changes, this approach compares the *average* of the control and treatment groups in the years before and after the reform year.

engaging in innovative activity to Belgium. For the other firm characteristics (Size and total employment), the new firms fall in between the 240,396 Belgian firm-years we use in our cross country tests (*BE* = 1) that include Belgian firms with and without patents reported in Panel A, and the subsample of firm-years that have patents in the pre-period (*BE_PAT* = 1) that we use in our within Belgium tests reported in Panel B. Overall, this descriptive evidence suggests that our balanced panel results are lower-bound estimates of the effect of the Belgian IP box on innovative activities and ETRs.

6. Conclusion

We investigate whether and to what extent the Belgian IP box regime affects innovative activities and effective tax rates. In contrast to recent research on IP boxes that examines multiple countries, we focus on one country because it provides strong internal validity allowing us to identify targeted innovative activity and the resulting tax benefits. We deploy a difference-in-difference research design with Belgian (Belgian-patenting) firms as the treatment group, and German, Swedish, and French (Belgian non-patenting) firms as the control group.

Our results suggest that, relative to control firms, patent applications in Belgium increased from 0.4 percent to 1.8 percent, and patent grants increase from 0.4 percent to 5.1 percent, while patent quality declines. This pattern is substantially robust across all comparisons of Belgian and control firms with and without entropy balancing. Within our Belgian sample, we also find a substantial increase in jobs requiring university degrees for patenting firms after the adoption of the IP box in Belgium, ranging on average from 38.8 percent to 46.7 percent, after controlling for overall employment levels.

We also examine the types of firms that benefit from the Belgian IP Box. Relative to non-patenting Belgian firms, we find that Belgian firms with patents reduce their effective tax rates

by approximately 7.2 percent to 7.9 percent after the adoption of the IP box. We also find cross-sectional variation in the types of firms that enjoy the IP box tax benefits. Effective tax rate savings appear most pronounced for MNEs that do not have an incentive to shift income out of the country, followed by MNEs with income shifting incentives. In contrast, domestic firms experience relatively minor reductions in ETRs after the introduction of the IP box regime.

Our research makes several contributions. We identify a strong setting to investigate the direct impact of an IP box regime on patenting activity and the types of firms that reap the financial benefits. 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 sources
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.
BE_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 holds at least one patent in the Pre-Reform period (before 2008). Source: PATSTAT 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.
Employees – BE	Natural logarithm of the number of employees of firm *i* in year *t*. Source: Belgian National Bank - Annual statements of Belgian firms.
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.
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.
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.
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.
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, 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.
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.
Y(Year)	Variable taking the value of the current financial year.

APPENDIX B
Overview IP Boxes

(Sources: EY (2014); Alstadsæter et al., (2018); Evers et al., (2015))

		BE	CH	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/	Existing IP	No[k)]	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes
Acquired IP	Acquired IP	Yes[l)]	Yes	Yes	No	Yes[l)]	Yes	Yes	Yes	Yes	Yes	No	No	Yes[l)]
Location of	Group	Yes[m)]	Yes	Yes	Yes [n)]	Yes	Yes	Yes	Yes	Yes	Yes	Yes[o)]	Yes	Yes[q)]
R&D	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%.

[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 EY (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.

APPENDIX C
Theoretical Effect of the Belgian IP box on Effective Tax Rates

Panel A: *90%* of income non-patent related; *10%* of income patent-related

	No IP box	**IP box**
Non-patent related income	90	90
Patent-related income (e.g., royalties)	10	10
Pre-tax Income	100	100
Tax on income subject to statutory tax rate (33.99%)	33.99	30.59
Tax on income subject to IP box tax rate (6.8%)	-	0.68
Total tax	33.99	31.27
Net income	66.01	68.73
Effective Tax Rate	33.99%	31.27%
Difference in percentage points	**-2.72% points**	
Difference in percent	**-8.00%**	

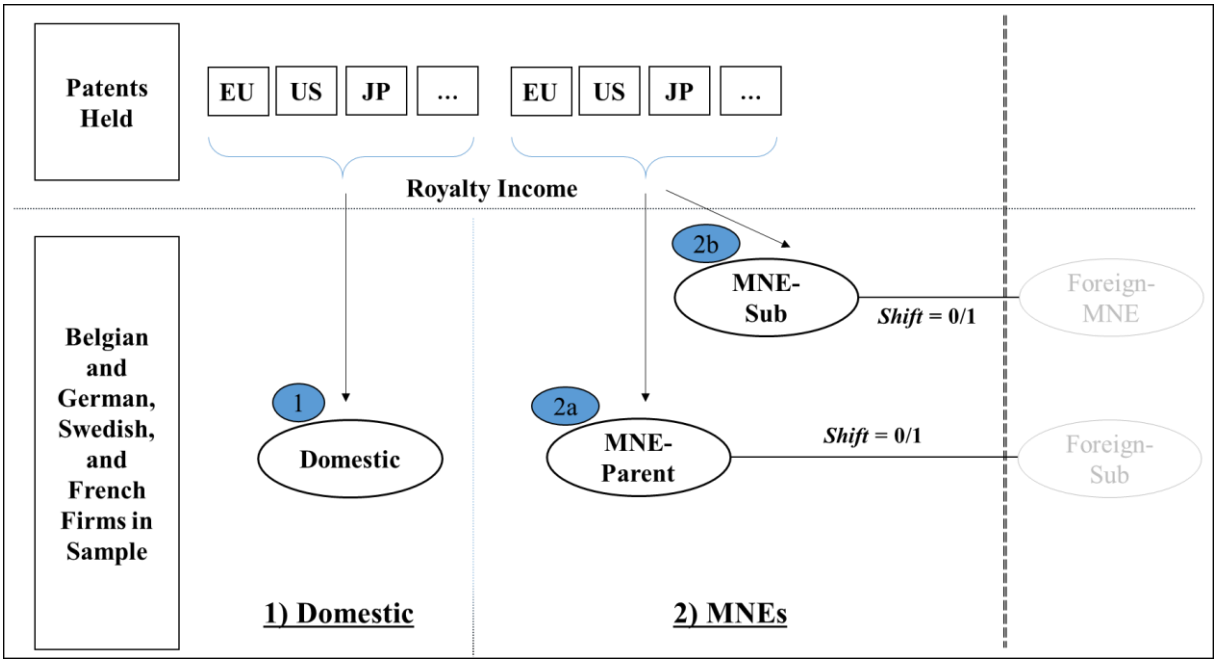
Panel B: *70%* of income non-patent related; *30%* of income patent-related

	No IP box	**IP box**
Non-patent related income	70	70
Patent-related income (e.g., royalties)	30	30
Pre-tax Income	100	100
Tax on income subject to statutory tax rate (33.99%)	33.99	23.79
Tax on income subject to IP box tax rate (6.8%)	-	2.04
Total tax	33.99	25.83
Net income	66.01	74.17
Effective Tax Rate	**33.99%**	**25.83%**
Difference in percentage points	**-8.16% points**	
Difference in percent	**-24.00%**	

This Appendix provides two examples of the effect of the Belgian IP box on a firm's effective tax rate. Panel A assumes that 90% of the income generated is non-patent related and 10% is patent-related. Panel B assumes that 70% of income is non-patent related and 30% is patent-related.

