

## The Impact of Patent Box Regimes on the M&A Market

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March 2018

### Abstract

Patent box regimes reward ownership of successful technology by imposing a lower tax rate on income derived from the commercialization of patented products relative to other sources of business income. Coupled with explicit provisions regarding the eligibility of acquired intellectual property, patent boxes may affect merger and acquisition (M&A) incentives through multiple channels. Applying panel difference-in-differences and event study methodologies at the firm level, we examine the effects of these modified incentives on the probability that a firm becomes either the target or acquirer in the context of international and domestic acquisitions. In patent box regimes with strict nexus requirements, reducing the tax rate on patent income by 1 percentage point is associated with a 2.5 percent reduction in the probability of being acquired for patent-owning firms due to the potential loss of eligibility for preferential taxation. This effect dissipates where nexus requirements are relaxed. Significant positive effects of patent box tax savings on M&A activity in the latter more permissive regimes are indicative of increased after-tax valuations of merger-driven synergies.

**Keywords:** patent box, tax policy, cross-border, M&A, innovation

**JEL classification:** K34, H25, H32

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We thank Peter Merrill, Jane Gravelle, Johannes Voget, and conference and seminar participants at the University of Tuebingen, the International Institute of Public Finance, the University of Pennsylvania Law School, the Business Policy Symposium at Washington State University, the National Tax Association, and the Summer School on Taxation and R&D at the University of Mannheim for helpful comments.

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## 1. Introduction

Tax policy routinely applies different tax rates to different types of investment in order to promote activities that are associated with positive spillover effects or to discourage tax avoidance. Seventeen countries have adopted so-called “patent boxes”<sup>1</sup> over the period 2000-2016—of which 12 are in the European Union (EU)—as a way to both encourage domestic innovation and discourage income shifting (Bradley et al., 2015; Merrill, 2016).<sup>2</sup> These preferential tax regimes encourage research and development but, rather than providing a traditional up-front investment subsidy, do so by imposing a lower tax rate on returns from intellectual property (IP). The rules are therefore structured to reward the owner(s) of qualifying intangible assets and not necessarily their creator(s), thereby generating possible distortions in patterns of ownership and control of IP. We examine whether patent box regimes create tax-induced distortions to ownership of IP via mergers and acquisitions (M&A).

The salience of understanding whether patent box regimes distort the ownership of IP is perhaps best framed in the context of capital ownership neutrality (Desai and Hines, 2003, 2004; Weisbach, 2014).<sup>3</sup> As one principle often used to evaluate tax policy, it argues that assets should be owned by firms with the highest reservation price in the absence of any tax considerations.

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<sup>1</sup> We use primarily the narrower—but more popular—terminology of “patent boxes” to refer interchangeably to all intellectual property (IP) or innovation box regimes. Most analyses of IP box regimes—including our own—examine patents because these are generally the easiest form of IP to observe empirically.

<sup>2</sup> Given the recent introduction of many of these regimes, there is still disagreement among researchers and practitioners as to what constitutes a patent or innovation box. Thus, for example, Merrill (2016) excludes Cyprus from his list of IP boxes, but includes Israel, whereas most other lists feature the reverse (e.g. Chen et al., 2017). China’s preferential tax rate for “high-tech” firms has many of the features of an IP box, but is generally not classified as such. We take the consensus view and focus on EU member states in our analysis. As of this writing, these include Belgium, Cyprus, France, Hungary, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Spain, and the United Kingdom. Non-EU countries with patent boxes (outside the realm of our analysis) include Israel, Liechtenstein, South Korea, Switzerland (Nidwalden Canton), and Turkey.

<sup>3</sup> Given the increasing importance of M&A transactions as a mode of foreign direct investment, capital ownership neutrality (as distinct from capital export or import neutrality) is viewed as a desirable characteristic of tax systems to avoid distortions to international capital flows.

Empirical evidence of tax-induced distortions to asset ownership via M&A remains relatively sparse, and pertains primarily to general features of international tax systems.<sup>4</sup> The argument against tax policies that distort asset ownership is that who owns assets affects their productivity, and productivity will be greatest in the hands of the owner with the highest reservation price absent tax considerations. For instance, Todtenhaupt and Voget (2017) find that tax incentives to engage in M&A distort the efficient allocation of productive factors after the deal and thus mitigate any resulting productivity improvements.

This debate is of particular importance in the context of intangible assets as innovation is widely perceived as the key to economic growth. Intellectual property (IP) provides varying degrees of strategic (non-tax) and tax-related ownership advantages, making these assets particularly difficult from a tax policy perspective. For instance, Guadalupe et al. (2012) examine the relationship between foreign ownership and innovation among Spanish firms and find that multinational subsidiaries generally outperform comparable domestic firms due to the superior technologies, organizational practices, and market access afforded by their foreign owners. Yet, at the same time, foreign ownership of innovative assets facilitates profit shifting, thus eroding the domestic tax base (e.g., Grubert and Mutti, 2009; Dischinger and Riedel, 2011; Griffith et al., 2014).

Tax policy surrounding the treatment of IP must therefore address the desire to encourage (domestic) innovation while simultaneously discouraging (domestic) base erosion. As a result of increasing the after-tax return to IP and reducing the tax rate differential between statutory corporate tax rates and tax rates on IP, we hypothesize that patent box regimes may alter M&A patterns through several channels. We label these the *nexus*, *net income expansion*, and *tax-*

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<sup>4</sup> See Arulampalam et al., 2017; Feld et al., 2016; Huizinga and Voget, 2009; Voget, 2011; Bird 2016; or Hanlon et al., 2015.

*planning* channels and consider their impacts on the likelihood of firms becoming either targets or acquirers in domestic versus international deals. We elaborate on each channel in Section 2 but describe them briefly here in advance of previewing our main results.

The *nexus* channel unambiguously decreases incentives for all deal types in regimes where IP owners—including new acquirers—must perform IP development in the patent box country as a pre-condition for regime eligibility, since acquisitions of IP in regimes with strict nexus requirements may lead to a loss of preferential tax treatment. The *net income expansion* channel unambiguously increases incentives for all deal types by raising the *after-tax* value of any synergistic gains attributable to IP following an M&A transaction (i.e. by increasing sales, raising prices through increased market concentration, or lowering operating expenses). The *tax-planning* channel has more ambiguous incentive effects and should play a more important role in the context of international deals involving IP-intensive target firms located in patent box countries. In general, M&A-driven restructurings may constitute an important opportunity for relocating IP income in a tax efficient manner (i.e., by masking the arm’s-length price of specific assets). Hence, if the ability to relocate IP income from higher-taxed to lower-taxed jurisdictions constitutes a comparative advantage for foreign bidders relative to domestic bidders, then the introduction of a patent box regime in the target country should reduce foreign acquirers’ advantage in bidding for IP-owning targets. On the other hand, targets in patent box countries could be more attractive to foreign bidders intending to shift their own IP income into the target country in order to access the patent box. The former explanation is generally more consistent with the literature; nevertheless, whether the net effect of these tax planning motives is positive or negative remains an empirical question.

In this paper, we strive to quantify the extent to which reductions in the preferential tax rate on IP income (i.e., the “patent box tax savings rate”) and the presence of eventual nexus requirements affect the likelihood of a firm becoming either a target or acquirer in an M&A deal. We hence exploit firm-level panel difference-in-differences (DiD) and event study methodologies to estimate the probability that a firm is either acquired or makes an acquisition as a function of country-level characteristics (including characteristics of any applicable patent box regime) and firm-level characteristics (including a measure of IP intensity).<sup>5</sup> Our estimation strategy considers interactions among patent ownership, patent box tax savings, and nexus requirements, as well as separate consideration of international and domestic deals, in order to distinguish among the various channels summarized.

We find strong and consistent evidence across all specifications that strict nexus requirements unambiguously weaken incentives to engage in all types of M&A deals for both targets and acquirers. This negative effect is generally less pronounced in the context of domestic deals, which may reflect lesser barriers to engaging in further local development of acquired IP when both targets and acquirers have existing operations in the patent box country. Nevertheless, our results suggest that the recent trend towards strengthening nexus requirements within the EU, with the objective of reducing opportunities for tax base erosion, are also likely to be met with a less active M&A market. To the extent that this deters M&A transactions that would otherwise be driven by tax planning motives, this may be desirable; however, a casualty of these provisions might also be deals driven by opportunities for synergistic productivity enhancements. Countries should therefore give careful thought to the interaction of changes in control of IP assets and accessibility to the benefits of a patent box regime. Phillips and Zhdanov (2013) find for instance

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<sup>5</sup> We adapt the probability of being an acquirer model slightly to exclude a measure of patent holdings in the acquirer, which we discuss further in Section 3.

that firms' incentives to conduct research and development (R&D) increase with the probability that they become targets of M&A deals. Thus, if nexus requirements intend to increase domestic innovation, overly strict policies could instead stifle domestic innovation indirectly through less active M&A markets.

In patent box regimes where acquired IP is not subject to strict nexus requirements, we instead find statistically insignificant or significantly *positive* effects of regime generosity on both the probability of being acquired or of becoming an acquirer, and this effect is generally stronger and more persistent in the context of domestic M&A deals. Our analyses thus highlight a significant increase in the probability of being acquired as a function of the patent box tax savings rate in the period immediately surrounding regime adoption, as well as a more sustained increase in the probability of becoming an acquirer (for domestic deals only). We interpret these results as suggesting a strong positive influence of the net income expansion channel, especially where synergistic gains attributable to both the target and acquirer's IP are eligible for preferential taxation, as in the case of domestic deals. Conversely, we find no apparent evidence of important tax planning effects, even in countries without nexus requirements, such that the deterrent effect of these requirements may primarily affect deals that would otherwise be productivity-enhancing.

Our study joins a growing literature examining the real economic effects of patent box regimes (e.g., Chen et al., 2017; Bornemann et al., 2017). The link between patent box regimes and M&A has not been addressed in the extant literature but is important because M&A simultaneously impacts both the productivity of IP assets (Guadalupe et al., 2012), but also incentives to create those assets (Phillips and Zhdanov, 2013). Policymakers should hence give careful consideration to the implications of our results in the current environment, where revenue needs and a desire to promote innovation and productivity via tax policy frequently conflict.

## **2. Background, related literature, and expected economic effects**

To advance the notion that tax policy for innovation, and in particular patent box regimes, can distort the ownership of innovative assets through M&A patterns, we lay out a framework below that combines two distinct literatures.<sup>6</sup> First, we describe the link between tax policy and M&A patterns more generally. Second, we describe patent box regimes and their potential economic effects. Third, we describe the channels through which the introduction of a patent box regime might influence M&A patterns and summarize the various expected economic effects.

### *2.1. Background: Tax Policy, M&A and Related Literature*

M&A plays an important role in the economy by allowing companies to reorganize and expand relatively quickly in response to changes in their environment. M&A creates economic value when it combines two companies that are worth more together than they are apart. This additional value comes from the “synergies” created by the deal, and comes from many sources. For example, companies may share technologies or processes to improve efficiency, or they may share tangible assets like factories, research labs, or distribution systems to create greater “economies of scale.” Finally, they may increase revenues by agreeing to sell each other’s products in non-overlapping areas, or they be able to raise prices through increased market power. Though many perceive these transactions as opportunities for productivity improvements (e.g., Guadalupe et al., 2012), variation in tax system characteristics can also provide potential owners with a

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<sup>6</sup> Note that ‘distort’ need not imply undesirable, but more simply that the introduction of a patent box regime changes the relative incentives across bidders to acquire targets that are holding innovative assets in a country that is introducing a patent box regime.

comparative advantage (after tax), thereby distorting acquirers' reservation prices for target firms (e.g., Huizinga and Voget, 2009).

The premium that rival bidders are willing to pay for a target company over and above its market capitalization is a function of the extent to which the deal will generate incremental after-tax cash flows (e.g., through synergies described above). The underlying assumption is that the market capitalization of a firm already reflects its expected future cash flows (i.e. the target's outside option). Hence, the pre-deal market capitalization of a target firm serves as its reservation price. In domestic deals, where all bidders face the same tax regime, and in the absence of deal-specific productivity differences, no bidders should be willing to pay in excess of the target's reservation price.<sup>7</sup>

This thought experiment becomes more complex in an international context. Some argue that cross-border M&A can produce larger synergies because of the greater "gains from trade" (EY 2015). That is, companies from different countries may differ in their local expertise and product types, or in their access to specialized suppliers, workforces, or capital markets, all of which can have an important influence on the competitive capabilities of the combined firm. Others argue that integration issues are more complex in cross-border M&A. Thus, in conflict with the conventional view of productivity driven FDI, most studies fail to find evidence that foreign acquisitions improve target firms' productivity relative to domestic acquisitions (Harris and Robinson, 2002; Wang and Wang, 2015).<sup>8</sup> In contrast, numerous empirical studies document that

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<sup>7</sup> Note that the above discussion does not consider bid price distortions that may reflect tax differences between an incumbent owner and a potential acquirer.

<sup>8</sup> Harris and Robinson (2002) provide evidence that productivity declines after foreign acquisitions of UK companies, which would they claim to be consistent with difficulties associated with assimilating these established firms into the new organization. Similarly, Wang and Wang (2015) find no evidence that foreign acquisitions improve productivity in Chinese target firms.

domestic M&A is followed by substantial changes in the performance of target firms (e.g., Maksimovic and Phillips, 2001).

In the cross-border context, there is increased scope for taxation to play an important role. Rival bidders may face different national tax systems, not only from each other but also from the target firm. It follows that when two rival bidders identical in all non-tax respects seek to acquire a target company, they will anticipate the same incremental *pre-tax* cash flows. However, when bidders face different national tax systems, the maximum bid price will differ to the extent that the expected incremental *after-tax* cash flows differ. Todtenhaupt and Voget (2017) examine the realization of productivity gains in M&A in the context of ‘tax-motivated’ international deals and estimate that a 1-percentage point increase in the absolute tax differential between the locations of two merging firms reduces the subsequent total factor productivity gain by 4.5 percent.

Taxes may affect M&A activity through several channels. First, M&A transactions themselves generate tax liabilities for incumbent owners, so some studies focus on the role of shareholder taxation and deal pricing (e.g., Landsman and Shackelford, 1995; Erickson, 1998; Ayers et al., 2003). Second, acquiring firms’ tax status, target firms’ tax status, and the tax attributes of the target firm can influence both transaction structure and prices (e.g., Hayn, 1989; Erickson and Wang, 2000). Third, mergers can give rise to new tax planning opportunities post-acquisition whereby tax-sophisticated acquirers may have the ability to improve tax-planning strategies in the target (e.g., Belz et al., 2017). Alternatively, deals may create new tax synergies due to different tax systems faced by acquirers and their targets (Huizinga and Voget, 2009; Voget, 2011; Feld et al., 2016; Hanlon et al., 2015). Most, but not all, of the literature that considers the role of new tax planning opportunities in M&A focuses on cross-border deals where there exists more significant variation in tax systems.

