The Impact of IP Box Regimes on the M&A Market*,**

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Abstract

Intellectual property (IP) box regimes reward ownership of successful technology by imposing lower tax rates on income derived from IP relative to other sources of business income. Coupled with explicit provisions regarding the eligibility of acquired IP, IP boxes may affect merger and acquisition (M&A) incentives through multiple channels. Applying panel differences-in-differences, triple-differencing, and event study methods, we examine the effects of these modified incentives on the volume of M&A transactions and acquisition probabilities. In regimes with strict nexus requirements, reduced taxation of IP income is associated with reductions in the number of deals and 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, and significant positive effects of IP box tax savings in more permissive regimes point to increased after-tax valuations of merger-driven synergies. JEL Codes: K34, H25, H32

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1. Introduction

Technological innovation drives the creation of high-skilled jobs and economic growth, but the intellectual property (IP) underlying this progress is highly mobile and can easily be separated from economic activity. Devising national fiscal policies that promote innovation while simultaneously retaining or attracting mobile IP and its associated taxable income is currently one of the greatest challenges facing policymakers around the world. The rate at which IP income is taxed affects taxpayers' returns to innovation, and reducing such taxation is therefore a key consideration for pro-growth fiscal policy. At the same time, the tax-motivated reallocation of IP-related income between countries is widely blamed for the erosion of the corporate income tax base in countries with higher tax rates. The overall scale of the problem is large, with aggregate tax revenue losses estimated to be between 4 and 10 percent of total corporate tax revenues worldwide (OECD, 2015). National governments are hence under pressure to revise their IP-related fiscal policies to promote innovative activities while retaining or attracting mobile income to protect and expand their domestic tax base.

Over the period 2000-2016, seventeen countries implemented preferential tax regimes that feature a reduced corporate tax rate on income from qualifying IP (Bradley et al. (2015), Merrill (2016)). Since firms must check a box on their tax returns to claim this preferential rate (Chen et al., 2018), these tax regimes are known as "IP box" regimes.[1] Eligibility for the preferential IP box tax rate is dictated by an assortment of provisions; collectively, these rules determine each country's approach to balancing its revenue needs with its desire to spur innovation. A country may restrict the forms of IP that qualify, for example, meaning that while patents are universally accepted as a potential source of eligible income the same may not be true for trademarks. Countries may also restrict access to the reduced tax rate based on the level of active participation in development

[1]Depending on the definition of qualifying IP, these regimes are also referred to as patent boxes or innovation boxes. We use the more general and succinct "IP box" terminology throughout.

of the IP asset, or by demarcating types of eligible income such as royalties, licensing fees, gains on the sale of IP, sales of goods and services incorporating IP, and patent infringement awards. By imposing a lower tax rate on IP income, countries intend to stimulate domestic R&D relative to other forms of investment, to discourage outbound shifting of related profits, and potentially to encourage *inbound* profit-shifting involving foreign-developed IP. By merely attracting IP *ownership*, however, this last objective may conflict with a country's desire to promote *domestic* R&D (Graetz et al., 2013) unless conditions are imposed that require the IP owners to participate in the underlying innovative activity. Such conditions, linking the location of taxable profits with real activity, are referred to as "nexus requirements" and are imposed to varying degrees across IP box countries. Regimes with no nexus requirements grant reduced tax rates on IP income regardless of whether the IP owner also developed the IP. Regimes with strict nexus requirements, however, may disallow preferential taxation for IP that was acquired rather than self-developed.