FIGURE 1

Firms included in Primary *Tests of H1 and H2: Belgian, German, Swedish, and French Firms*

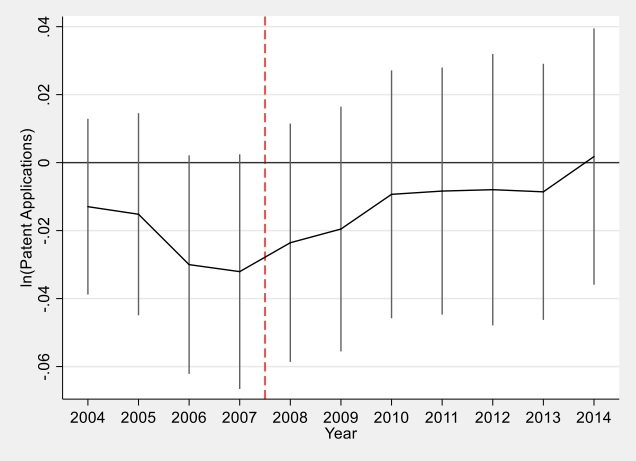


MNEs are firms that have subsidiaries in foreign countries (MNE-Parent) or are part of a multinational group headquartered in a foreign country (MNE-Sub). *Shift* is an indicator variable that takes a value of one if the statutory tax rate of a foreign subsidiary or parent is lower than the statutory tax rate in the respective country, 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.

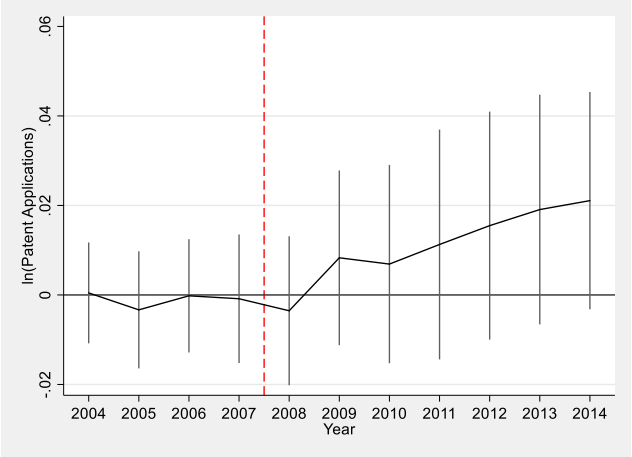
FIGURE 2

Changes in Patent Applications – Belgium vs. Non-Reform Countries

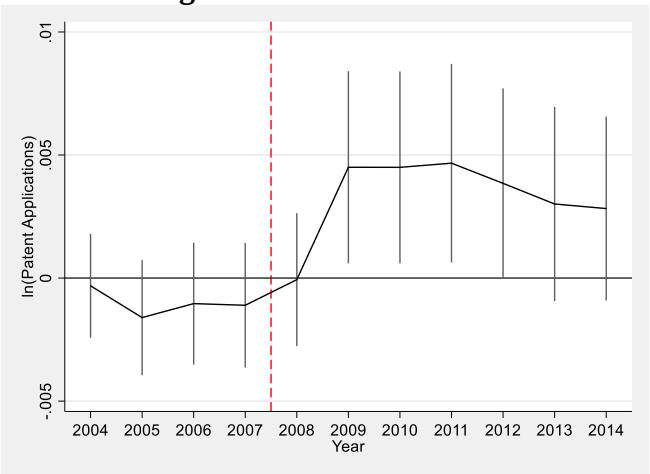
Panel A: Belgium and Germany



Panel B: Belgium and Sweden



Panel C: Belgium and France

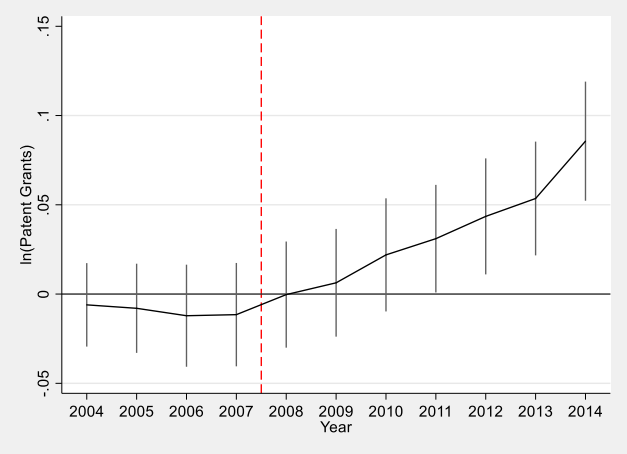


This figure presents graphical evidence on the effect of the introduction of an IP Box in Belgium (2008) on patent applications (*Patent Applications*) of Belgian firms relative to German (Panel A), Swedish (Panel B), and French (Panel C) firms. *Patent Applications* is the natural logarithm of patent applications. The x-axis depicts years with the introduction of the reform indicated as a dashed vertical line. The y-axis depicts the yearly coefficient of the interaction $Year \times BE$ of regression equation (1) representing the increase/decrease in patent applications of Belgian firms relative to German (Panel A), Swedish (Panel B), and French (Panel C) firms. Yearly solid vertical lines indicate the confidence interval at the 99%-level.