## 2.2. *Background: Patent Box Regimes and Related Literature*

Tax policy plays an important role in promoting innovation, which is widely perceived as the key to economic growth and productivity. Historically, these policies have focused on subsidizing investment in R&D and a large literature examines the effects of these incentives on the location of R&D (e.g., Hines, 1997).<sup>9</sup> Although studies have documented that an educated labor force and high quality infrastructure are important factors in determining the location of R&D, generous rules surrounding the deductibility or creditability of expenditures also attract R&D activity. Ernst et al. (2014) use patent application data to construct measures of R&D quality to show that tax incentives subsidizing R&D investment increase the quantity but not the quality of R&D, suggesting that traditional tax policies may subsidize inefficient investment.

More recent studies examine how tax incentives affect where firms locate ownership of intellectual property (IP). Dischinger and Riedel (2011) document a negative effect of corporate tax rates on intangible asset holdings within multinationals, while Karkinsky and Riedel (2012) and Griffith et al. (2014), finds similar effects on the location of patent ownership.<sup>10</sup> Evidence in Böhm et al. (2015) suggests that patent quality amplifies this relationship, presumably because firms expect that higher quality patents will generate more income and thus, more tax savings. The more recent focus on the location of IP as opposed to the location of R&D investment recognizes that firms may opportunistically relocate IP rights within the firm in response to taxes. This is indeed a major channel through which multinational firms shift income to low-tax countries (Grubert, 2003; Grubert and Mutti, 2009). Where a given IP asset is created versus owned depends

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<sup>9</sup> Two papers discuss how traditional R&D tax incentives interact with lower patent box tax rates (Ernst and Spengel, 2011; Evers et al., 2015). For a literature review, see European Commission (2014).

<sup>10</sup> Dischinger and Riedel's (2011) measure of intangible asset holdings (from the balance sheet) represents intangible assets purchased through arm's length transactions; by comparison, Karkinsky and Riedel (2012) and Griffith et al. (2014) focus on intangible assets created within the firm.

on a number of factors, including investment subsidies, the ease of re-locating IP (Ernst and Spengel, 2011; De Simone and Sansing, 2017), and other non-tax factors such as R&D wages and IP protection laws.

Patent box regimes indirectly encourage R&D investment because rather than providing a traditional up-front investment subsidy, these regimes impose a lower tax rate on returns from IP.<sup>11</sup> Thus, the R&D must be successful in order to benefit from these regimes, which essentially render IP income tax-favored. The popularity of these regimes has grown extensively over the past decade, particularly in Europe, where they now exist in 15 countries as of this writing. Table 1 describes the most salient distinguishing characteristics of the 12 regimes that have been adopted in the EU which serve as the focus of our analysis. Policymakers intend for these regimes to encourage domestic IP (e.g., in the country with the patent box regime), and to reduce incentives to relocate IP income from the country of the patent box to countries with lower tax rates. Given that many of these regimes are relatively new, and that the desired outcomes are difficult to measure (i.e., increased domestic R&D and reduced erosion of the domestic tax base due to relocation of IP income), whether they achieve these objectives remains an open question. It is also possible that these regimes have other, perhaps unintended, economic effects.

The introduction of a tax regime that rewards ownership of successful R&D may produce several noticeable short-term effects.<sup>12</sup> First, in response to tax incentives that increase after-tax returns to patent income, firms may accelerate applications for as-yet unpatented domestic

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<sup>11</sup> Patent boxes indirectly encourage R&D in the patent box country because when MNEs make the initial R&D location decision they know that there will be tax costs of transferring patent ownership since such transactions are subject to transfer pricing rules (Griffith et al., 2014).

<sup>12</sup> There may also be longer-term effects. For instance, firms could have incentives to expand or re-locate R&D or improve the quality of existing R&D. Ernst et al (2014) find that policies lowering the tax rate on the income stream from successful IP increase both quantity *and* quality of R&D performed domestically. Chen et al. (2017) find increased fixed asset investment in countries that introduce patent box regimes. This may represent the re-location of R&D activity but this Chen et al. (2017) does not directly test for or answer that question.

innovations, or choose to patent IP previously held as trade secrets. Early studies of the effects of patent box regimes corroborate this general prediction by documenting immediate increases in (domestic) patenting activity (Bradley et al., 2015; Bornemann et al., 2017; Alstadsæter et al., 2018).<sup>13</sup> However, none of these studies is able to address the extent to which increased patenting represents new innovation. Second, firms could alter their transfer pricing policies with respect to existing IP to effect an increase (decrease) in their inbound (outbound) income reallocation into the patent box. In this vein, Chen et al. (2017) find evidence that firms reduce income shifting out of countries that introduce patent box regimes. Third, firms could re-locate IP rights to the patent box country from a non-patent box country (Bradley et al., 2015; Ciaramella, 2017; Gaessler et al., 2017). Finally, firms could seek to alter their allocation of income and expenses to existing IP to more fully exploit patent box regime provisions, or—in the longer term—engage in additional R&D investment. To date, no study has been able to examine these longer-term incentives explicitly.

In practice, patent box regimes differ along multiple dimensions besides preferential rates, which may have an important influence on their resulting incentive effects. Evers et al. (2015) provide a detailed discussion of these provisions and calculate their combined impact on effective tax rates for IP income across patent box countries. As shown in Table 1, one major source of variation in regime provisions is the extent to which *domestic* innovation constitutes a precondition for patent box eligibility. Thus, whereas some regimes were designed to grant preferential tax treatment to acquired IP in a permissive manner, others have required from the outset that owners of acquired IP engage in further development, while others largely exclude

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<sup>13</sup> Although specific provisions differ, patent box regimes generally grant preferential tax treatment to other types of IP income in addition to patents (hence the interchangeable use of the terms, patent, IP or innovation boxes). Patent application data has traditionally been the most accessible measure of IP activity, but recent studies are beginning to exploit richer measures of IP. The use of data on trademarks by Pfeiffer and Voget (2016) is a leading example.

acquired IP altogether.<sup>14,15</sup> In the absence of self-development conditions (i.e. *nexus requirements*) firms may conduct R&D in one country and subsequently transfer the resulting IP and associated income to the patent box country, thereby earning these countries a reputation as tax havens for IP assets (Graetz and Doud, 2013). Consequently, the OECD published final recommendations on October 5, 2015 as part of their Action 5 report (OECD 2015) to require firms to establish a nexus between their IP income and the expenditures incurred to develop the underlying IP assets in order for the income to qualify for preferential taxation as part of a patent box.<sup>16</sup>

### 2.3. *Expected Economic Effects of Patent Box Regimes on M&A*

In this section, we propose that patent box regimes may alter incentives to engage in M&A through three primary channels. This lays the groundwork for our empirical analysis. Concretely, we consider changes in the likelihood of being a target or an acquirer in an M&A transaction after the introduction of a patent box regime. We strive to differentiate among possible channels by drawing comparisons between domestic and international deals, which we distinguish according to whether targets and acquirers are located in the same or different countries, respectively.<sup>17</sup> For purposes of this discussion, we assume that potential targets or acquirers own eligible IP; however, we explicitly account for this in our analysis and exploit patent ownership as a source of

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<sup>14</sup> We classify the treatment of acquired IP in Table 1 as “permitted,” “restricted,” and “disallowed,” respectively.

<sup>15</sup> Self-development conditions constitute at least a partial nexus requirement, whereby *some* research activity must be carried out in the respective country for the resulting IP to be taxed at the lower patent box rate. Alstadsæter et al. (2018) find that conditions surrounding acquired patents matters for patenting activity, while Gaessler et al. (2017) find that patent boxes do not seem to encourage transfer to a country unless acquired patents are included. Finally, Schwab and Todtenhaupt (2018) find these requirements influence spillover effects on neighboring countries.

<sup>16</sup> The guidance specifically states that countries should amend preferential IP regimes with effect from no later than 1 July 2016. Existing regimes may continue to be available for up to a further five years for patents (including patents pending) already in the regime at 30 June 2016, though mandatory information exchange will be required for any new entrants to regimes after 6 February 2015. Nevertheless, it is important to understand the impact these regimes have had on M&A in the past, and the potential future impact if countries introduce only weak nexus requirements.

<sup>17</sup> Our definition of international deals also includes deals where the acquirer is located in the same country as the target, but the acquirer is either itself a subsidiary of a foreign parent or owns foreign subsidiaries. We describe our deal characterization further in Section 3.

identification. Table 2 summarizes our anticipated effects on deal probabilities, which we expand upon in the following paragraphs.

The first channel that we consider we label the *nexus* channel. As discussed in the previous section, the absence of nexus requirements enables firms to conduct R&D in one country and subsequently transfer the resulting IP and associated income to the patent box regime country. Therefore, the presence of such a requirement—whereby acquired IP is ineligible for preferential tax treatment without further development by the acquirer—would unambiguously disincentivize M&A deals because of the resulting *loss* of tax advantages at the target side. With respect to being an acquirer, introducing an IP box with nexus requirements makes Greenfield investment in IP for potential acquirers more attractive, since this is the only way to profit from the reduced IP box tax rate. Hence, this channel should have unambiguously negative effects on the probability of both domestic and international deals from the perspective of either targets or acquirers, with more negative effects in the countries with the most restrictive nexus requirements.

The second channel that we consider we label the *net income expansion* channel. As patent box regimes promote IP commercialization, the introduction of such a regime provides firms with a strong incentive to increase returns from IP (i.e., shift their tax base towards the generation of tax-favored income). M&A transactions may provide one means to accomplish this relatively quickly. In general, parties to an M&A deal expect that deal synergies will result in higher prices, higher sales quantities, or lower non-tax costs, all of which could increase the returns from IP. The adoption of a patent box increases the *after-tax* gains from deal synergies to the extent that these synergistic gains are attributable to qualifying IP. Previously marginal deals (i.e. deals for which transaction costs previously exceeded expected after-tax gains) should therefore become more likely under a patent box. This may be especially true in the context of domestic deals where

increased returns to both the target and acquirer are eligible for preferential taxation, but this should increase the likelihood of international deals as well and affect both the probability of being an acquirer or a target.<sup>18</sup>

The third channel that we consider we label the *tax-planning* channel. This channel recognizes that ownership of IP assets is an important conduit for profit shifting, especially insofar as firms that are part of multinational groups have opportunities to reallocate IP income across countries in a tax-efficient manner. However, whereas transfer-pricing rules are likely to constrain relocation of IP in the context of individual asset purchases, we argue that the complexity of M&A transactions may facilitate the relocation of IP by masking the arm's length price of the underlying asset(s), hence the special appeal of M&A transactions to implement cross-border tax minimization strategies. By lowering that tax rate on patent income of a potential target, this reduces the scope for a foreign acquirer to exploit such strategies and extract further tax reductions in relation to the target's assets. This would suggest that the tax-planning channel should reduce incentives for international deals involving patent-owning targets in patent box countries.

On the other hand, the introduction of a patent box in the target country could instead render the target firm more attractive to foreign bidders intending to shift IP income *into* the target, whereas if the acquirer country adopted a patent box, this might introduce new opportunities for the acquirer to shift a foreign target's IP income into the country of the acquirer. This result would suggest that patent box regimes may increase base erosion by increasing incentives for cross-border ownership of IP assets. Whether the net effect of the tax planning channel is positive or negative is hence ambiguous.

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<sup>18</sup> Opportunities for market expansion (i.e. via improved access to foreign markets in order to increase units sold) may be more likely to motivate international deals, whereas increased market concentration or cost reductions would more likely motivate domestic deals. Our empirical tests are unable to address these possibilities, however.

### 3. Data and Methodology

#### 3.1 Data Sources

The data for this analysis are drawn from multiple sources and combine unconsolidated firm-level financial statement and M&A transaction data from Bureau van Dijk's Orbis and Zephyr databases for the period 1994-2014 along with patent application information from PATSTAT for which Bureau van Dijk has assigned unique applicant firm identifiers. We hence start from approximately 45 million patent applications linked to a business owner and registered with patent offices around the world over the years 1978 to 2014—of which 14.7 million are recorded as granted (i.e., awarded legal protection)—and we merge these according to the identity of patent applicant(s)<sup>19</sup> to the universe of actual and potential M&A target and acquiring firms covered by the Bureau van Dijk data.<sup>20</sup>

We complement these firm-level data with a set of country-level macroeconomic control variables drawn from the World Bank's World Development Indicators database following Arulampalam et al. (2012) and Belz et al. (2017). We also employ the Fraser Institute's Economic Freedom Index to capture variation in a general set of conditions thought to be conducive to economic development and business. Evers et al. (2015) and Merrill and Shanahan (2012) serve as the main sources of information on preferential patent box regime tax rates and special provisions, while additional corporate and withholding tax rate data are compiled from several sources, including corporate tax guides from Ernst and Young and PwC, as well as Comtax.

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<sup>19</sup> As discussed in Quick and Day (2006), legal patent ownership generally accrues to the applicant(s) registering the patent. We hence refer to patent applicants and owners interchangeably throughout. Historically, patent applicants for patents filed in particular countries, such as the U.S., patent inventors were also required to be listed among the set of but these inventor-applicants would typically relinquish their rights to all associated income under the terms of their employment contracts. This issue does not arise in our sample of firms located exclusively in the EU.

<sup>20</sup> Although we observe all older patents our choice of 1978 for the first patent included in a firm's stocks is based on WIPO definition of patent expiration, which lies between 15 and 20 for most countries, and the first year included in our analysis.

### 3.2 Sample Restrictions

Variation in statutory requirements for filing unconsolidated financial statements gives rise to wide variation across countries in the number of useable observations available through Orbis. As a result, U.S. firms, for instance, are vastly underrepresented in our initial matched Orbis-Zephyr-PATSTAT sample. Taken in conjunction with the fact that patent box regimes remain predominantly an EU phenomenon, we consequently restrict our analysis exclusively to the EU-28 member states (independent of their year of accession).

Furthermore, given our desire to exploit patent ownership as a source of identification in mediating the effects of patent boxes on M&A activity, we emphasize the role of *granted* patents only. Due to lags in the compilation of patent application information and an average period of 2.37 years between the time of application, the receipt of legal patent protection (if granted), and publication, we therefore terminate our sample estimation period in 2014. This excludes from possible consideration the initial impacts of the most recent patent box adoptions in the EU (i.e. Italy in 2015 and Ireland in 2016). Nevertheless, our sample encompasses the termination of Ireland's first preferential regime in 2010 plus the adoption of 10 new patent boxes that were in effect as of 2014. The distribution of firms in our estimation sample that are represented in each of these EU patent boxes are given in Table 1, alongside a description of the main features of these regimes.