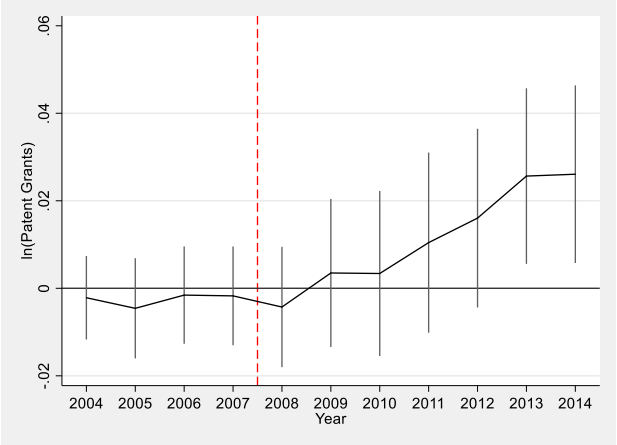
FIGURE 3

Changes in Patent Grants – Belgium vs. Non-Reform Countries

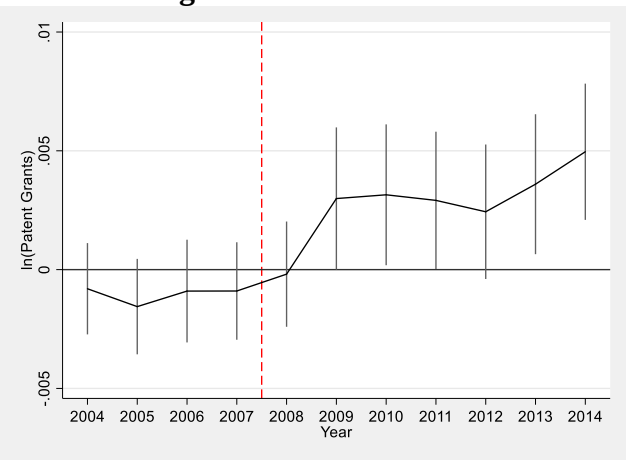
Panel A: Belgium and Germany



Panel B: Belgium and Sweden



Panel C: Belgium and France

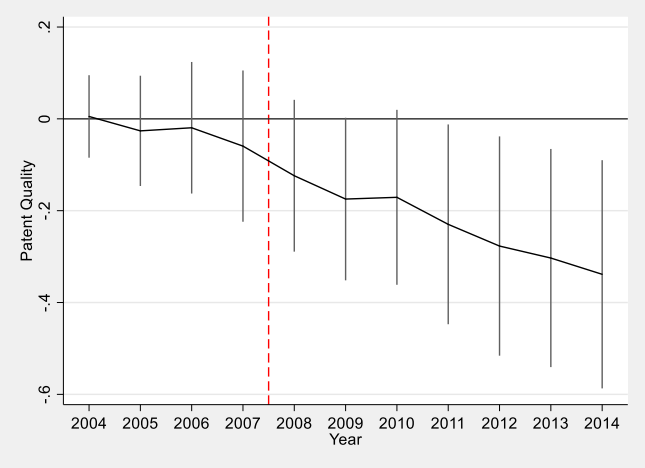


This figure presents graphical evidence on the effect of the introduction of an IP Box in Belgium (2008) on patent grants (*Patent Grants*) of Belgian firms relative to German (Panel A), Swedish (Panel B), and French (Panel C) firms. *Patent Grants* is the natural logarithm of patent grants. The x-axis depicts years with the introduction of the reform indicated as a dashed vertical line. The y-axis depicts the yearly coefficient of the interaction $Year \times BE$ of regression equation (1) representing the increase/decrease in patent grants of Belgian firms relative to German (Panel A), Swedish (Panel B), and French (Panel C) firms. Yearly solid vertical lines indicate the confidence interval at the 99%-level.

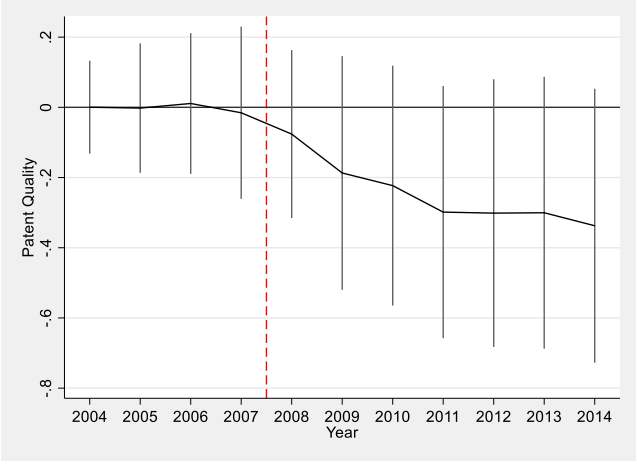
FIGURE 4

Changes in Patent Quality – Belgium vs. Non-Reform Countries

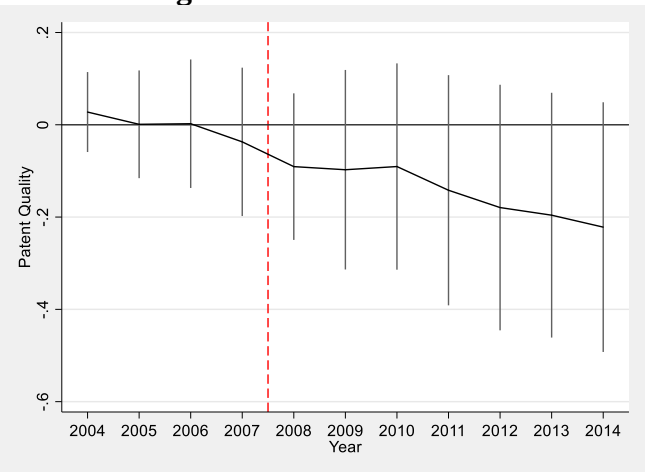
Panel A: Belgium and Germany



Panel B: Belgium and Sweden



Panel C: Belgium and France

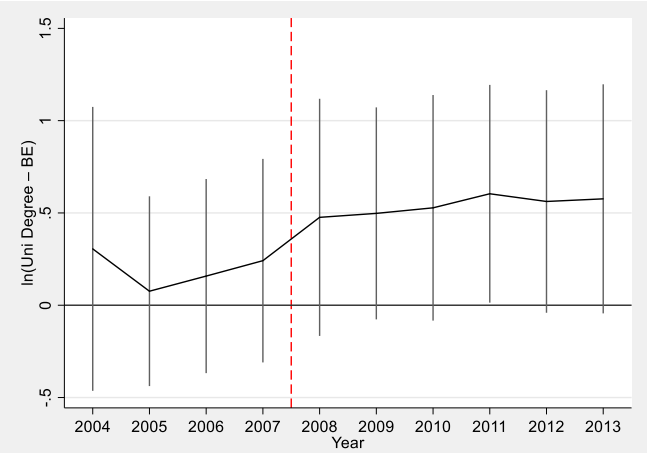


This figure presents graphical evidence on the effect of the introduction of an IP Box in Belgium (2008) on patent quality (*Patent Quality*) of Belgian firms relative to German (Panel A), Swedish (Panel B), and French (Panel C) firms. *Patent Quality* is the composite quality indicator developed by Lanjouw and Schankerman (2004). The x-axis depicts years with the introduction of the reform indicated as a dashed vertical line. The y-axis depicts the yearly coefficient of the interaction $Year \times BE$ of regression equation (1) representing the increase/decrease in patent quality of Belgian firms relative to German (Panel A), Swedish (Panel B), and French (Panel C) firms. Yearly solid vertical lines indicate the confidence interval at the 99%-level.

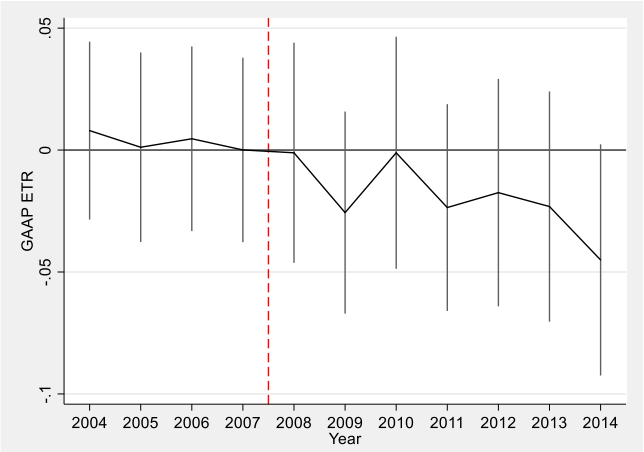
FIGURE 5

Changes in Forms of Employment and GAAP ETR – Belgian Firms only

Panel A: Employees with University Degrees



Panel B: GAAP ETR



This figure presents graphical evidence on the effect of the introduction of an IP Box in Belgium (2008) on employment levels (Panel A) and GAAP effective tax rates (Panel B). The x-axis depicts years with the introduction of the reform indicated as a dashed vertical line. The y-axis depicts the yearly coefficient of the interaction $Year \times BE\_PAT$ of regression equation(1) and (2) representing the increase/decrease in employment levels and *GAAP ETR* of firms that apply for a patent in the pre-period (BE_*PAT = 1*) relative to firms that do not apply for a patent in the pre-period (BE_*PAT = 0*). Yearly solid vertical lines indicate the confidence interval at the 99%-level.