In order to improve the power of our analysis, we focus exclusively on manufacturing-sector firms where patent ownership is most heavily concentrated and where patent boxes are consequently most likely to constitute a relevant consideration. Concretely, we select firms falling in sectors 32 and 33 according to the North American Industry Classification System (NAICS).<sup>21</sup>

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<sup>21</sup> These sectors encompass all manufacturing except food, beverages, tobacco, textiles, apparel, and leather products.

These sectors account for just 6.5 percent of all firms in Orbis, yet they encompass 77.7 percent of all granted patents, 43.8 percent of patent-owning firms, and 19.1 (21.5) percent of M&A targets (acquirers) over our sample period.

Finally, after applying each of the abovementioned country, year, and industry restrictions, we preserve only those firms whose financial statements meet minimal data quality requirements in three consecutive years. Concretely, we retain only those firms that report non-missing and non-zero information for total assets, earnings before interest and taxes (EBIT), and taxes paid over a three-year period, and we exclude any remaining such firms that never report more than \$1 million in total assets (near the median value of firm size in our matched sample).<sup>22</sup> Observations for firms that report being in a net loss position over at least three prior years are likewise omitted.

Our final sample thus consists of just over 1.2 million observations, representing nearly 230000 individual firms. Despite applying these multiple sample restrictions, it is worth noting that patent ownership and M&A transactions nevertheless remain rare events. Just 11 percent of firms ever own patents in our sample, and a mere 0.19 percent of firms are acquired in any given year. Becoming an acquirer is somewhat more likely, with an unconditional probability of 0.51 percent. Among the set of firms that are acquired (become acquirers), however, 26.3 (49.8) percent were patent owners at the time of acquisition, consistent with the notion that ownership of IP is an important determinant of engaging in M&A activity.

### *3.3 Model and Variable Definitions*

Following the set of predictions discussed in Section 2, we model the probability of being acquired (becoming an acquirer) as a function of target (acquirer) firm characteristics related to

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<sup>22</sup> Results involving even only the largest 20 percent of firms as measured by total assets (not shown) are qualitatively unchanged.

strategic non-tax and tax motives and extend the prior literature by exploiting cross-sectional and time-series variation in the implementation of patent box regimes in order to identify their particular incentive effects as they pertain specifically to the ownership of innovative assets (i.e. patents).<sup>23</sup> From the target's perspective, the probability that firm  $i$  in industry  $j$  and country  $c$  is acquired in year  $t$  is thus:

$$\begin{aligned} \Pr(\text{Target}_{ijct} = 1) = & \alpha + \vec{\beta} \cdot (\overline{\text{Tax}}_{ct} + \overline{\text{IPBox}}_{ct}) + \vec{\rho} \cdot \vec{X}_{ijct-1} + \gamma \cdot \text{Patent}_{ijct-1} \quad (1) \\ & + \vec{\delta} \cdot \left( (\overline{\text{Tax}}_{ct} + \overline{\text{IPBox}}_{ct}) \cdot \text{Patent}_{ijct-1} \right) + \vec{\varphi} \cdot \vec{W}_{ct} + \mu_j + \eta_c + \zeta_t + \varepsilon_{ijct} \end{aligned}$$

where  $\overline{\text{Tax}}_{ct}$  represents a vector of country-level tax characteristics (excluding IP-specific tax treatment),  $\vec{X}_{ijct-1}$  represents a vector of firm-level pre-acquisition financial characteristics,  $\text{Patent}_{ijct-1}$  characterizes patent holdings of the target firm, and  $\overline{\text{IPBox}}_{ct}$  designates either the existence of patent box legislation or the generosity thereof relative to the treatment of other sources of income (defined as the difference between the statutory corporate tax rate,  $CIT$ , and the tax rate applied to patent income).  $\vec{W}_{ct}$  represents a vector of additional time-varying target country non-tax characteristics, while time-invariant target industry and country fixed effects are captured in  $\mu_j$  and  $\eta_c$ , respectively. Industries are defined at the NAICS 4-digit level.

In practice,  $\overline{\text{Tax}}_{ct}$  consists of the statutory corporate income tax rate, which should affect the “ordinary” tax motives for M&A activity, as well as an indicator for whether royalties received by the target firm would be taxed abroad at a rate in excess of the tax rate on patent income,  $I[\text{High Royalty Tax}]$  (in which case preferential taxation of patent income in the target country would be less likely to yield benefits from foreign market expansion following acquisition).  $\text{Patent}_{ijct-1}$

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<sup>23</sup> Other forms of innovative assets might likewise play a special role in M&A decisions. However, patent applications represent the most readily-measurable and tangible form of successful innovation. Moreover, although many patent box regimes grant preferential tax treatment to other forms of IP-related income, patent income is uniformly included in all such regimes.

is measured as a binary indicator identifying a target firm's directly-owned patent stock ownership as of the prior year,  $I[Own Patent]$ .<sup>24</sup>

$\vec{X}_{ijct-1}$  and  $\vec{W}_{ct}$  consist of a large set of firm- and country-level controls common to the literature on M&A activity.<sup>25</sup> Each of these variables are defined in Tables 3 and 4. These include measures of firms' tax sophistication (based on effective tax rates), multinational status, profitability, size, cash holdings, leverage, the relative importance of intangible versus fixed assets intensity, capital expenditures and asset growth, and whether the firm is publicly listed. Besides the aforementioned country-specific tax variables, country-level controls also include measures of economic output, the size of the labor force, unemployment, the importance of aggregate stock market capitalization and exports relative to GDP, inflation, the real effective exchange rate, and an index of economic freedom.

Beyond the inclusion of these numerous controls, it is important to note that the use of country, industry, and year fixed effects implies that the source of identification for our analysis is based on within-country variation in the tax treatment of patent income combined with cross-sectional variation in firm-level patent holdings. Our empirical strategy thus resembles a panel triple-differenced specification whereby target firms are differentiated by the timing and country of eligibility for preferential treatment of patent income *and the applicability (among patent owners) thereof*.

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<sup>24</sup> In a previous version of the paper,  $Patent_{ijct-1}$  was alternatively defined as a quality-adjusted measure of a target firm's directly-owned patent stock, where quality was determined following the literature from a factor components analysis combining individual measures of patent family size, forward citations, and the number of 8-digit IPC codes. However, this measure of patent ownership can only be computed through 2012 based on our data, thereby precluding our ability to study the adoption of more recent regimes and evaluate longer-term impacts of these policies. Results involving quality-adjusted patent stocks over this truncated sample period were qualitatively similar to those involving the binary indicator over the same period but were generally statistically insignificant.

<sup>25</sup> See Harford (1999) for a list of typical financial factors affecting acquisition decisions. Our analysis closely follows the set of controls included in Belz et al. (2017) and Arulampalam et al. (2012).

We model the probability that firm  $i$  becomes an *acquirer* in year  $t$  in a symmetric manner, with the main distinction being that we constrain patent box effects to be independent of the potential acquirer’s patent holdings. This restriction reflects the reality that nexus requirements play no role in this context (i.e. acquisitions do not affect the patent box eligibility of the *acquirer*’s own pre-existing IP), nor should patent ownership by the acquiring firm affect the after-tax value of synergistic gains via the net income expansion or tax planning channels, at least not to a first order.<sup>26</sup> Identification hence rests on a narrower panel DiD approach, and the modified model from the perspective of potential acquiring firm  $i$  becomes:

$$\Pr(\text{Acquirer}_{ijct} = 1) = \alpha + \vec{\beta} \cdot (\vec{\text{Tax}}_{ct} + \vec{\text{IPBox}}_{ct}) + \vec{\rho} \cdot \vec{X}_{ijct-1} + \gamma \cdot \text{Patent}_{ijct-1} \quad (2)$$

$$+ \vec{\varphi} \cdot \vec{W}_{ct} + \mu_j + \eta_c + \zeta_t + \varepsilon_{ijct}$$

All of the independent variables are as described above, except that each should be viewed as reflecting the firm and country characteristics of potential acquirers instead of targets. In practice, we estimate both (1) and (2) using an identical sample of firms as our set of potential acquired or acquiring firms, such that the only distinctions between analyses are in terms of the outcomes of interest and the treatment of patent ownership.

### 3.4 Descriptive Statistics

Figures 1 and 2 depict the distribution across countries of observations and firms included in our final estimation sample, while Figures 3 and 4 show the corresponding percentage of firms that are ever involved in an M&A transaction over the period 1994-2014, either as a target (Figure

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<sup>26</sup> Implicitly, this reflects the presumption that M&A transactions are driven primarily by opportunities to extract greater after-tax returns from the set of assets held by the *target* (either through reductions in the target’s effective tax rate or non-tax costs, or through increased revenues) rather than through gains attributable to the acquirer’s pre-existing assets. This asymmetry presumably plays a dominant role in determining which entity becomes the acquirer in the transaction.

3), or as an acquirer (Figure 4). As shown, whereas Italy, Spain, and France account for more than half of all observations in our sample,<sup>27</sup> the concentration of M&A activity is relatively more diffuse. Consistent with more general patterns of business dynamism, northern EU member states thus show generally higher rates of M&A activity (either as targets or acquirers) than the more southern or eastern member states. Conversely, there is no clear evidence in this unconditional graphical framework of either higher or lower rates of M&A activity in patent box regime countries.

A snapshot of the mean values of our regression variables at the end of our sample period are presented in Table 5, with sample means computed separately depending on whether firms were involved in any M&A transactions in 2014.<sup>28</sup> Columns 1-3 hence show a comparison of variable means between the set of firms that were not acquired (Column 1) versus those that were acquired, either as part of an international (Column 2) or domestic (Column 3) deal. Statistically-significant differences in means between non-acquired and acquired firms of each type are designated in a conventional manner. Columns 4-6 present comparable information for the set of firms that did not make any acquisitions in 2014 versus those that were involved in at least one international or domestic acquisition.

As shown, target firms—especially those that are acquired in international deals—are significantly different from non-acquired firms along numerous dimensions. Target firms are nearly twice as likely to hold patents, face lower effective tax rates, earn higher rates of return, and

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<sup>27</sup> The (over)representation of Italian or Spanish firms in our sample (relative to German firms, for example) largely reflects the set countries for which financial statement information is most widely available through Orbis, either because of country-specific requirements pertaining to financial statements, variation in the prevalence of privately-held businesses, or simple variation in data collection effort and technology on the part of Bureau van Dijk. Lack of a more representative distribution of observations across countries would only be problematic insofar as acquired or acquiring firms are differentially more or less likely to be included in the sample due to unobserved factors related to international taxation, which appears unlikely.

<sup>28</sup> Only year 2014 observations are included to avoid compositional effects related to historical variation in M&A activity.

they are generally larger and less leveraged. Targets acquired through international deals are also significantly more likely to be multinationals themselves, are more intangible intensive, and hold a smaller share of their assets in cash. They also reside in countries with lower corporate tax rates and unemployment and face lower average withholding tax rates on royalty receipts and greater aggregate stock market capitalization. Notably, target firms do *not* differ in a statistically-significant manner in terms of capital expenditures or growth, or in the probability of being publicly-listed, however. Acquiring firms, meanwhile, differ in virtually every meaningful dimension. Not surprisingly, acquirers are thus 3-5 times more likely to own patents, 6-9 times more likely to be multinationals, and are vastly more likely to own subsidiaries in at least one tax haven jurisdiction or to be publicly-listed. They also face significantly lower effective rates; are larger, more intangible intensive, and more profitable; are more likely to be deemed to be high-growth; and are less heavily leveraged.

To the extent that any of these characteristics may be spuriously correlated with the temporal or geographic distribution of patent box regimes, these statistics confirm the importance of controlling for these many attributes in our analyses of M&A probabilities. Among the subset of firms located in patent box countries, both targets and acquirers are disproportionately concentrated in regimes offering *less* generous treatment of patent income, especially for international deals. This is suggestive of a potential role played by tax planning opportunities in motivating cross-border M&A transactions, and the reduction of the appeal thereof in countries granting more favorable taxation of IP.

## 4. Results

### 4.1. Likelihood of becoming a target

Table 6 presents ordinary least squares regression estimates for our first empirical specification involving interactions of patent box tax savings rates, *IPBoxSavings*, indicators for the stringency of nexus requirements, *I[LimitedNexus]* and *I[NoNexus]*, and an indicator of patent ownership, *I[OwnPatent]*.<sup>29</sup> Using these interactions, along with comparisons between outcomes involving all deals versus strictly international or domestic deals, we intend to tease out the various hypothesized effects summarized in Table 2. For purposes of legibility, the dependent variable is set equal to 100 if a firm is acquired in an M&A deal; otherwise, it is set to zero.<sup>30</sup> The broad research question of interest is whether and to what extent the patent box tax savings rate and the presence of eventual nexus requirements at the country level affect a firm's likelihood of becoming a target in an M&A deal.

For brevity, we only report coefficient estimates for the various patent box-related interaction terms in the upper half of Table 6 followed by their implied marginal effects, expressed as the relevant sum of partial effects attributable to a one unit change in *IPBoxSavings*, scaled by the corresponding unconditional probability of acquisition for patent-less and patent-owning firms. The latter (overall) marginal effects in the bottom half of Table 6 hence measure the effect of a one percentage point change in *IPBoxSavings* in terms of a percent change in the predicted probability of acquisition. The full set of coefficient estimates, including our numerous control variables, are shown in appendix Table A.1. These generally have the predicted sign, but given

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<sup>29</sup> We estimate equation (1) as a linear probability model in order to allow for consistent estimation of country, industry, and year fixed effects, along with a set of non-linear patent ownership and tax interactions. Binary dependent variable models (probit or logit) are not well suited to fixed effects estimation, nor do they yield well-defined marginal effects for interacted regressors.

<sup>30</sup> Multiplication of our binary dependent variable by 100 merely rescales all of our coefficient estimates accordingly, such that these have the interpretation of *percentage point* impacts on the probability of acquisition directly.

the rarity of M&A transactions, the overall predictive fit of the model remains low. As one would expect, results from more basic specifications that exclude tax and patent interaction terms (unreported) do not reveal any significant effects on deal probabilities. Without considering interactions among patent ownership, tax savings, and nexus requirements, these specifications cannot distinguish among the various channels summarized in Table 2.