TABLE 1

Sample Selection

Step	Description	No. of observations remaining				
		Full Sample	**Belgium**	**Germany**	**Sweden**	**France**
1	All firm-years listed in ORBIS from 2003-2014 (12 years)	20,033,447	2,637,596	7,335,961	1,939,173	8,120,717
2	Less: firm-years with missing data for total assets	10,925,163	1,618,458	520,489	1,488,457	7,297,759
3	Less: firms with negative or zero total assets	10,910,021	1,618,424	520,486	1,485,718	7,285,393
4	Less: firm-years with missing data for control variables and industry classification	10,017,573	1,618,424	518,828	1,397,115	6,483,206
5	Less: firms with negative or zero profit before tax	7,217,092	1,325,746	443,698	936,413	4,511,235
6	**Full Sample** - firms with 12 observations in the sample period	**757,284**	**240,396**	**23,616**	**21,552**	**471,720**

This table contains the sample selection procedure for our tests that includes Belgian, German, Swedish, and French firms. We require twelve observations per firm. The 240,396 Belgian firm-year observations consist of 2,280 firm-year observations of firms that hold patents in the pre-reform period (*BE_PAT* = 1) and 238,116 firm-year observations that do not hold patents in the pre-period (*BE_PAT* = 0). Our highly skilled employees tests comprise 6,838 Belgian firm-year observations, a subset of the 240,396. 590 observations hold a patent in the pre-reform period (*BE_PAT* = 1) and 6,248 firm-year observations do not hold patents in the pre-period (*BE_PAT* = 0).

TABLE 2

Descriptive Statistics

Panel A: Cross-Country Sample

	Full Sample						Belgium (reform country)					
	N	**Mean**	**S.D.**	**P25**	**Median**	**P75**	**N**	**Mean**	**S.D.**	**P25**	**Median**	**P75**
Patent Applications	757,284	0.016	0.212	0.000	0.000	0.000	240,396	0.005	0.101	0.000	0.000	0.000
Patent Grants	757,284	0.011	0.162	0.000	0.000	0.000	240,396	0.002	0.069	0.000	0.000	0.000
Patent Quality	20,012	-0.448	0.664	-0.908	-0.469	-0.027	1,811	-0.721	0.950	-1.079	-0.708	-0.063
Size	757,284	7.350	1.560	6.312	7.174	8.216	240,396	6.797	1.442	5.799	6.612	7.623
Leverage	757,284	0.367	0.298	0.057	0.358	0.622	240,396	0.470	0.257	0.258	0.471	0.678
Intangibility	757,284	0.052	0.131	0.000	0.000	0.025	240,396	0.017	0.069	0.000	0.000	0.000
ROA	757,284	0.149	0.131	0.061	0.115	0.196	240,396	0.153	0.142	0.059	0.115	0.199
Capital Intensity	757,284	0.179	0.204	0.033	0.100	0.251	240,396	0.267	0.241	0.070	0.193	0.410
Inventory	757,284	0.481	0.337	0.131	0.545	0.761	240,396	0.098	0.155	0.000	0.007	0.149
MNE	757,284	0.267	0.442	0.000	0.000	1.000	240,396	0.075	0.263	0.000	0.000	0.000
Shift	201,924	0.940	0.238	1.000	1.000	1.000	18,012	0.830	0.376	1.000	1.000	1.000

	Germany (non-reform country)						Sweden (non-reform country)					
	N	**Mean**	**S.D.**	**P25**	**Median**	**P75**	**N**	**Mean**	**S.D.**	**P25**	**Median**	**P75**
Patent Applications	23,616	0.252	0.869	0.000	0.000	0.000	21,552	0.041	0.351	0.000	0.000	0.000
Patent Grants	23,616	0.170	0.671	0.000	0.000	0.000	21,552	0.028	0.269	0.000	0.000	0.000
Patent Quality	5,631	-0.261	0.606	-0.666	-0.286	0.085	1,159	-0.355	0.677	-0.692	-0.238	0.092
Size	23,616	10.634	1.650	9.376	10.529	11.767	21,552	7.709	1.580	6.603	7.506	8.686
Leverage	23,616	0.440	0.229	0.258	0.433	0.607	21,552	0.341	0.289	0.039	0.313	0.582
Intangibility	23,616	0.023	0.055	0.001	0.005	0.015	21,552	0.005	0.026	0.000	0.000	0.000
ROA	23,616	0.114	0.104	0.046	0.086	0.149	21,552	0.137	0.109	0.061	0.114	0.183
Capital Intensity	23,616	0.404	0.260	0.182	0.375	0.620	21,552	0.275	0.261	0.040	0.191	0.471
Inventory	23,616	0.586	0.260	0.372	0.611	0.808	21,552	0.586	0.260	0.384	0.601	0.797
MNE	23,616	0.099	0.298	0.000	0.000	0.000	21,552	0.075	0.264	0.000	0.000	0.000
Shift	2,328	0.775	0.417	1.000	1.000	1.000	1,620	0.295	0.456	0.000	0.000	1.000

	France (non-reform country)					
	N	**Mean**	**S.D.**	**P25**	**Median**	**P75**
Patent Applications	471,720	0.009	0.143	0.000	0.000	0.000
Patent Grants	471,720	0.007	0.113	0.000	0.000	0.000
Patent Quality	11,411	-0.506	0.608	-0.969	-0.584	-0.101
Size	471,720	7.451	1.374	6.548	7.324	8.257
Leverage	471,720	0.312	0.307	0.008	0.220	0.588
Intangibility	471,720	0.074	0.153	0.000	0.004	0.063
ROA	471,720	0.150	0.126	0.062	0.116	0.198
Capital Intensity	471,720	0.119	0.142	0.024	0.069	0.160
Inventory	471,720	0.666	0.232	0.531	0.692	0.855
MNE	471,720	0.382	0.486	0.000	0.000	1.000
Shift	179,964	0.959	0.199	1.000	1.000	1.000

Panel B: Belgian Sub-Sample Firms only

	BE_PAT = 1						BE_PAT = 0					
	N	**Mean**	**S.D.**	**P25**	**Median**	**P75**	**N**	**Mean**	**S.D.**	**P25**	**Median**	**P75**
ln(Uni Degree – BE)	590	2.861	1.370	1.792	2.639	3.466	6,248	2.346	1.099	1.386	2.079	2.944
GAAP ETR	2,280	0.277	0.148	0.201	0.300	0.346	238,116	0.304	0.164	0.224	0.302	0.355
Size	2,280	9.117	1.456	7.965	9.341	10.713	238,116	6.774	1.423	5.790	6.597	7.593
Leverage	2,280	0.513	0.232	0.339	0.534	0.685	238,116	0.470	0.258	0.257	0.471	0.678
Intangibility	2,280	0.013	0.038	0.000	0.001	0.007	238,116	0.017	0.070	0.000	0.000	0.000
ROA	2,280	0.137	0.123	0.052	0.101	0.188	238,116	0.154	0.143	0.059	0.115	0.200
Capital Intensity	2,280	0.186	0.159	0.055	0.150	0.276	238,116	0.268	0.241	0.070	0.193	0.412
Inventory	2,280	0.160	0.141	0.035	0.137	0.242	238,116	0.097	0.155	0.000	0.006	0.148
MNE	2,280	0.311	0.463	0.000	0.000	1.000	238,116	0.073	0.260	0.000	0.000	0.000
Shift	708	0.780	0.415	1.000	1.000	1.000	17,304	0.832	0.374	1.000	1.000	1.000
ln(Employees – BE)	1,898	3.852	1.609	2.708	3.689	4.997	115,813	2.113	1.195	1.099	1.946	2.833

This table presents summary statistics for the full sample, Belgium (reform country) that introduced the IP box in 2008, and each non-reform country (Germany, Sweden, and France) that did not introduce an IP box in 2008 in Panel A. We also present descriptive statistics of our main variables separately for Beligan firms that hold patents before 2008 (*BE_PAT* = 1) and Belgian firms that do not hold patents before 2008 (*BE_PAT = 0*) in Panel B. All variables are defined in Appendix A.

TABLE 3
Pearson Correlations

Panel A: Pearson Correlations for Cross-Country Sample

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	*Patent Applications*	1										
(2)	*Patent Grants*	**0.948**	1									
(3)	*Patent Quality*	**0.266**	**0.250**	1								
(4)	*Size*	**0.182**	**0.163**	**0.287**	1							
(5)	*Leverage*	**-0.006**	**-0.003**	-0.004	**-0.096**	1						
(6)	*Intangibility*	**-0.004**	-0.003	**0.061**	**-0.054**	**-0.014**	1					
(7)	*ROA*	0.001	0.003	**0.028**	**-0.214**	**-0.070**	**-0.037**	1				
(8)	*Capital Intensity*	**0.029**	**0.025**	**0.119**	**0.006**	**0.188**	**-0.129**	**-0.099**	1			
(9)	*Inventory*	**0.021**	**0.022**	-0.013	**0.148**	**-0.033**	**-0.110**	**0.004**	**-0.454**	1		
(10)	*MNE*	**-0.006**	**-0.006**	0.015	**0.051**	**-0.076**	**0.006**	**-0.045**	**-0.180**	**0.288**	1	
(11)	*Shift*	**-0.079**	**-0.070**	**-0.135**	**-0.260**	**-0.080**	**0.067**	**-0.032**	0.003	**0.051**	**.**	1

Panel B: Pearson Correlations for Belgian Sub-Sample

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	*Uni Degree – BE*	1											
(2)	*GAAP ETR*	0.004	1										
(3)	*Size*	**0.403**	**-0.061**	1									
(4)	*Leverage*	0.024	**0.170**	**0.136**	1								
(5)	*Intangibility*	**0.102**	**0.030**	**-0.094**	**0.113**	1							
(6)	*ROA*	**-0.092**	**-0.016**	**-0.259**	**-0.088**	**0.035**	1						
(7)	*Capital Intensity*	**-0.064**	**0.031**	**-0.120**	**0.167**	**-0.079**	**-0.166**	1					
(8)	*Inventory*	**-0.068**	**-0.047**	**0.225**	**0.116**	**-0.092**	**-0.185**	**-0.204**	1				
(9)	*BE_PAT*	**0.128**	**-0.016**	**0.158**	**0.016**	**-0.005**	**-0.012**	**-0.033**	**0.039**	1			
(10)	*MNE*	**0.107**	**0.028**	**0.291**	**0.053**	**-0.021**	**0.008**	**-0.115**	**0.035**	**0.088**	1		
(11)	*Shift*	0.019	**-0.063**	**-0.129**	**-0.039**	0.005	-0.003	**0.075**	-0.013	**-0.027**	**.**	1	
(12)	*Employees – BE*	**0.616**	**0.051**	**0.736**	**0.132**	**-0.010**	**-0.060**	**-0.109**	**0.059**	**0.179**	**0.300**	**-0.068**	1

This table provides Pearson correlations for the full sample of Belgian, German, Swedish and French firms in Panel A and the Belgian subsample in Panel B. Bold letters denote statistical significance at the 1% level. All variables are defined in Appendix A.

TABLE 4

Entropy Balancing

Panel A: Cross-Country Sample
Covariate Distributions before Entropy Balancing

	Belgian Firms **(N = 240,396)**			***German Firms*** **(N = 23,616)**			***Swedish Firms*** **(N = 21,552)**			***French Firms*** **(N = 471,720)**		
	Mean	**S.D.**	**Skewness**	**Mean**	**S.D.**	**Skewness**	**Mean**	**S.D.**	**Skewness**	**Mean**	**S.D.**	**Skewness**
Size	6.551	2.074	0.664	10.450	2.811	0.209	7.315	2.683	0.489	7.117	1.885	0.428
Leverage	0.516	0.065	-0.130	0.463	0.063	0.097	0.570	0.043	-0.209	0.578	0.045	-0.194
Intangibility	0.029	0.009	3.955	0.023	0.003	4.277	0.005	0.001	7.240	0.075	0.024	2.777
ROA	0.158	0.020	2.032	0.119	0.012	2.329	0.139	0.012	2.020	0.159	0.017	1.723
Capital Intensity	0.276	0.058	0.960	0.040	0.069	0.273	0.278	0.068	0.776	0.121	0.019	2.166
Inventory	0.100	0.025	1.884	0.587	0.069	-0.243	0.665	0.072	-0.547	0.753	0.056	-1.259

Covariate Distributions after Entropy Balancing

	Belgian Firms **(N = 240,396)**			***German Firms*** **(N = 23,616)**			***Swedish Firms*** **(N = 21,552)**			***French Firms*** **(N = 471,720)**		
	Mean	**S.D.**	**Skewness**	**Mean**	**S.D.**	**Skewness**	**Mean**	**S.D.**	**Skewness**	**Mean**	**S.D.**	**Skewness**
Size	6.551	2.074	0.664	8.219	4.204	0.031	6.551	4.388	0.477	6.551	2.335	0.157
Leverage	0.516	0.065	-0.130	0.456	0.102	0.007	0.516	0.073	0.254	0.516	0.116	0.573
Intangibility	0.029	0.009	3.955	0.035	0.004	3.082	0.029	0.007	2.587	0.029	0.012	4.952
ROA	0.158	0.020	2.032	0.130	0.008	1.170	0.158	0.041	2.396	0.158	0.024	2.066
Capital Intensity	0.276	0.058	0.960	0.320	0.051	0.958	0.276	0.138	0.811	0.276	0.127	0.701
Inventory	0.100	0.025	1.884	0.397	0.038	0.308	0.100	0.011	1.571	0.100	0.011	2.517

TABLE 4 (continued)