In contrast, looking first at Column 1 of Table 6 (All Deals), we see that lower tax rates on IP income (i.e. more generous *IPBoxSavings*) have a negative impact on the probability of a target firm being acquired in any type of M&A deal when  $I[LimitedNexus]$  and  $I[NoNexus]$  are both zero (i.e. acquired IP is disallowed preferential tax treatment). Moreover, this negative effect is significantly more pronounced where the target is also a patent owner, consistent with the idea that IP-owning target firms may become less attractive in patent box countries where acquisitions risk triggering a loss of patent box eligibility for IP income.<sup>31</sup>

In terms of economic magnitude, the combined coefficients on *IPBoxSavings* and  $IPBoxSavings \times I[OwnPatent]$  imply that a 1 percentage point increase in patent box regime generosity (e.g., through a 1 percentage point reduction in the tax rate on IP income, holding the main corporate tax rate fixed) is associated with an overall reduction in the probability of being acquired for a patent-owning firm of approximately 2.5 percent (p-value = 0.001). Assuming an average level of *IPBoxSavings* of 18.2 percentage points, the implication is that the exclusion of

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<sup>31</sup> Our theory predicts that the nexus channel would have a negative effect on deal probabilities for IP-owning target firms in countries that do not extend preferential treatment to acquired IP. Evidence of a statistically significant negative coefficient on the uninteracted *IPBoxSavings* term (-0.6030; p < 0.01) suggests either the influence of other channels not directly related to target patent ownership, or—as is generally true across all of our specifications—this may reflect in part the limitations associated with using patent ownership as a proxy for patent box eligibility. First, as discussed previously, many patent box regimes encompass various forms of IP besides patents, which we do not observe. Second, our ability to identify patent-owning firms is limited by Bureau van Dijk’s gradual process of updating firm identifiers in the patent application data to facilitate merging Orbis and PATSTAT data. Thus, some of our patent-less firms may in fact own patents, or be on the verge of receiving patent protection for a prior application. Depending on the prevalence of this form of measurement error, this will result in smaller estimates of the differential effects of patent ownership.

acquired IP from preferential taxation is associated with a roughly 50 percent reduction in the probability of being acquired for patent-owning firms. Though identification of the nexus channel here is based on IP box savings, we also find a similar effect (unreported) where identification is instead based exclusively on a patent box dummy (i.e., based purely on the existence of a patent box irrespective of the tax savings rate).

When we further differentiate among countries extending preferential treatment to acquired IP, the negative effect of the patent box regime on the likelihood of becoming a target dissipates, but only in the most permissive regimes as indicated by the positive coefficient on triple interaction,  $I[NoNexus] \times IPBoxSavings \times I[OwnPatent]$ . The net effect on deal probabilities for IP-owning targets resident in permissive IP box countries is hence not significantly different from zero (i.e. net semi-elasticity = 0.009 with a p-value = 0.992). Without differentiating between international and domestic deals, we thus find strong support for the importance of the nexus channel, albeit in a manner independent of our identification of patent-ownership.

Contrasting the columns 2 and 3 of Table 6, labelled “international” and “domestic” deals, respectively, we explore whether the tax-planning channel might further affect deal probabilities. As described in Section 2.3, the tax-planning channel should manifest itself as a reduced probability of being acquired through an international deal the more generous the patent box regime, whereas domestic deals should remain largely unaffected given the absence of international tax arbitrage opportunities between the target and acquirer. We find that for both deal types, the impact of *IPBoxSavings* is generally negative and largest in patent box regimes that disallow acquired IP, such that among patent-owning firms, the probability of being acquired in an international deal when nexus requirements are binding is reduced on net by a statistically-

significant 2.87 percent for every one percentage point increase in *IPBoxSavings*, and by 1.16 percent for domestic deals (albeit not in a statistically significant manner).

For international deals, we see that this effect loads primarily on patent-less firms, as evidenced by the coefficient of -0.62 (p-value<0.01) on the baseline uninteracted *IPBoxSavings* term, and there is no evidence of a statistically-significant differential effect among patent-owning firms likewise located in patent box countries with strict nexus requirements (i.e. when *I[LimitedNexus]* and *I[NoNexus]* are both zero). In contrast, for domestic deals, the negative effect of patent box tax savings in countries with strict nexus requirements is driven by patent-owning targets, as given by the significant negative coefficient estimate on *IPBoxSavings* x *I[OwnPatent]*.<sup>32</sup>

For both types of deals, these negative effects of patent box tax savings are largely offset for patent-holding firms located in regimes where acquired IP remains eligible for preferential taxation (*I[NoNexus]* = 1), and even more than fully offset in the case of domestic deals. Despite large standard errors, the point estimates on the marginal effect of *IPBoxSavings* in patent box regimes with no nexus requirements thus suggest a positive overall impact of tax savings on the probability of being acquired in a domestic deal for both patent-less and patent-owning firms (i.e., 2.99 and 2.83, respectively). The fact that the net effect of patent box tax savings on the probability of being acquired for international deals remains negative for firms in a comparable situation is suggestive of the existence of an effect beyond the nexus channel. Indeed, the existence of a negative effect of *IPBoxSavings* (on net) for international deals, but not domestic deals, may indicate a negative

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<sup>32</sup> Again, the possibility of mismeasurement of IP box eligibility on the basis of patent ownership makes it difficult to interpret this difference across deal types unambiguously, but it is possible that the larger firms which tend to be targets of international deals are more likely to have indirectly-held patents or IP assets other than patents. In other words, identifying targets most likely to benefit from IP box regimes using (direct) patent ownership may be more precise in smaller firms that are part of domestic deals.

impact of patent boxes attributable to the tax-planning channel. Alternatively, this could suggest a more modest (positive) effect of the net income expansion channel for international deals than for domestic deals, where by construction, both the target *and* the acquirer’s original operations are potentially eligible for preferential taxation. Absent stronger evidence of a significant positive overall effect of patent box provisions on the probability of being acquired, we cannot claim to find conclusive evidence of the net income expansion channel, but the large positive coefficients on the triple interaction of  $I[NoNexus] \times IPBoxSavings \times I[OwnPatent]$  are suggestive. Our event study analysis discussed in Section 4.3 brings additional clarity and corroboration on this point.

#### 4.2. *Likelihood of becoming an acquirer*

Table 7 presents ordinary least squares regression estimates for our main empirical specification considering the likelihood of becoming an acquirer. The question of interest, once again, is whether the adoption of a patent box regime—specifically, the choice of preferential tax rate relative to the ordinary corporate rate and the presence of eventual nexus requirements—affect the business decision of a firm to engage in an M&A deal, except that we now consider this from the perspective of a potential acquirer. Our dependent variable is therefore set to 100 if a firm is an acquirer in an M&A transaction and zero otherwise, and we consider separate outcomes for the set of all deals versus international and domestic deals only. Again, we only present results for our main patent box-related regressors of interest for brevity, but the full set of coefficient estimates are available in appendix Table A.2.<sup>33</sup>

Looking first at the “All Deals” column (column 1) of Table 7, when  $I[LimitedNexus]$  and  $I[NoNexus]$  are both zero (i.e. acquired IP is ineligible for preferential tax treatment), we see that,

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<sup>33</sup> Notably, our model delivers considerably greater predictive fit when we focus on predicting the probability of becoming an acquirer rather than a target. This likely reflects in part the higher frequency of such events in our sample, which is itself a likely consequence of better coverage of financial statement information in Orbis for larger firms.

as in Section 4.1, *IPBoxSavings* has a negative impact on M&A deals in general, which manifests itself here as a decrease in the likelihood of becoming an acquirer. Introducing an IP box with a nexus requirement creates an incentive for firms to develop profitable IP assets *internally*, as this is the only way to profit from the reduced tax rate on IP in such countries. Consequently, forms of business investment other than greenfield or brownfield investment, including M&A or IP asset markets (e.g., in the spirit of Serrano, 2006), become relatively less attractive overall.

In terms of economic magnitude, the coefficient on *IPBoxSavings* implies that a 1 percentage point increase in patent box regime generosity (e.g., through a 1 percentage point reduction in the tax rate on IP income, holding the main corporate tax rate fixed) is associated with an overall reduction in the probability of making an acquisition of approximately 3.6 percent (p-value = 0.001). We find a similar effect for both international and domestic deals, as well as when we base our identification on a patent box dummy (unreported) rather than the extent of the tax savings. If the nexus requirements are relaxed, engaging in M&A is one way to profit from the reduced IP box tax rate. Thus, when we further differentiate among countries extending preferential treatment to acquired IP, the negative effect of the patent box regime on the likelihood of becoming an acquirer dissipates, but only in the most permissive regimes as indicated by the positive coefficient on the interaction,  $I[NoNexus] \times IPBoxSavings$ .

Contrasting the second and third columns of Table 7 labelled “international” and “domestic” deals, respectively, we see that the negative effect attributable to nexus requirements no longer dissipates for international deals. In the case of international deals, it is not sufficient to acquire a foreign target in order to profit from the introduction of an IP box with a permissive regime allowing for acquired IP. As a further step, the acquirer needs to restructure the target after the deal in order to locate acquired IP in the country of residency of the acquirer, where the IP box

applies. The insignificant coefficient on the interaction term  $I[NoNexus] \times IPBoxSavings$  in column 2 suggests that such a restructuring for the purposes of exploiting a patent box specifically may be too costly from the acquirers perspective, especially given the (continued) existence of alternative opportunities for strategic income reallocation involving tax havens or other low-tax jurisdictions.

In case of the most permissive regimes allowing for acquired IP ( $I[NoNexus] = 1$ ), the results involving domestic deals present a stark contrast. A one-percentage point increase in  $IPBoxSavings$  is associated with a precisely-estimated 7.2 percent *increase* in the probability that a firm makes a domestic acquisition, consistent with a strong effect operating through the net income expansion channel. Given that the tax-planning channel is not likely to play a dominant role in the likelihood of being an acquirer across deal types (for reasons described above), we interpret these differences as consistent with differences in expected productivity improvements. Numerous empirical studies document that domestic M&A is followed by substantial productivity improvements, while there is comparatively little evidence of productivity improvements in international M&A (Wang and Wang, 2015). Guadalupe et al. (2012) offers a rare exception in a sample of Spanish manufacturing firms. These differences allow the net income expansion channel to play a more significant role in the domestic setting. That is, the lower risk of integration in domestic deals, relative to international deals, results in an IP box without nexus requirements as being a stronger investment incentive in the domestic setting. Moreover, we generally expect the acquirer to confer larger gains in after-tax profitability on the target's original operations than vice versa.

### 4.3 Intertemporal Effects

To the extent that details of patent box regime characteristics were known before formally going into effect, firms may have acted in *anticipation* of regime implementation by either accelerating or delaying M&A transactions to best exploit the relevant patent box tax advantages or disadvantages. For example, firms might conceivably have sought to pre-empt the imposition of nexus requirements by acquiring IP prior to regime implementation. Anticipation effects of this sort would constitute a violation of the parallel trends assumption underlying our panel DiD identification strategy and would tend to bias our estimated patent box effects toward zero. More broadly, simple pre-/post-IP box comparisons—as the preceding analysis implicitly emphasizes—might correspondingly fail to pick up important trends in firm responses arising both before and after regime adoption.

We consequently extend our previous analyses by applying an event study methodology, which allows us to test explicitly for leads and lags of patent box incentive effects. For each patent box country, we define period  $t = 0$  as the year of regime adoption, and we construct a full set of binary indicator variables flagging periods  $t = -2$  through  $t = 2$  centered around the year of adoption. To these we add two endpoint indicators which take on values of 1 for all periods at least 3 years before or after regime adoption. Each of these indicators are then used to construct interactions with our measures of period  $t = 0$  patent box tax savings and nexus requirement indicators.<sup>34</sup> As a final normalization, we constrain our estimates of patent box effects in period  $t = -3$  (including earlier years) to be zero, such that our remaining estimates for periods  $t = -2$

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<sup>34</sup> Using a Spanish firm as an example, we would have  $IPBoxSavings_{-3} = 0.18$  for all years  $\leq 2005$  and 0 otherwise;  $IPBoxSavings_{-2} = 0.18$  in 2006 and 0 otherwise;  $IPBoxSavings_{-1} = 0.18$  in 2007 and 0 otherwise; etc., until we get to  $IPBoxSavings_{+3} = 0.18$  for all years  $\geq 2011$  and 0 otherwise. Among countries that never adopt a patent box, all of these terms are uniformly zero. For patent box regimes that change provisions over time, we use the set of provisions that were in effect at the time of initial regime adoption.

through  $t = 3+$  should be interpreted as differential effects relative to this base period.<sup>35</sup> This yields a modified empirical model in which each component of the vector of patent box characteristics,  $\overline{IPBox}_{ct}$ , from equations (1) and (2) is replaced with 6 period-specific regressors:

$$\begin{aligned} \overline{IPBox}_{ct} = & \sum_{s=-2}^{3+} IPBoxSavings_{ct_s} + \sum_{s=-2}^{3+} IPBoxSavings_{ct_s} \cdot I[LimitedNexus]_{ct_s} \\ & + \sum_{s=-2}^{3+} IPBoxSavings_{ct_s} \cdot I[NoNexus]_{ct_s} \end{aligned}$$

As before, each of these terms are further interacted with  $I[Own Patent]$  when we consider acquisitions of targets (for a total of 36 period-specific patent box-related regressors in a single specification). All other elements of our main empirical specifications including controls and fixed effects remain unchanged.

Results from our event study analyses examining the effects of patent box regime characteristics on the likelihood of being acquired are depicted graphically in Figure 5. Panels (a), (c), and (e) on the left report the estimated effects of regime adoption on international deals, assuming a patent box tax savings rate near the median level of regime generosity (i.e.  $IPBoxSavings = 0.15$ ), while our results for domestic deals (based on the set of 36 period-specific patent box-related coefficient estimates discussed above) are split across the three panels on the right. Panels (a) and (b) depict the baseline patent box effect *in countries with strict nexus requirements*, while the panels in the middle and bottom rows report the relevant comparable effects in countries with limited nexus requirements and no nexus requirements, respectively (i.e.

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<sup>35</sup> This normalization implicitly assumes that firms could not have anticipated the effects of patent box adoption more than 3 years prior to implementation. This appears plausible given the typical time elapsed between serious tax policy reform discussions, policy enactment, and implementation. Extending the analysis to test for earlier anticipation effects is confounded by changes in sample composition due to our sample period beginning in 1997, 3 years prior to the first new patent box enactment (France).

summing coefficients for  $IPBoxSavings_{ct_s} + IPBoxSavings_{ct_s} \cdot I[LimitedNexus]_{ct_s}$  (middle row) and  $IPBoxSavings_{ct_s} + IPBoxSavings_{ct_s} \cdot I[NoNexus]_{ct_s}$  (bottom row), with the tax savings rate set to 0.15). Whisker bars extending around each point estimate denote 95 percent confidence intervals.