Entropy Balancing

Panel B: Belgian Sub-Sample
Covariate Distributions before Entropy Balancing

	BE_PAT = 1 **(N = 2,280)**			***BE_PAT = 0*** **(N = 238,116)**		
	Mean	**S.D.**	**Skewness**	**Mean**	**S.D.**	**Skewness**
Size	8.912	2.377	-0.397	6.528	2.017	0.651
Leverage	0.564	0.052	-0.316	0.515	0.065	-0.128
Intangibility	0.013	0.002	5.722	0.029	0.009	3.940
ROA	0.144	0.016	2.038	0.158	0.020	2.031
Capital Intensity	0.195	0.026	1.211	0.278	0.058	0.945
Inventory	0.157	0.019	0.879	0.100	0.025	1.896

Covariate Distributions after Entropy Balancing

	BE_PAT = 1 **(N = 2,280)**			***BE_PAT = 0*** **(N = 238,116)**		
	Mean	**S.D.**	**Skewness**	**Mean**	**S.D.**	**Skewness**
Size	8.912	2.377	-0.397	8.911	2.587	-0.535
Leverage	0.564	0.052	-0.316	0.564	0.067	-0.324
Intangibility	0.013	0.002	5.722	0.013	0.003	6.615
ROA	0.144	0.016	2.038	0.144	0.019	2.138
Capital Intensity	0.195	0.026	1.211	0.195	0.043	1.498
Inventory	0.157	0.019	0.879	0.157	0.032	1.183

This table presents the mean, variance and skewness of each covariate for the cross-country sample (Panel A) and the Belgian sub-sample (Panel B) before and after entropy balancing. *BE_PAT* is an indicator variable equal to one if a (Belgian) firm holds at least one patent in the pre-reform period (before 2008) and equal to zero, otherwise. All variables are defined in Appendix A.

TABLE 5

Parallel Trends Tests

Panel A: Cross-Country Sample

Patent Applications	**(1)** **Belgium & Germany**	**(2)** **Belgium & Sweden**	**(3)** **Belgium & France**
Y2005 × BE	-0.015*	-0.003	-0.002**
Y2006 × BE	-0.030***	-0.000	-0.001
Y2007 × BE	-0.030***	-0.001	-0.001

Patent Grants	**(1)** **Belgium & Germany**	**(2)** **Belgium & Sweden**	**(3)** **Belgium & France**
Y2005 × BE	-0.008	-0.005	-0.002**
Y2006 × BE	-0.012	-0.002	-0.001
Y2007 × BE	-0.012	-0.002	-0.001

Patent Quality	**(1)** **Belgium & Germany**	**(2)** **Belgium & Sweden**	**(3)** **Belgium & France**
Y2005 × BE	-0.026	-0.002	0.001
Y2006 × BE	-0.019	0.011	0.002
Y2007 × BE	-0.059	-0.016	-0.037

Panel B: Belgian Sub-Sample

	(1) **Uni Degree – BE**	**(2)** **GAAP ETR**
Y2005 × BE_PAT	0.076	0.001
Y2006 × BE_PAT	0.158	0.005
Y2007 × BE_PAT	0.242	0.000

This table provides tests of the parallel trends assumptions. Panel A presents yearly pre-reform (before 2008) coefficients of the interaction $Reform\ (Year) \times BE$ of regression equation (1) for the entropy-balanced sample. In Panel A, column (1) presents the results for Belgium and Germany, column (2) for Belgium and Sweden, and column (3) for Belgium and France. *Patent Applications* is the natural logarithm of patent applications, *Patent Grants* is the natural logarithm of patent grants. *Patent Quality* is the composite quality indicator developed by Lanjouw and Schankerman (2004). *BE* is an indicator variable equal to one if a firm is located in Belgium, and zero otherwise. Panel B presents yearly pre-reform (before 2008) coefficients of the interaction $Year \times BE\_PAT$ of regression equation (1) and (2) for the entropy-balanced sample of Belgian firms. In Panel B, column (1) presents the results for *Uni Degree - BE*, and column (2) for *GAAP ETR*. *Uni Degree – BE* is the natural logarithm of the number of employees with a university degree. *GAAP ETR* is the GAAP effective tax rate (tax expense/profit before tax) of firm *i* in year *t*. *BE_PAT* is an indicator variable equal to one if a firm hold at least one patent in the pre-reform period (before 2008) and equal to zero, otherwise. We include year and country-industry fixed effects. *, **, and *** denote significance of two-tailed tests at the 10%, 5%, and 1% levels, respectively. All variables are defined in Appendix A.

TABLE 6

Effect of the IP Box on Firms' Innovation

Panel A: Cross-Country Sample

Patent Applications

		Full Sample			Entropy Balanced Sample		
		Belgium & Germany	**Belgium & Sweden**	**Belgium & France**	**Belgium & Germany**	**Belgium & Sweden**	**Belgium & France**
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Pred. Sign	**Patent Applications**	**Patent Applications**	**Patent Applications**	**Patent Applications**	**Patent Applications**	**Patent Applications**
Reform × BE	+	**0.018*** **	**0.006**	**0.004*** **	**0.007**	**0.011** **	**0.004*** **
		(0.007)	**(0.004)**	**(0.001)**	**(0.007)**	**(0.005)**	**(0.001)**
Size		0.026***	0.009***	0.010***	0.105***	0.022***	0.009***
		(0.002)	(0.001)	(0.001)	(0.011)	(0.004)	(0.001)
Leverage		-0.029***	-0.007***	-0.005***	-0.095***	-0.014*	-0.005***
		(0.005)	(0.002)	(0.001)	(0.025)	(0.008)	(0.002)
Constant		-0.157***	-0.055***	-0.063***	-0.743***	-0.135***	-0.057***
		(0.016)	(0.007)	(0.005)	(0.087)	(0.027)	(0.005)
Observations		264,012	261,948	712,116	264,012	261,948	712,116
Adj. R^2		0.236	0.117	0.039	0.271	0.183	0.039
Country-Ind. FE		Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes	Yes	Yes

Patent Grants

		Full Sample			Entropy Balanced Sample		
		Belgium & Germany	**Belgium & Sweden**	**Belgium & France**	**Belgium & Germany**	**Belgium & Sweden**	**Belgium & France**
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Pred. Sign	**Patent Grants**	**Patent Grants**	**Patent Grants**	**Patent Grants**	**Patent Grants**	**Patent Grants**
Reform × BE	+	**0.050*** **	**0.009*** **	**0.004*** **	**0.042*** **	**0.013*** **	**0.003*** **
		(0.006)	**(0.003)**	**(0.001)**	**(0.006)**	**(0.004)**	**(0.001)**
Size		0.018***	0.006***	0.007***	0.075***	0.015***	0.006***
		(0.002)	(0.001)	(0.001)	(0.009)	(0.003)	(0.001)
Leverage		-0.021***	-0.004**	-0.004***	-0.068***	-0.006	-0.004***
		(0.004)	(0.002)	(0.001)	(0.019)	(0.006)	(0.001)
Constant		-0.129***	-0.037***	-0.044***	-0.552***	-0.098***	-0.039***
		(0.013)	(0.006)	(0.004)	(0.071)	(0.021)	(0.003)
Observations		264,012	261,948	712,116	264,012	261,948	712,116
Adj. R^2		0.201	0.110	0.032	0.230	0.164	0.032
Country-Ind. FE		Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes	Yes	Yes