Examination of Figure 5 brings additional useful nuance to our results discussed in Section 4.1. First, it appears that anticipation effects—though present in some cases—were not enormously influential, thereby offering some reassurance regarding the validity of our general panel DiD approach. Significant patent box effects are thus seen to be primarily concentrated immediately around the period of regime adoption. Second, many of the patterns discussed in the context of our DiD results are well corroborated by the trends in patent box effects. For example, panels (a) and (b) both confirm the general negative effects of patent box adoption on the probability of being acquired in countries with strict nexus requirements, especially among patent-among firms. However, we also see that this negative effect is felt most strongly in the year of patent box adoption and the following two years before dissipating partially by the end of the event period. Furthermore, international deals appear more suddenly and significantly affected on impact than domestic deals, which may reflect the greater sensitivity of international M&A transactions to tax considerations (of all types). Indeed, a similar time pattern of adjustment between international and domestic deals also manifests itself in patent box regimes that impose limited nexus requirements on acquired IP or none at all. Anticipation effects appear to play a more important role in countries where acquired IP is granted preferential tax treatment subject to certain self-development requirements (panels (c) and (d)), as evidenced by statistically-significant positive effects (p-value < 0.1) prior to the year of regime adoption, but these effects arise a year earlier in the context of international deals than for domestic deals. These peak effects also arise

a year or more sooner than in the most permissive regimes. This may reflect the possibility that firms were more likely to seek to pre-empt the loss of patent box eligibility for acquired IP in countries where at least some nexus requirements were expected to be imposed.

Irrespective of the timing of firm responses, it is also noteworthy that the impact of the implementation of patent box regimes—at least among regimes offering close to the average level of tax savings—was positive among patent-owning targets, albeit typically in only a single period surrounding regime adoption. The lack of more persistent positive effects is likely responsible for our inability to find evidence of significant positive effects of patent box tax savings in our general DiD analysis, but this is consistent with the net income expansion channel triggering a short-lived spike in M&A activity as marginal transactions whose restructuring costs previously outweighed the expected after-tax value of synergistic gains suddenly become attractive on an after-tax basis. Despite heightened ongoing incentives, such a spike in M&A activity might subsequently induce a mechanical decline in acquisitions due to a temporary depletion of the pool of potential deals, thereby resulting in an apparent zero effect of patent box provisions on the probability of being acquired in the medium term.

Translated into percent changes in the probability of acquisition, the estimates depicted in Figure 5 for international and domestic deals are of a relatively similar magnitude (i.e. given that the unconditional probability of being acquired is roughly twice as large for international deals as for domestic deals). To the extent that the tax planning channel ought to impact international and domestic deals differently (while the net income expansion and nexus channels ought to have similar effects), a final implication of Figure 5, therefore, is to reinforce the conclusion that tax planning does not appear to play an important role in modulating the effects of patent box regimes on the probability of becoming a target.

Comparable results for our event study analysis of the probability of becoming an acquirer generally suffer from weaker statistical precision and wider confidence intervals, as shown in Figure 6. Nevertheless, these results largely mirror those from our general DiD analysis discussed in Section 4.2 while presenting a more muted picture of period-specific reactions overall, such that anticipation effects do not appear important. Panels (a) and (b) suggest that nexus requirements only have a significant negative effect on international deals in the year of patent box adoption. Thereafter, the effect on international deals remains negative but not significantly different from zero. In the case of domestic deals—where would-be acquirers and targets are equally eligible to benefit from preferential taxation—the effect of patent box adoption coupled with strict nexus requirements is largely flat, before spiking upwards 3-plus years out. Without the ability to condition on the *target's* patent ownership, nexus requirements may only bind infrequently from the perspective of a potential acquirer (i.e. only for the subset of deals that would involve IP-owning targets) and may constitute less of a hardship when the acquirer already has operations in the same country as the target. In countries with no nexus requirements (panels (e) and (f)), the general patterns from panels (a) and (b) are reversed in the sense that international deals appear largely unaffected by the adoption of patent box provisions, whereas the probability that a firm acquires a domestic target increases significantly in the year of patent box adoption and remains elevated thereafter. (Viewed differently, the net effect of competing incentive effects shift the probability of becoming acquirer up by a comparable amount for international and domestic deals.)

As discussed above, we generally expect tax planning motives to play a lesser role in terms of the effect of patent box adoption on the probability of becoming an acquirer. Hence, the appearance of significant positive effects of patent box adoption on the probability of making domestic acquisitions without a corresponding positive effect for international deals in countries

without nexus requirements is instead evidence of differences in the importance of the net income expansion channel. If synergistic gains from M&A transactions are primarily attributable to the assets held by the target, domestic transactions where both the acquirer and target are eligible for preferential taxation of IP income should drive larger increases in deal attractiveness than international transactions, where only the acquirer's original IP assets are eligible. This argument may likewise explain the *relatively* larger incentive effects attributable to the net income expansion channel among patent-owning firms for international deals as compared to domestic deals, as shown in panels (e) and (f) of Figure 5 for the probability of becoming a *target*. In that context, as long as there are no nexus requirements, the target's assets are eligible for preferential taxation regardless of the type of M&A transaction, such that domestic and foreign acquirers might have more similar opportunities for expanding net income via the target.

## **5. Conclusion**

Patent box regimes reward ownership of successful technology by imposing a lower tax rate on income derived from the commercialization of patented products relative to other sources of business income. These tax regimes are motivated by two broad objectives: (1) to foster domestic innovation and the creation of high-value jobs, and (2) to reduce erosion of the domestic tax base that occurs when mobile sources of income are shifted to tax havens or other low-tax jurisdictions through intra-firm transfer pricing or cost-sharing agreements. This latter objective, however, may come at the expense of increased base erosion elsewhere in the world, and concerns about this fact have led to the OECD's BEPS project conclusion that patent box regimes ought to impose strict nexus requirements.

A potential unintended consequence of this recent emphasis, however, is that imposing such requirements and disallowing preferential tax treatment for acquired IP may lead to distortions in the M&A market and thereby violate the principle of capital ownership neutrality. As we show, patent box regimes have a significant negative effect on the probability of firms either being acquired or becoming acquirers in countries where acquired IP is ineligible for preferential taxation. In contrast, in regimes without nexus requirements, we see a general positive impact of patent boxes on M&A activity for both international and domestic deals, with relatively larger and more persistent effects arising in the domestic context. We attribute these positive effects to the net income expansion channel, which may confer larger benefits to the merging parties in situations where both the acquirer and target are directly eligible for the patent box, as in domestic deals. The tax planning channel, meanwhile, appears to play a negligible role.

Strict nexus requirements may consequently discourage precisely the wrong types of M&A transactions from an efficiency standpoint: namely, deals which might otherwise generate important synergies and productivity improvements. A plausible path forward for policymakers intent on preserving patent box incentives for *domestic* innovation while discouraging outbound *and inbound* base erosion might involve differentiating the treatment of IP acquired via M&A versus asset purchases (with appropriate guardrails to prevent recharacterization of the latter as the former).

## References

- Alstadsæter, A., Barrios, S., Nicodeme, G., Skonieczna, A.M., Vezzani, A., 2018. Patent boxes design, patents location and local R&D. *Economic Policy* 33(93), 131–177.
- Arulampalam, W., Devereux, M., Liberini, F., 2017. Taxes and the location of targets. Oxford University Centre for Business Taxation working paper 17/04.
- Ayers, B., Lefanowicz, C., Robinson, J., 2003. Shareholder taxes in acquisition premiums: the effect of capital gains taxation. *Journal of Finance* 58, 2783–2801.
- Belz, T., Robinson, L., Ruf, M., Steffens, C., 2017. Tax avoidance as a driver of mergers and acquisitions. *Working Paper*.
- Bird, A., 2016. Domestic taxes and inbound acquisitions. *Working Paper*.
- Bradley, S., Dauchy, E., Robinson, L., 2015. Cross-country evidence on the preliminary effects of patent box regimes on patent activity and ownership. *National Tax Journal* 68(4), 1047-1072.
- Böhm, T., Karkinsky, T., Knoll, B., Riedel, N., 2015. The impact of corporate taxes on R&D and patent holdings. *Working paper*.
- Bornemann, T., Laplante, S., Osswald, B., 2017. The effect of intellectual property boxes on innovative activity & effective tax rates. *Working paper*.
- Ciamarella, L., 2017. Patent boxes and the relocation of intellectual property. *Working paper*.
- Chen, S., De Simone, L., Hanlon, M., Lester, R., 2017. The effect of innovation box regimes on income shifting and real activity. *Working paper*.
- De Simone, L., Sansing, R., 2017. Income Shifting Using a Cost Sharing Arrangement. *Working paper*.
- Desai, M., Foley, C., Hines, J., 2009. Domestic effects of the foreign activities of U.S. multinationals. *American Economic Journal: Economic Policy* 1(1), 181–203.
- Desai, M., Hines, J., 2003. Evaluating international tax reform. *National Tax Journal* 56:3, 487–502.
- Desai, M., Hines, J., 2004. Old rules and new realities: Corporate tax policy in a global setting. *National Tax Journal* 57(4), 937-960.
- Dischinger, M., Riedel, N., 2011. Corporate taxes and the location of intangible assets within multinational firms. *Journal of Public Economics* 95(7-8), 691-707.

- Edwards, A., Kravet, T., Wilson, R., 2012. Agency costs of permanently reinvested earnings. *Working Paper*.
- Erickson, M., 1998. The effect of taxes on the structure of corporate acquisitions. *Journal of Accounting Research* 36, 279–298.
- Erickson, M., Wang, S., 2000. The effect of transaction structure on price: evidence from subsidiary sales. *Journal of Accounting and Economics* 30, 59–97.
- Ernst, C., Spengel, C., 2011. Taxation, R&D tax incentives, and patent applications in Europe.” Centre for European Economic Research working paper 11-024.
- Ernst, C., Richter, K., Riedel, N., 2014. Corporate taxation and the quality of research and development.” *International Tax and Public Finance* 21 (4), 694–719.
- Ernst and Young (EY), 2015. Buying and selling: Cross-border mergers and acquisitions and the US corporate income tax. Prepared for the Business Roundtable, March.
- European Commission (EC), 2014. “A Study on R&D Tax Incentives — Final Report.” Taxation Papers, Working Paper N. 52 – 2014. European Commission, Brussels, Belgium.
- Evers, L., Miller, H., Spengel, C., 2015. Intellectual property box regimes: Effective tax rates and tax policy considerations. *International Tax and Public Finance* 22(3), 502–530.
- Feld, L., Ruf, M., Scheuering, U., Schreiber, U., Voget, J., 2016. Repatriation taxes and outbound M&As. *Journal of Public Economics* 139, 13-27.
- Gaessler, F. Hall, B., Harhoff, D., 2017. Patent boxes and patent transfers. *Working paper*.
- Graetz, M., Doud, R., 2013. Technological innovation, international competition, and the challenges of international income taxation.” *Columbia Law Review* 113, 347–445.
- Griffith, R., Miller, H., O’Connell, M., 2014. Ownership of intellectual property and corporate taxation. *Journal of Public Economics* 112, 12–23.
- Grubert, H., 2003. Intangible income, intercompany transactions, income shifting, and the choice of location. *National Tax Journal* 56 (1), 221–242.
- Grubert, H., Mutti, J., 2009. The effect of taxes on royalties and the migration of intangible assets abroad. In *International Trade in Services and Intangibles in the Era of Globalization*, ed. Reinsdorf, Marshall and Slaughter, Matthew J. 111-137. University of Chicago Press.
- Guadalupe, M., Kuzmina, O., Thomas, C., 2012. Innovation and foreign ownership. *American Economic Review* 102(7), 3594-3627.

- Hanlon, M., Lester, R., Verdi, R., 2015. The effect of repatriation tax costs on U.S. multinational investment. *Journal of Financial Economics* 116(1), 179-196.
- Harford, J., 1999. Corporate cash reserves and acquisitions. *Journal of Finance* 52, 1969-1997.
- Harris, R., Robinson, C., 2002. The effect of foreign acquisitions on total factor productivity: Plant-level evidence from U.K. manufacturing, 1987–1992. *Review of Economics and Statistics* 84(3), 562-568.
- Hayn, C., 1989. Tax attributes as determinants of shareholder gains in corporate acquisitions. *Journal of Financial Economics* 23, 121–153.
- Hines, J., 1997. International taxation and corporate R&D: Evidence and implications.” In Poterba, James M. (ed.), *Borderline Case: International Tax Policy, Corporate Research and Development, and Investment*, 39–52. National Research Council, Washington, DC.
- Huizenga, H., Voget, J., 2009. International taxation and the direction and volume of cross-border M&A. *Journal of Finance* 64(3), 1217–1249
- Karkinsky, T., Riedel, N., 2012. Corporate taxation and the choice of patent location within multinational firms. *Journal of International Economics* 88, 176-185.
- Landsman, W., Shackelford, D., 1995. The lock-in effect of capital gains taxes: evidence from the RJR Nabisco leveraged buyout. *National Tax Journal* 48, 245–259.
- Lewellen, K., Robinson, L., 2013. Internal ownership structures of U.S. multinational firms. *Working Paper*.
- Maksimovic, V., Phillips, G., 2001. The market for corporate assets: who engages in mergers and assets sales and are there efficiency gains? *Journal of Finance* 56(6), 2019-2065.
- Merrill, P., 2016. Innovation boxes: BEPS and beyond. *National Tax Journal* 69(4), 847-862.
- Merrill, P., Shanahan, J., 2012. Is it time for the United States to consider the patent box?” *Tax Notes* (March 26), 1665–1675.
- Organization for Cooperation and Development (OECD), 2015. BEPS Action Plan: Action 5 – Countering harmful tax practices.
- Phillips, G. and Zhdanov, A., 2013. R&D and the Incentives from Merger and Acquisition Activity. *Review of Financial Studies* 26(1): 34 – 78.
- Pfeiffer, O., Voget, J., 2016. Corporate taxation and location of intangible assets: Patents versus trademarks. *Working paper*.

- Quick, P.D., Day, T.L., 2006. “Management of IP: Intercompany Transfers, Offshore Planning and Recent Developments Regarding Cost-Sharing.” *The Licensing Journal* 1, 14–21.
- Schwab, T. and Todtehaupt, M., 2018. Thinking outside the box: The cross-border effect of tax cuts on R&D. *Working paper*.
- Serrano, C., 2006. The market for intellectual property: Evidence from the transfer of patents. *Working paper*.
- Seru, A., 2014. Firm boundaries matter: Evidence from conglomerates and R&D activity. *Journal of Financial Economics* 111, 381 – 405.
- Todtenhaupt, M., Voget, J., 2017. International taxation and productivity effects of M&As.
- Voget, J., 2011. Relocation of headquarters and international taxation. *Journal of Public Economics* 95(9-10), 1067–1081.
- Wang, J. Wang, X., 2015. Benefits of foreign ownership: Evidence from foreign direct investment in China. *Journal of International Economics* 97(2), 325-338.
- Weisbach, D., 2014. The use of neutralities in international tax policy. *Working paper*.

Figure 1: Sample Distribution by Country: 1994-2014

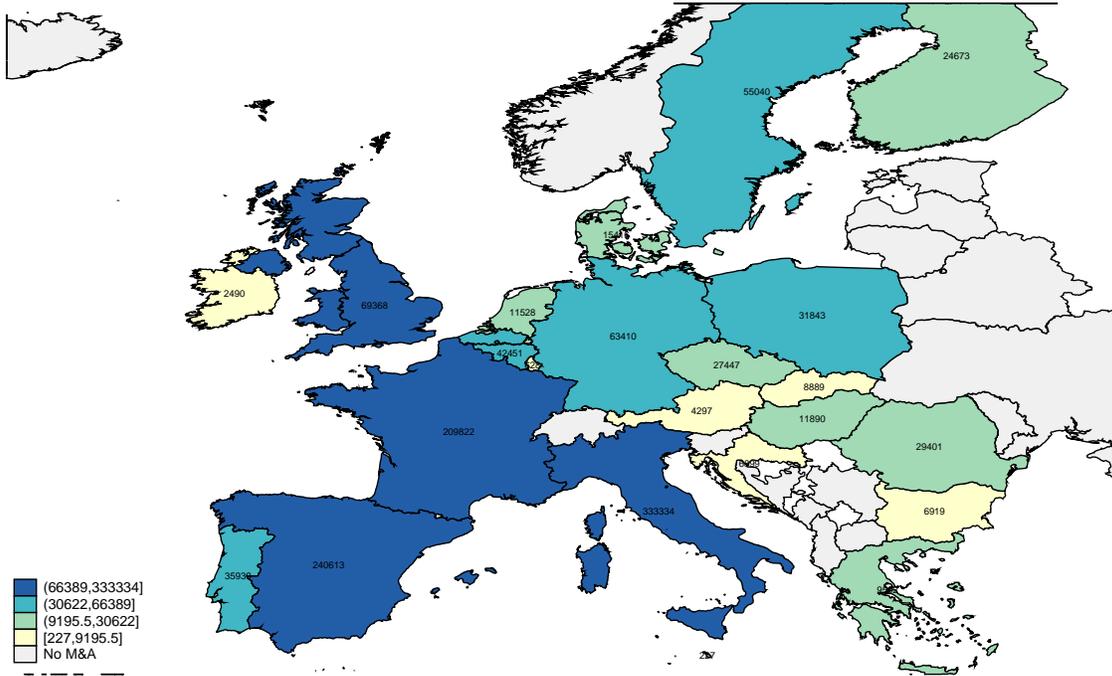


Figure 2: Firm Distribution by Country: 1994-2014

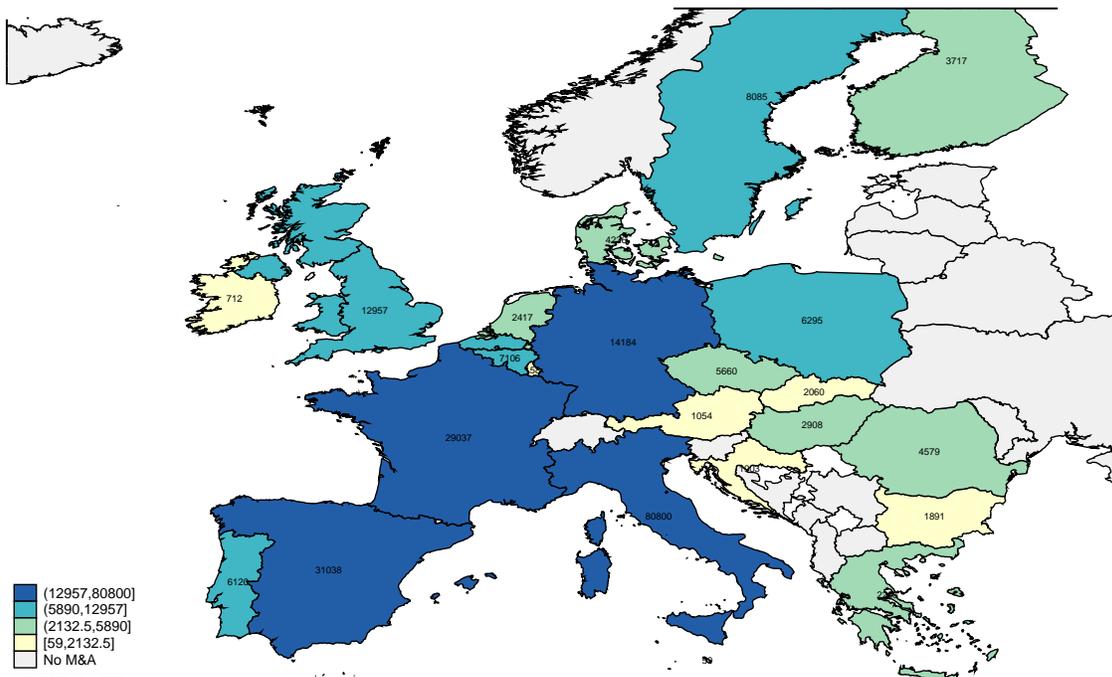


Figure 3: Share of Acquired Firms by Target Country: 1994-2014

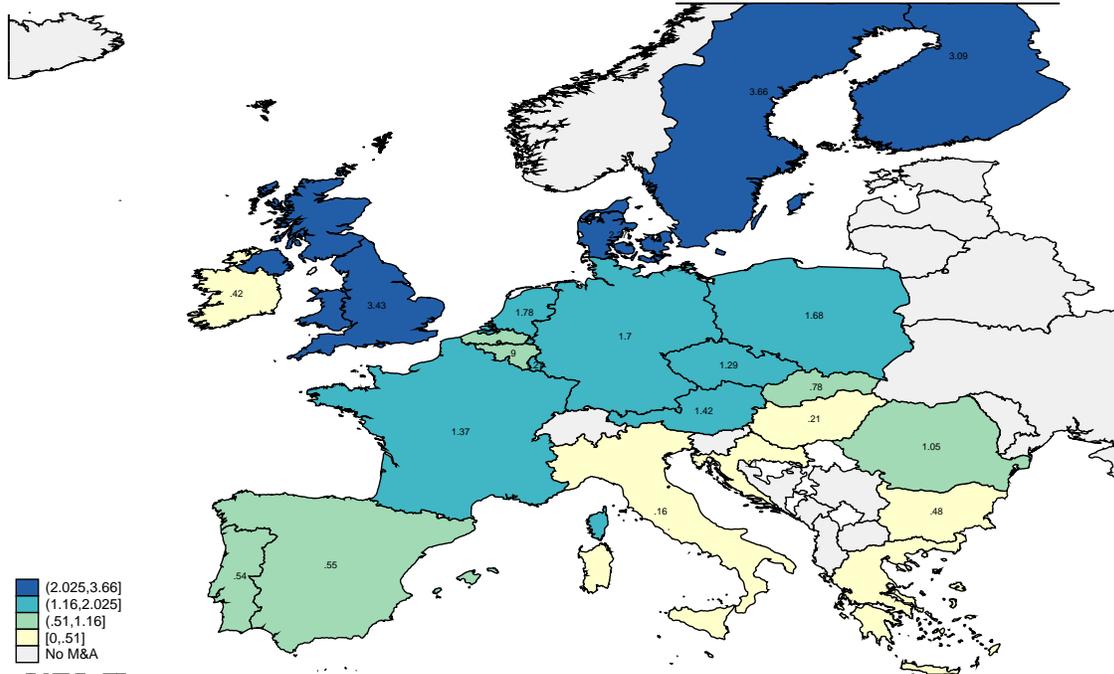


Figure 4: Share of Acquiring Firms by Acquirer Country: 1994-2014

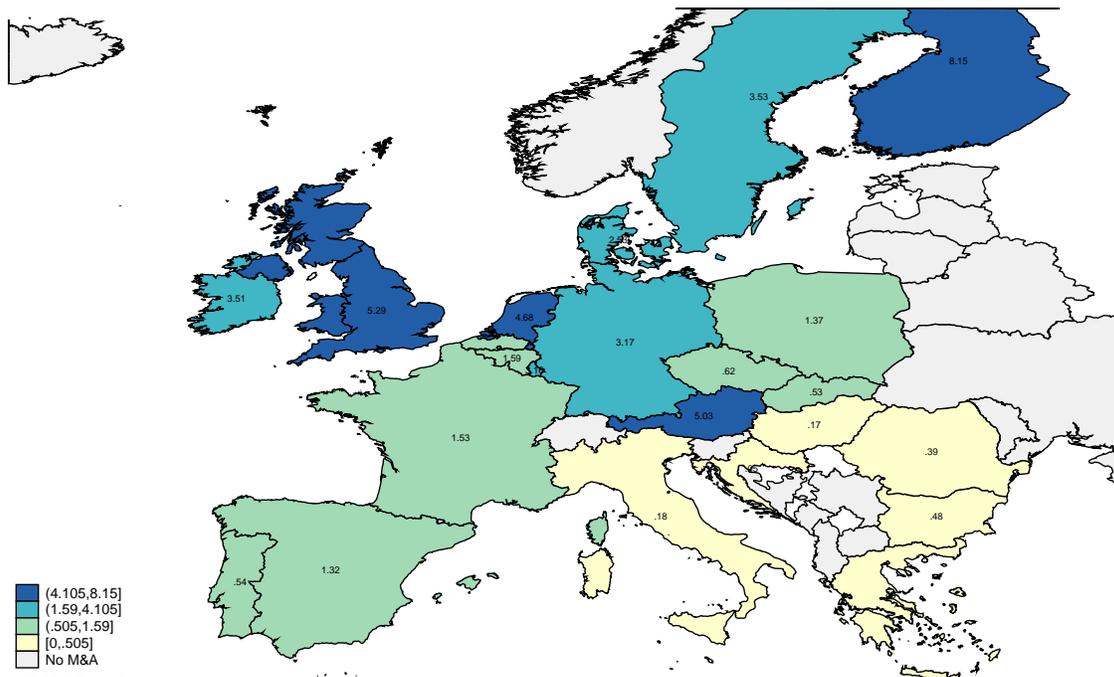
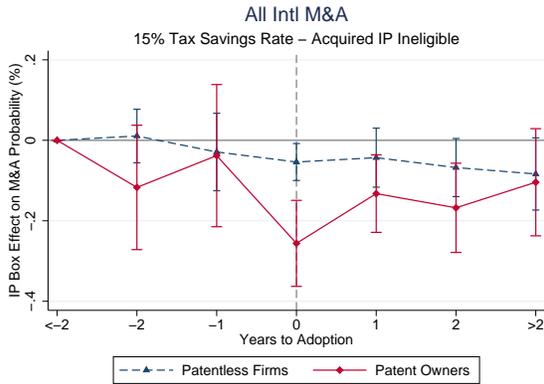
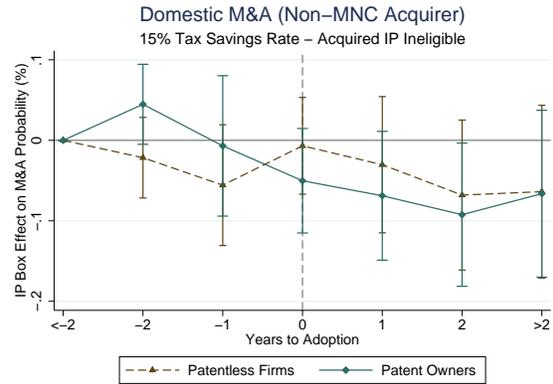


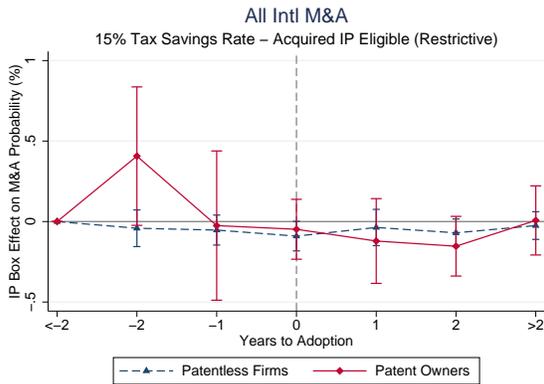
Figure 5: Patent Box Effects on the Likelihood of Target Acquisition: Event Study Estimates



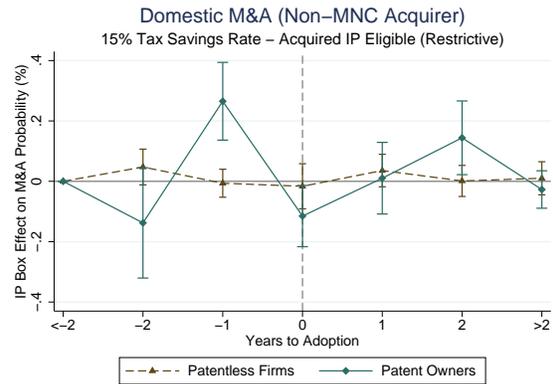
(a)



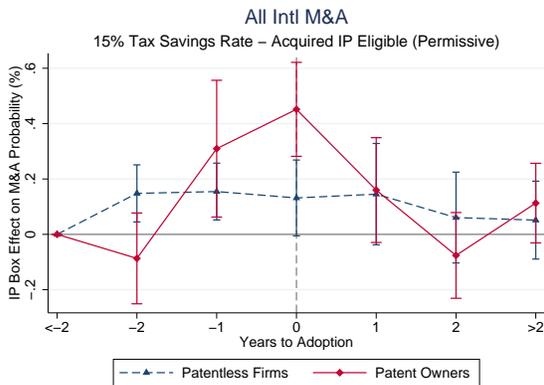
(b)



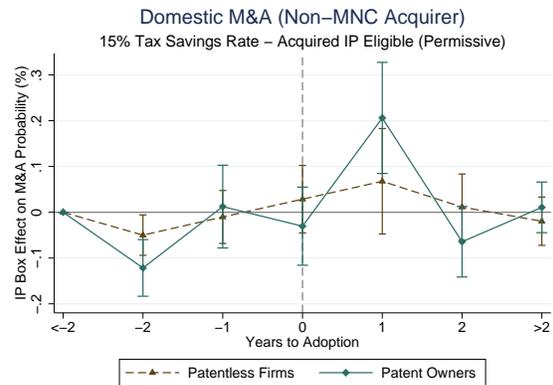
(c)



(d)



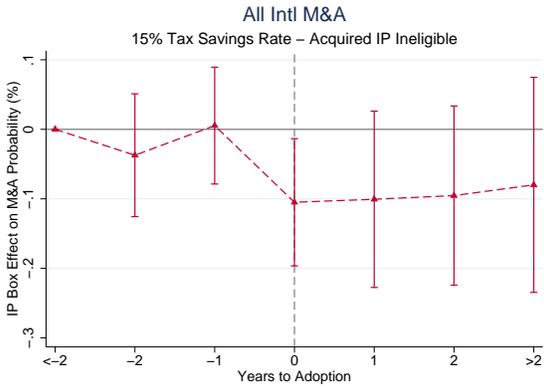
(e)



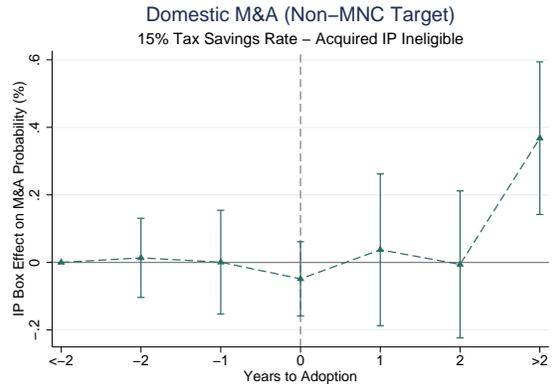
(f)

Whisker bars represent 95% confidence intervals.