TABLE 6 (continued)

Effect of the IP Box on Firms' Innovation

Patent Quality

		Full Sample			Entropy Balanced Sample		
		Belgium & Germany	**Belgium & Sweden**	**Belgium & France**	**Belgium & Germany**	**Belgium & Sweden**	**Belgium & France**
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Pred. Sign	**Patent Quality**	**Patent Quality**	**Patent Quality**	**Patent Quality**	**Patent Quality**	**Patent Quality**
Reform × BE	**-**	**-0.213*** **	**-0.221*** **	**-0.136*** **	**-0.214*** **	**-0.241*** **	**-0.142*** **
		(0.044)	**(0.076)**	**(0.050)**	**(0.045)**	**(0.082)**	**(0.052)**
Size		0.102***	0.090**	0.086***	0.108***	0.127***	0.084***
		(0.015)	(0.038)	(0.013)	(0.015)	(0.044)	(0.014)
Leverage		0.003	0.053	-0.061	-0.013	0.113	-0.044
		(0.096)	(0.151)	(0.074)	(0.105)	(0.169)	(0.085)
Constant		-1.431***	-1.360***	-1.285***	-1.468***	-1.633***	-1.284***
		(0.178)	(0.370)	(0.119)	(0.180)	(0.449)	(0.134)
Observations		7,442	2,970	13,222	7,442	2,970	13,222
Adj. R^2		0.308	0.278	0.193	0.285	0.333	0.207
Country-Ind. FE		Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Belgian Sub-Sample - Highly-Skilled Employees

		Full Sample	Entropy Balanced Sample
	Pred. Sign	**(1)** **Uni Degree - BE**	**(2)** **Uni Degree - BE**
BE_PAT		-0.087	-0.262***
		(0.102)	(0.100)
Reform × BE_PAT	**+**	**0.328*** **	**0.383*** **
		(0.096)	**(0.095)**
Size		0.019	-0.111
		(0.021)	(0.070)
Leverage		0.163**	-0.303
		(0.076)	(0.218)
ln(Employees – BE)		0.586***	0.796***
		(0.026)	(0.060)
Constant		-0.415**	0.014
		(0.162)	(0.548)
Observations		6,836	6,836
Adj. R^2		0.595	0.789
Industry FE		Yes	Yes
Year FE		Yes	Yes

This table reports the results of our primary tests of Hypothesis 1 using equation (1). Panel A presents cross-country results for patent applications (*Patent Applications),* patent grants (*Patent Grants*) and Patent Quality (*Patent Quality*). Columns (1) to (3) ((4) to (6)) of Panel A present results for the sample before (after) entropy balancing. *Patent Applications* is the natural logarithm of patent applications, *Patent Grants* the natural logarithm of patent grants and *Patent Quality* is the composite quality indicator developed by Lanjouw and Schankerman (2004). We include year and country-industry fixed effects in Panel A. Panel B reports results of Hypothesis 1 using equation (1) for Belgian firms using the number of employees holding a university degree (*Uni Degree – BE*) as dependent variable. Column (1) ((2)) in Panel B presents results for the sample before (after) entropy balancing. *Reform* is an indicator variable taking value one for years 2008 onwards and zero otherwise. *BE_PAT* is an indicator variable equal to one if a firm holds at least one patent in the pre-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 at the 10%, 5%, and 1% levels. We use one-tailed tests when a sign is predicted and two-tailed otherwise.

TABLE 7

Effect of the IP Box on Firms' Effective Tax Rates

Panel A: Test of H2a to H2c using the Belgian Sub-Sample

		Full sample					Entropy Balanced Sample				
Test of hypothesis		H2a	H2b		H2c		H2a	H2b		H2c	
Prediction (*Reform × BE_PAT)*		-	| - | ? | - |		| - | < | - |		-	| - | ? | - |		| - | < | - |	
(Sub)-Sample	***Pred. Sign***	**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)**
		GAAP ETR	**GAAP ETR**	**GAAP ETR**	**GAAP ETR**	**GAAP ETR**	**GAAP ETR**	**GAAP ETR**	**GAAP ETR**	**GAAP ETR**	**GAAP ETR**
BE_PAT		0.002	0.001	-0.004	-0.013	0.003	0.001	0.000	-0.028*	-0.032***	-0.024
		(0.007)	(0.009)	(0.012)	(0.016)	(0.016)	(0.008)	(0.009)	(0.014)	(0.011)	(0.019)
Reform × BE_PAT	**-**	**-0.021*** **	**-0.009**	**-0.038*** **	**-0.071** **	**-0.044** **	**-0.022*** **	**-0.011***	**-0.035** **	**-0.052** **	**-0.037** **
		(0.007)	**(0.009)**	**(0.014)**	**(0.031)**	**(0.018)**	**(0.007)**	**(0.009)**	**(0.014)**	**(0.026)**	**(0.018)**
Size		-0.008***	-0.008***	-0.014***	-0.023***	-0.013***	-0.006**	-0.005**	-0.005	-0.013*	-0.004
		(0.001)	(0.001)	(0.002)	(0.004)	(0.002)	(0.002)	(0.003)	(0.005)	(0.007)	(0.006)
Leverage		0.116***	0.111***	0.154***	0.094***	0.165***	0.117***	0.116***	0.097***	0.093**	0.100***
		(0.003)	(0.003)	(0.009)	(0.019)	(0.010)	(0.012)	(0.013)	(0.026)	(0.044)	(0.027)
Intangibility		-0.058***	-0.055***	-0.019	0.079	-0.031	-0.010	0.032	-0.308**	-0.044	-0.377**
		(0.008)	(0.008)	(0.049)	(0.097)	(0.053)	(0.049)	(0.049)	(0.129)	(0.105)	(0.158)
ROA		-0.061***	-0.065***	-0.063***	-0.126***	-0.053***	0.005	-0.022	0.109***	0.179***	0.113***
		(0.004)	(0.005)	(0.016)	(0.031)	(0.018)	(0.018)	(0.018)	(0.036)	(0.057)	(0.040)
Capital Intensity		-0.019***	-0.015***	-0.038***	-0.078***	-0.029**	0.000	-0.007	0.049	-0.061	0.068*
		(0.003)	(0.003)	(0.011)	(0.024)	(0.012)	(0.010)	(0.010)	(0.034)	(0.054)	(0.036)
Inventory		-0.028***	-0.024***	-0.030*	-0.047	-0.022	0.010	0.007	0.006	0.032	0.003
		(0.005)	(0.005)	(0.016)	(0.031)	(0.017)	(0.021)	(0.022)	(0.056)	(0.065)	(0.064)
Constant		0.319***	0.325***	0.377***	0.526***	0.354***	0.281***	0.283***	0.301***	0.388***	0.285***
		(0.004)	(0.005)	(0.016)	(0.042)	(0.016)	(0.019)	(0.020)	(0.048)	(0.060)	(0.058)
Observations		240,396	222,384	18,012	3,062	14,950	240,396	222,384	18,012	3,062	14,950
Adj. R^2		0.053	0.051	0.111	0.126	0.114	0.089	0.085	0.205	0.323	0.193
Industry FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Variables		**Panel B: Triple Interactions for Full Sample**		**Panel C: Triple Interactions for Entropy Balanced Sample**	
	Pred. Sign	(2) + (3) *GAAP ETR*	(4) + (5) *GAAP ETR*	(2) + (3) *GAAP ETR*	(4) + (5) *GAAP ETR*
Reform x BE_PAT	-	-0.009	-0.050**	-0.010	-0.036*
		(0.009)	(0.029)	(0.009)	(0.025)
Reform x BE_PAT x MNE	-	-0.029*		-0.028*	
		(0.016)		(0.016)	
Reform x BE_PAT x Shift	+		0.006		-0.001
			(0.035)		(0.030)
Controls		Yes	Yes	Yes	Yes
Observations		240,396	18,012	240,396	18,012
Adj. R^2		0.055	0.113	0.092	0.205
Industry FE		Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes