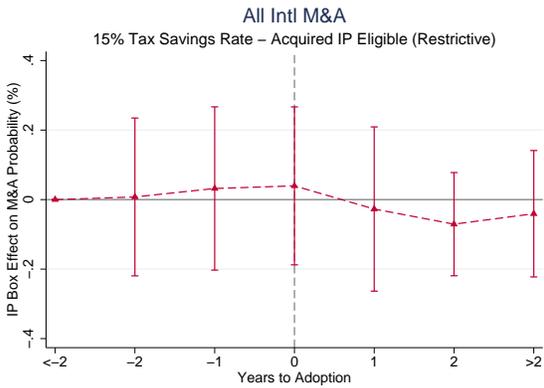
Figure 6: Patent Box Effects on the Likelihood of Acquirer Acquisition: Event Study Estimates



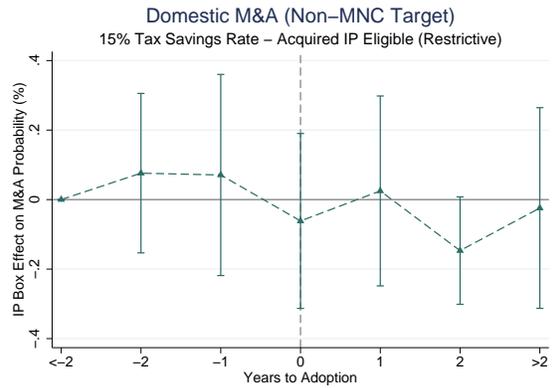
(a)



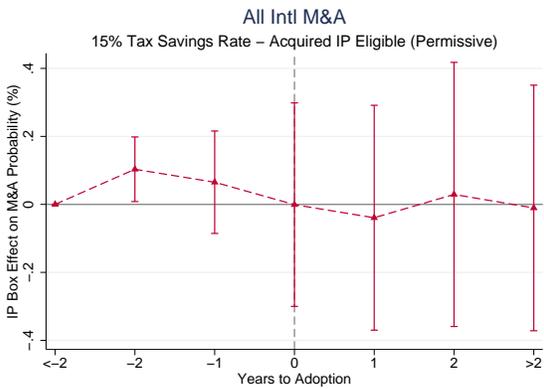
(b)



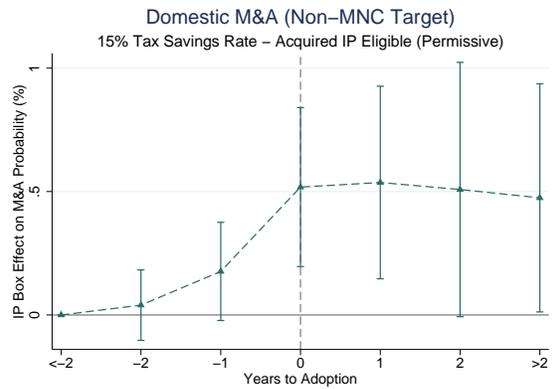
(c)



(d)



(e)



(f)

Whisker bars represent 95% confidence intervals.

Table 1: Selected Characteristics of EU Patent Box Regimes and Distribution of Sample Firms (1994-2014)

Country	Years	Number of Sample Firms	Tax Rate (Percent)		Eligible IP		Qualifying Income IP Types <sup>e</sup>	Tax Base Deductibility of Current R&D
			IP Income	Main	Acquired IP <sup>d</sup>	Existing IP		
BE	2007 -	7106	6.8	34	Restricted	No	Narrow	Gross income
CY	2012 -	29	2.5	12.5	Permitted	Yes	Broad	Net income
ES	2008 -	31038	12	30	Disallowed	Yes	Narrow	Net income
FR	2000 -	29037	16.76	38	Permitted	Yes	Narrow	Net income
HU	2003 -	2908	9.5	19	Permitted	Yes	Broad	Gross income
IE <sup>a</sup>	1973 - 2010	712	0	12.5	Permitted	Yes	Broad	Net income
IT	2015 -	80800	15.65	31.3	Restricted	Yes	Broad	Net income
LU	2008 -	158	5.84	29.3	Restricted	No	Broad	Net income
MT	2010 -	59	0	35	Permitted	No	Broad	Not deductible
NL <sup>b</sup>	2007 -	2417	5	25	Restricted	No	Narrow	Net income
PT	2014 -	6120	11.5	30	Disallowed	No	Narrow	Gross income
UK <sup>c</sup>	2013 -	12957	10	21	Restricted	Yes	Broad	Net income

Sources: Merrill and Shanahan (2012); Evers, Miller, and Spengel (2015); PwC (2015); Schwab and Todtenhaupt (2017); and Chen et al. (2017). Corporate tax rates are based on applicable rates for the last year in our sample (2014) using data from Comtax and the OECD. Tax rates on IP income are based upon full phase-in of patent box provisions (e.g. NL, IT, UK).

<sup>a</sup> Prior to enacting a new IP box regime in 2016, Ireland had a patent box that it terminated in 2010 after an EC case challenging the country's original nexus requirements (which led to an initial lack of nexus requirements throughout EU patent box regimes). Irish nexus requirements under its original regime were terminated in 2008.

<sup>b</sup> The Netherlands lowered its patent box tax rate to 5 percent in 2010.

<sup>c</sup> The UK regime is being phased in over five years. In 2013, companies were only entitled to 60 percent of the full benefit, increasing to 70 percent, 80 percent and 90 percent in subsequent years, becoming fully available (i.e., at the 10 percent rate) in 2017. The relevant tax base for the deductibility of current R&D expenses is net income *before interest*.

<sup>d</sup> Our characterization of the treatment of acquired IP treats divergent classifications in Schwab and Todtenhaupt (2017) and Chen et al. (2017) as constituting an intermediate (i.e., "restrictive") regime. Specific provisions vary widely between countries. Pursuant to the OECD's 2015 Action 5 report, all new and existing patent box regimes are required to institute new nexus provisions. These requirements post-date our analysis and are not reflected here.

<sup>e</sup> "Narrow" qualifying IP is limited to patents and may extend to patentable or protected inventions such as SPC (supplementary protection certificates), software, and designs/models. "Broad" qualifying IP is not limited to patents but extends to other types of IP such as trademarks, know-how, business secrets, business formulas, and copyrights.

Table 2: Channels through Which Patent Box Regimes Could Impact M&A

Probability of:	Channel		
	Nexus	Net Income Expansion	Tax Planning
Being a target (domestic deal)	-	+	No effect
Being a target (international deal)	-	+	±
Being an acquirer (domestic deal)	-	+	No effect
Being an acquirer (international deal)	-	+	±

Table 3: Firm-Level Variable Names and Definitions

Variable Name	Description	Timing
$I[OwnPatent]_{t-1}$	Binary indicator equal to 1 for direct ownership of at least 1 patent	1-year lag
$E\bar{T}R_{-3}$	Effective tax rate: equal to taxes paid divided by pre-tax income (EBIT) and winsorized to [0,1]	Lagged 3-year average
$R\bar{O}A_{-3}$	Profit rate: equal to pre-tax income (EBIT) divided by total assets	Lagged 3-year average
$\log(\bar{Assets})_{-3}$	Firm size: equal to the natural log of total assets	Lagged 3-year average
$\bar{Intan}_{-3}$	Intangibles intensity: equal to intangible assets divided by total assets	Lagged 3-year average
$\bar{Cash}_{-3}$	Cash holdings: equal to cash and cash equivalents divided by total assets	Lagged 3-year average
$I[HighGrowth]_{t-1}$	Binary indicator equal to 1 for firms experiencing above-median growth in total assets	1-year difference
$CapitalSpend_{-3}$	Capital expenditures: equal to the change in fixed assets	Lagged 3-year difference
$I[Listed]_{t-1}$	Binary indicator equal to 1 for publicly-listed firms	1-year lag
$\bar{Leverage}_{-3}$	Leverage: equal to total liabilities divided by total assets	Lagged 3-year average
$\bar{Tangibility}_{-3}$	Tangibility: equal to fixed assets divided by total assets	Lagged 3-year average
$I[MNC]$	Binary indicator equal to 1 for multinational firms (based on existence of foreign subsidiaries)	
$I[HavenSubs]$	Binary indicator equal to 1 for firms with at least one foreign tax haven subsidiary	

Table 4: Country-Level Variable Names and Definitions

Variable Name	Description
$I[IPBox]$	Binary indicator equal to 1 in patent box regime countries
$CIT$	Statutory corporate income tax rate
$IPBoxSavings$	Patent box tax savings: equal to $CIT$ minus tax rate on patent income (patent box rate or $CIT$ )
$I[LimitedNexus]$	Binary indicator equal to 1 in patent box countries that grant preferential treatment to acquired IP (modestly restrictive)
$I[NoNexus]$	Binary indicator equal to 1 in patent box countries that grant preferential treatment to acquired IP (unrestricted)
$I[HighRoyaltyTax]$	Binary indicator equal to 1 in countries whose average bilateral royalty withholding tax rate on royalty receipts exceeds the tax rate applied to patent income
$MarketCap$	Market capitalization as a share of GDP
$\Delta MarketCap$	Annual change in market capitalization as a share of GDP
$\log(LaborForce)$	Natural log of total labor force
$Unemp$	Unemployment rate
$Exports$	Exports as a share of GDP
$\log(GDP)$	Natural log of real GDP per capita (PPP)
$CPI$	Inflation, measured according to consumer price index
$REER$	Real effective exchange rate
$EFI$	Fraser Institute Economic Freedom Index

Table 5: Variable Means by M&A Deal Status  
2014 Estimation Sample

	Target Deals			Acquirer Deals		
	None (1)	Intl (2)	Domestic (3)	None (4)	Intl (5)	Domestic (6)
<i>Firm-Level Characteristics:</i>						
$I[OwnPatent]_{t-1}$	0.112	0.206***	0.188	0.11	0.552***	0.392***
$I[MNC]$	0.1	0.303***	0.083	0.097	0.943***	0.579***
$I[HavenSubs]$	0.017	0.032	0.021	0.015	0.536***	0.272***
$\overline{ETR}_{-3}$	0.386	0.313***	0.281***	0.386	0.298***	0.267***
$\overline{ROA}_{-3}$	0.09	0.123***	0.125**	0.09	0.101**	0.100*
$\log(\overline{Assets})_{-3}$	8.54	9.9***	9.09***	8.53	13.1***	11.5***
$\overline{Intan}_{-3}$	0.026	0.044**	0.017	0.025	0.179***	0.115***
$\overline{Cash}_{-3}$	0.131	0.11*	0.201**	0.131	0.112***	0.101***
$I[HighGrowth]_{t-1}$	0.504	0.503	0.458	0.503	0.613***	0.573**
$\overline{CapitalSpend}_{-3}$	-0.069	0.009	-0.003	-0.069	0.036	0.036
$\overline{Listed}_{t-1}$	0.008	0.019	0.063	0.007	0.51***	0.288***
$\overline{Leverage}_{-3}$	0.586	0.559*	0.476***	0.586	0.526***	0.556***
$\overline{Tangibility}_{-3}$	0.28	0.251**	0.253	0.28	0.264	0.313***
<i>Country-Level Characteristics:</i>						
$\overline{CIT}$	0.299	0.275***	0.29	0.299	0.264***	0.272***
$I[HighRoyaltyTax]$	0.113	0.058***	0.063	0.112	0.083	0.199***
$\overline{MarketCap}$	54.3	72.5***	83.1***	54.1	85.8***	84.8***
$\Delta\overline{MarketCap}$	0.363	0.383	0.379	0.363	0.407**	0.341
$\log(\overline{LaborForce})$	16.8	16.8	16.6	16.8	16.5***	16.7
$\overline{Unemp}$	0.119	0.096***	0.094***	0.119	0.084***	0.11**
$\overline{Exports}$	0.377	0.388	0.399	0.377	0.45***	0.392*
$\log(\overline{GDP})$	10.5	10.5***	10.5***	10.5	10.6***	10.5***
$\overline{CPI}$	0.003	0.006***	0.006***	0.003	0.007***	0.006***
$\overline{REER}$	0.996	1.02***	1.01*	0.995	1.02***	1.02***
$\overline{EFI}$	7.36	7.5***	7.5***	7.36	7.59***	7.55***
<i>Patent Box Characteristics<sup>a</sup></i>						
$\overline{IPBoxSavings}$	0.182	0.141***	0.177	0.182	0.152***	0.156***
Observations	94990	155	48	94683	194	316

Significance levels are designated as \*\*\* p<0.01, \*\* p<0.05, and \* p<0.1 and refer to tests of differences in means (assuming unequal variances) between the no-deal and international (domestic) deal means.