This table reports the results of our tests of Hypotheses 2a to 2c using equation (2) for Belgian firms. Panel A, Columns (1) to (5) present results for the sample before entropy balancing. Panel A, Columns (6) to (10) present results for the entropy-balanced sample. Columns 1 (6) report the results for our tests of H2a, while columns (2) to (3) and (7) to (8) report the results for our tests of H2b, respectively. Columns (4) to (5) and (9) to (10) report the results for our tests of H2c before and after entropy balancing, respectively. Panel B presents triple interactions testing the incremental effect of the Belgian IP box on multinationals compared to domestic firms (H2b). Panel C presents triple interactions testing the incremental effect of the Belgian IP box on MNEs with shifting opportunities (*Shift* = 1) compared to MNEs without shifting opportunities (*Shift* = 0). *GAAP ETR* is the GAAP effective tax rate (tax expense/profit before tax) of firm *i* in year *t*. *Reform* is an indicator variable equal to one for years 2008 onwards and zero otherwise. *BE_PAT* is an indicator variable equal to one if a firm holds at least one patent in the pre-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 foreign 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 at the 10%, 5%, and 1% levels, respectively. We use one-tailed tests when a sign is predicted and two-tailed otherwise.

TABLE 8

Falsification and Random Treatment Assignment Tests

Panel A: Cross-Country Sample

Patent Applications	**(1)** **Belgium & Germany**	**(2)** **Belgium & Sweden**	**(3)** **Belgium & France**
Reform2005 × BE	-0.017**	-0.002	-0.001**
Reform 2006 × BE	-0.023***	0.001	-0.000
Reform 2007 × BE	-0.019**	0.000	-0.000
Reform × TreatmentRandom	-0.002	0.004	-0.000

Patent Grants	**(1)** **Belgium & Germany**	**(2)** **Belgium & Sweden**	**(3)** **Belgium & France**
Reform 2005 × BE	-0.009	-0.002	-0.001*
Reform 2006 × BE	-0.009	0.001	-0.000
Reform 2007 × BE	-0.007	0.000	-0.000
Reform × TreatmentRandom	-0.004	0.003	-0.000

Patent Quality	**(1)** **Belgium & Germany**	**(2)** **Belgium & Sweden**	**(3)** **Belgium & France**
Reform 2005 × BE	-0.032	-0.005	-0.020
Reform 2006 × BE	-0.038	-0.014	-0.038
Reform 2007 × BE	-0.052	-0.029	-0.055*
Reform × TreatmentRandom	0.038	0.045	0.022

Panel B: Belgian Sub-Sample

	(1) **Uni Degree - BE**	**(2)** **GAAP ETR**
Reform 2005 × BE_PAT	-0.061	0.003
Reform 2006 × BE_PAT	0.067	0.001
Reform 2007 × BE_PAT	0.106	0.002
Reform × TreatmentRandom	0.196	0.004

This table presents results of placebo reforms and random treatment assignment tests. Panel A presents placebo results on Patent Applications (*Patent Applications*), Patent Grants (*Patent Grants*) and Patent Quality (*Patent Quality*) for the cross-country sample using equation (1). *Patent Applications* is the natural logarithm of patent applications, *Patent Grants* the natural logarithm of patent grants and *Patent Quality* is the composite quality indicator developed by Lanjouw and Schankerman (2004). Panel B presents results of placebo reforms using equation (1) and (2) for the Belgian sample. *Uni Degree – BE* denotes the number of employees holding a unversity degree. *GAAP ETR* is the GAAP effective tax rate (tax expense/profit before tax) of firm *i* in year *t*. *Reform(year)* is an indicator variable taking value one for placebo reform years 20XX onwards and zero otherwise. *BE* is an indicator variable equal to one if the firm is a Belgian firm, zero otherwise. *BE_PAT* is an indicator variable equal to one if a firm holds at least one patent in the pre-reform period and equal to zero, otherwise. *TreatmentRandom* is a randomly assigned treatment indicator. We include year and country-industry fixed effects in Panel A. We include industry and year fixed effects in Panel B. *, **, and *** denote significance of two-tailed tests at the 10%, 5%, and 1% levels, respectively. All variables are defined in Appendix A.

TABLE 9

Comparison of Belgian Firms in Balanced Sample and Firms Entering Unbalanced Sample After 2007

	Panel A: Balanced Sample (*BE* = 1)				Panel B: Balanced Sample (*BE_PAT* = 1)				Panel C: Firms With Innovative Activities Entering Unbalanced Sample				t-test (A vs. C)	t-test (B vs. C)
	N	**Mean**	**S.D.**	**Median**	**N**	**Mean**	**S.D.**	**Median**	**N**	**Mean**	**S.D.**	**Median**		
ln(Uni Degree – BE)	6,838	2.391	1.134	2.079	590	2.861	1.370	2.639	79	3.214	1.352	3.135	***	**
GAAP ETR	240,396	0.304	0.164	0.302	2,280	0.277	0.148	0.300	382	0.189	0.251	0.067	***	***
Size	240,396	6.797	1.442	6.612	2,280	9.117	1.456	9.341	382	7.530	2.172	7.551	***	***
Intangibility	240,396	0.017	0.069	0.000	2,280	0.013	0.038	0.001	382	0.064	0.126	0.001	***	***
ln(Employees – BE)	117,711	2.141	1.222	1.946	1,898	3.852	1.609	3.689	199	2.978	1.709	2.773	***	***

This table presents a comparison of descriptive summary statistics for Belgian firms (Panel A and Panel B) in the balanced sample and firms with innovative activities entering the unbalanced sample after 2007. Panel A presents descriptive summary statistics of all Belgian firms in the balanced sample (*BE* = 1). Panel B provides descriptive summary statistics of Belgian firms with at least one patent in the pre-reform period (*BE_PAT* = 1). Panel C presents descriptive summary statistics of firms with innovative activities (that file for at least one patent) entering the unbalanced sample after 2007. *, **, and *** denote significance of two-tailed t-tests at the 10%, 5%, and 1% levels, respectively. All variables are defined in Appendix A.