<sup>a</sup> Patent box characteristics are for the subset of observations in patent box countries only and consist of 39666, 62, 30, 39494, 86, and 178 firms, respectively.

Table 6: Patent Box Effects on the Likelihood of Target Acquisition

$Y = Pr(Target = 1), Y \in \{0, 100\}$	All Deals (1)	Deal Type International (2)	Domestic (3)
<b>LPM Coefficient Estimates</b>			
<i>IPBoxSavings</i>	-0.6030** (0.2308)	-0.6210*** (0.1708)	0.0180 (0.1759)
$I[LimitedNexus] \times IPBoxSavings$	0.4603 (0.3639)	0.4537 (0.2660)	0.0066 (0.1981)
$I[NoNexus] \times IPBoxSavings$	0.0717 (0.4382)	-0.0573 (0.3252)	0.1290 (0.2563)
$IPBoxSavings \times I[OwnPatent]_{t-1}$	-0.6366** (0.2849)	-0.4943 (0.2885)	-0.1423** (0.0538)
$I[LimitedNexus] \times IPBoxSavings$ $\times I[OwnPatent]_{t-1}$	0.5594 (0.4733)	0.5549 (0.4808)	0.0045 (0.0483)
$I[NoNexus] \times IPBoxSavings$ $\times I[OwnPatent]_{t-1}$	1.1724*** (0.2717)	0.8732*** (0.2710)	0.2991*** (0.0629)
	∴	∴	∴
<b>Unconditional <math>Pr(Target = 1)</math> (Percent):</b>			
<i>All firms</i>	0.192	0.137	0.055
<i>Patent-less firms</i>	0.157	0.108	0.049
<i>Patent-owning firms</i>	0.496	0.389	0.107
<b>Marginal Change in Predicted <math>Pr(Target = 1)^a</math>:</b>			
<i>Patent-less firms; Acquired IP disallowed</i>	-3.83***	-5.739***	0.366
<i>Patent-less firms; Limited nexus</i>	-0.906	-1.546	0.5
<i>Patent-less firms; No nexus</i>	-3.375	-6.269**	2.987
<i>Patent-owning firms; Acquired IP disallowed</i>	-2.499***	-2.871***	-1.157
<i>Patent-owning firms; Limited nexus</i>	-0.443	-0.275	-1.054
<i>Patent-owning firms; No nexus</i>	0.009	-0.771	2.829
Observations	1,242,120	1,242,120	1,242,120
R-squared	0.0035	0.0028	0.0011

Significance levels are designated as \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , and \*  $p < 0.1$ . Standard errors (in parentheses) are clustered at the country level.

All specifications include a full set of time-varying firm- and country-level controls along with country, year, and industry fixed effects. Complete results are reported in Appendix Table A.1.

<sup>a</sup> Marginal changes in  $Pr(Target = 1)$  are computed as the effect of a 1 unit (100 percentage point) change in *IPBoxSavings*, summing coefficients over relevant interaction terms and scaling by the unconditional mean probability of acquisition among patent-less or patent-owning firms, as appropriate.

$$\text{E.g. } \left\{ \frac{\partial Pr(Target=1)}{\partial IPBoxSavings} \cdot \frac{1}{Y} \right\}_{I[OwnPatent]=0, I[LimitedNexus]=0, I[NoNexus]=0} = -\frac{0.6030}{0.157} = -3.83.$$

Table 7: Patent Box Effects on the Likelihood of Acquirer Acquisition

$Y = Pr(\text{Acquirer} = 1), Y \in \{0, 100\}$	Deal Type		
	All Deals (1)	International (2)	Domestic (3)
<i>LPM Coefficient Estimates</i>			
<i>IPBoxSavings</i>	-1.8386*** (0.5704)	-0.9424*** (0.3105)	-0.8962** (0.3969)
$I[\text{LimitedNexus}] \times \text{IPBoxSavings}$	1.1097 (0.8941)	0.6830 (0.4398)	0.4267 (0.5378)
$I[\text{NoNexus}] \times \text{IPBoxSavings}$	3.2309* (1.7317)	-0.0246 (0.8160)	3.2555*** (1.1452)
	∴	∴	∴
<i>Unconditional Pr(Acquirer = 1) (Percent):</i>			
<i>All firms</i>	0.508	0.181	0.328
<i>Marginal Change in Predicted Pr(Acquirer = 1):<sup>a</sup></i>			
<i>Acquired IP disallowed</i>	-3.616***	-5.214***	-2.734**
<i>Limited nexus</i>	-1.434	-1.435	-1.432
<i>No nexus</i>	2.738	-5.35	7.199**
Observations	1,242,120	1,242,120	1,242,120
R-squared	0.1484	0.0765	0.0770

Significance levels are designated as \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , and \*  $p < 0.1$ . Standard errors (in parentheses) are clustered at the country level.

All specifications include a full set of time-varying firm- and country-level controls along with country, year, and industry fixed effects. Complete results are reported in Appendix Table A.1.

<sup>a</sup> Marginal changes in  $Pr(\text{Acquirer} = 1)$  are computed as the effect of a 1 unit (100 percentage point) change in  $\text{IPBoxSavings}$ , summing coefficients over relevant interaction terms and scaling by the unconditional mean probability of acquisition across all firms.

E.g.  $\left\{ \frac{\partial Pr(\text{Acquirer}=1)}{\partial \text{IPBoxSavings}} \cdot \frac{1}{\bar{Y}} \right\}_{|I[\text{LimitedNexus}]=0, I[\text{NoNexus}]=0} = -\frac{1.8386}{0.508} = -3.616$ .

Table A.1: Patent Box Effects on the Likelihood of Target Acquisition

$Y = Pr(Target = 1), Y \in \{0, 100\}$	Deal Type		
	All Deals (1)	International (2)	Domestic (3)
<i>IPBoxSavings</i>	-0.6030** (0.2308)	-0.6210*** (0.1708)	0.0180 (0.1759)
$I[LimitedNexus] \times IPBoxSavings$	0.4603 (0.3639)	0.4537 (0.2660)	0.0066 (0.1981)
$I[NoNexus] \times IPBoxSavings$	0.0717 (0.4382)	-0.0573 (0.3252)	0.1290 (0.2563)
$IPBoxSavings \times I[OwnPatent]_{t-1}$	-0.6366** (0.2849)	-0.4943 (0.2885)	-0.1423** (0.0538)
$I[LimitedNexus] \times IPBoxSavings$ $\times I[OwnPatent]_{t-1}$	0.5594 (0.4733)	0.5549 (0.4808)	0.0045 (0.0483)
$I[NoNexus] \times IPBoxSavings$ $\times I[OwnPatent]_{t-1}$	1.1724*** (0.2717)	0.8732*** (0.2710)	0.2991*** (0.0629)
$I[OwnPatent]_{t-1}$	0.2910 (0.2274)	0.2840 (0.2449)	0.0070 (0.0537)
$CIT \times I[OwnPatent]_{t-1}$	-0.6430 (0.7183)	-0.6308 (0.7861)	-0.0122 (0.1753)
$\bar{ETR}_{-3}$	0.0254 (0.0232)	0.0112 (0.0167)	0.0141 (0.0115)
$CIT$	0.8637 (0.6284)	0.4458 (0.5694)	0.4179** (0.1850)
$I[MNC]$	0.0480* (0.0277)	0.0390* (0.0201)	0.0090 (0.0090)
$I[HavenSubs]$	-0.3180** (0.1370)	-0.1652 (0.1029)	-0.1528*** (0.0505)
$\bar{ROA}_{-3}$	0.0925 (0.0868)	0.0821 (0.0749)	0.0104 (0.0139)
$\log(\bar{Assets})_{-3}$	0.0983*** (0.0172)	0.0806*** (0.0129)	0.0177*** (0.0054)
$\bar{Intan}_{-3}$	0.1084 (0.0668)	0.1349* (0.0778)	-0.0265 (0.0220)
$\bar{Cash}_{-3}$	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000** (0.0000)
$I[HighGrowth]_{t-1}$	0.0130 (0.0108)	0.0154* (0.0088)	-0.0024 (0.0042)
$CapitalSpend_{-3}$	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
$Listed_{t-1}$	0.0707	-0.1902	0.2609**

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	(0.2090)	(0.1542)	(0.1006)
<i>Leverage<sub>-3</sub></i>	0.0010	-0.0027	0.0038
	(0.0053)	(0.0050)	(0.0027)
<i>Tangibility<sub>-3</sub></i>	-0.0136	-0.0077	-0.0059
	(0.0119)	(0.0080)	(0.0046)
<i>HavenSubsShare</i>	0.3325	0.1789	0.1536**
	(0.2006)	(0.1540)	(0.0680)
<i>I[HighRoyaltyTax]</i>	0.1402	0.1786*	-0.0385
	(0.1396)	(0.0868)	(0.0661)
<i>MarketCap</i>	0.0001	0.0001	-0.0001
	(0.0005)	(0.0003)	(0.0003)
$\Delta$ <i>MarketCap</i>	0.0104	0.0137**	-0.0032
	(0.0084)	(0.0053)	(0.0039)
$\log(\text{LaborForce})$	-0.8704*	-0.9236**	0.0532
	(0.4574)	(0.3541)	(0.1957)
<i>Unemp</i>	0.3557	0.2295	0.1262
	(0.7920)	(0.4385)	(0.3997)
<i>Exports</i>	-0.5872	-0.5235	-0.0637
	(0.4505)	(0.3454)	(0.1925)
$\log(\text{GDP})$	-0.1867	-0.2320	0.0453
	(0.4782)	(0.3241)	(0.2188)
<i>CPI</i>	-0.4236	-0.0979	-0.3257
	(0.5220)	(0.4738)	(0.2644)
<i>REER</i>	0.0811	0.0348	0.0463
	(0.6003)	(0.4696)	(0.1574)
<i>EFI</i>	-0.1699**	-0.1101	-0.0598
	(0.0750)	(0.0662)	(0.0367)
Constant	14.6083	15.8545**	-1.2462
	(8.8971)	(6.6981)	(3.4574)
Observations	1,242,120	1,242,120	1,242,120
R-squared	0.0035	0.0028	0.0011

Significance levels are designated as \*\*\* p<0.01, \*\* p<0.05, and \* p<0.1. Standard errors (in parentheses) are clustered at the country level.

All specifications include a full set of country, year, and industry fixed effects.

Table A.2: Patent Box Effects on the Likelihood of Acquirer Acquisition

$Y = Pr(\text{Acquirer} = 1), Y \in \{0, 100\}$	Deal Type		
	All Deals (1)	International (2)	Domestic (3)
<i>IPBoxSavings</i>	-1.8386*** (0.5704)	-0.9424*** (0.3105)	-0.8962** (0.3969)
$I[\text{LimitedNexus}] \times \text{IPBoxSavings}$	1.1097 (0.8941)	0.6830 (0.4398)	0.4267 (0.5378)
$I[\text{NoNexus}] \times \text{IPBoxSavings}$	3.2309* (1.7317)	-0.0246 (0.8160)	3.2555*** (1.1452)
$I[\text{OwnPatent}]_{t-1}$	0.1417 (0.0928)	0.1111*** (0.0371)	0.0306 (0.0738)
$\overline{ETR}_{-3}$	0.0917 (0.1021)	0.0545 (0.0480)	0.0372 (0.0654)
<i>CIT</i>	2.5497 (2.8294)	1.4329 (1.2178)	1.1169 (1.6437)
$I[\text{MNC}]$	0.5004** (0.1944)	0.2451*** (0.0836)	0.2553** (0.1163)
$I[\text{HavenSubs}]$	11.8842*** (2.0387)	6.3212*** (1.1235)	5.5629*** (1.0184)
$\overline{ROA}_{-3}$	0.1297 (0.1482)	0.0704 (0.0670)	0.0592 (0.0859)
$\log(\overline{\text{Assets}})_{-3}$	0.2983*** (0.0833)	0.0990*** (0.0307)	0.1993*** (0.0540)
$\overline{\text{Intan}}_{-3}$	1.6867* (0.9650)	0.7786* (0.4407)	0.9080* (0.5264)
$\overline{\text{Cash}}_{-3}$	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
$I[\text{HighGrowth}]_{t-1}$	0.1593*** (0.0548)	0.0585** (0.0210)	0.1007** (0.0360)
$\text{CapitalSpend}_{-3}$	0.0006 (0.0007)	0.0003 (0.0003)	0.0003 (0.0004)
$\text{Listed}_{t-1}$	16.4156*** (2.9230)	6.2568*** (1.0926)	10.1588*** (1.8816)
$\overline{\text{Leverage}}_{-3}$	-0.0551 (0.0505)	-0.0330 (0.0234)	-0.0222 (0.0281)
$\overline{\text{Tangibility}}_{-3}$	0.0277 (0.0184)	0.0105 (0.0071)	0.0172 (0.0121)
<i>HavenSubsShare</i>	-15.0820*** (2.6077)	-7.9646*** (1.3990)	-7.1175*** (1.4030)
$I[\text{HighRoyaltyTax}]$	0.5553* (0.5553)	0.3156** (0.3156)	0.2397 (0.2397)

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	(0.2839)	(0.1506)	(0.1810)
<i>MarketCap</i>	-0.0013	0.0013**	-0.0027***
	(0.0012)	(0.0006)	(0.0008)
$\Delta MarketCap$	0.0086	0.0072	0.0014
	(0.0176)	(0.0081)	(0.0155)
$\log(LaborForce)$	-2.0530	-1.2162**	-0.8367
	(1.2667)	(0.5511)	(0.9444)
<i>Unemp</i>	2.3060	-0.3322	2.6382*
	(1.5831)	(0.4763)	(1.3506)
<i>Exports</i>	-1.4983	-0.7106	-0.7877
	(1.0639)	(0.4465)	(0.8828)
$\log(GDP)$	0.4779	-0.2622	0.7401
	(0.6434)	(0.2185)	(0.5248)
<i>CPI</i>	3.0916	1.0389	2.0527
	(2.2673)	(0.7924)	(1.6342)
<i>REER</i>	2.2106***	0.8424***	1.3682**
	(0.6968)	(0.2120)	(0.5338)
<i>EFI</i>	0.1965	0.0801	0.1164
	(0.1818)	(0.0548)	(0.1437)
Constant	16.1210	17.8341*	-1.7131
	(21.6091)	(10.1556)	(14.5366)
Observations	1,242,120	1,242,120	1,242,120
R-squared	0.1484	0.0765	0.0770

Significance levels are designated as \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , and \*  $p < 0.1$ . Standard errors (in parentheses) are clustered at the country level.

All specifications include a full set of country, year, and industry fixed effects.