Due to the relative novelty and complexity of these IP box tax regimes, their effects on business investment remain largely unknown. Early research into the effects of IP boxes has focused primarily on patenting activity (as a proxy for R&D) and, to a lesser extent, on the (re)location of IP ownership (Bradley et al. (2015), Alstadsæter et al. (2018), Bornemann et al. (2019), Gaessler et al. (2021))) or on income shifting (Chen et al. (2018)). None of these studies considers one of the most important mechanisms through which business investment and the transfer of IP ownership currently takes place, namely, through merger and acquisition (M&A) deals. Intangibles are a dominant consideration in M&A transactions: Over the period 2009-2018, acquisitions of intangibles ($\approx$ IP) by U.S. firms alone tallied $6.7 trillion, or 65 percent of the fair market value of total acquired assets.[2]

[2]The median ratio of fair market value of acquired intangibles to total acquired assets is even higher—89 percent—and is growing over time. Not all intangible assets recorded in U.S. acquirers' purchase price allocations would necessarily be considered eligible IP for purposes of an IP box, but

Given the well-established impact of general corporate tax provisions on M&A decisions,[3] the importance of IP to economic growth and tax revenues, and the prominent role of M&As as a mechanism through which IP changes hands, the potential impact of IP boxes on M&A incentives is large. In this paper, we focus on M&As as an especially important form of investment in IP and examine whether IP box regimes create tax-induced distortions to ownership of IP via acquisitions of target firms. We hypothesize that IP box regimes may alter patterns of M&A activity involving IP assets through three different channels. These channels refer to incentives or motives that play a role in all M&A decisions.

The first channel—the synergy channel—is the standard mechanism through which M&A incentives are affected; it relates to the expected value of deal-specific synergistic gains (e.g., Andrade et al. (2001), Devos et al. (2009)). After being acquired, an IP-holding target may be able to achieve higher pre-tax returns on its IP assets by increasing sales, by raising prices through increased market concentration, or by cutting costs. If M&A transactions are expected to create higher pre-tax returns on assets that are taxed at preferential rates, then the introduction of an IP box regime should unambiguously raise the likelihood of acquisition by increasing the after-tax value of those gains.

The second channel—the tax rate arbitrage channel—relates to the relative attractiveness of a target firm resulting from differences in the effective tax rates between the target and its acquirer (Hanlon et al. (2010), Arulampalam et al. (2019)). In general, the ability to relocate income to a low-tax jurisdiction constitutes an advantage for foreign bidders relative to domestic ones. M&A-driven restructurings may thus constitute an important opportunity to relocate IP income in a tax-efficient manner (i.e., by masking the arm's-length price of specific assets). By shrinking the scope for achieving any further

these data nevertheless provide a useful means of quantifying the importance of IP assets to M&As, since their valuations are otherwise generally unobservable.

[3]For a sampling of relevant treatments, see e.g., Huizinga et al. (2009), Hebous et al. (2011), Voget (2011), Hanlon et al. (2015), Feld et al. (2016), Bird et al. (2017), or Arulampalam et al. (2019).

reductions in a target's effective tax rate through tax rate arbitrage, the introduction of an IP box in the target firm's country should reduce foreign acquirers' bidding advantage and thus reduce the probability of a cross-border acquisition of an IP-owning target.

The third channel—the transaction cost channel—relates to the discrete costs directly triggered by a legal change of ownership. In a tax context, shareholder-level or corporate capital gains taxes (Ayers et al., (2003, 2004, 2007), Todtenhaupt et al. (2020)) are the most prominent examples of such transaction costs. The nexus requirements of IP box regimes, with their differential treatment of acquired IP, constitute a distinct and novel transaction cost. In countries with strict nexus requirements, the exclusion of acquired IP as a source of eligible income and the resulting loss of preferential taxation represents a clear transaction cost for deals involving IP assets. In countries with more limited nexus rules, "further development conditions" require the new owner (i.e., the acquirer) to commit additional resources towards developing or improving the acquired IP to preserve eligibility for preferential taxation.[4] Only in IP box regimes with no nexus requirements do no new transaction costs arise.[5] The implementation of nexus requirements should thus unambiguously disincentivize the acquisition of IP-holding targets, showing stronger effects where acquired IP is explicitly disallowed from partaking in the preferential rate.

Our empirical strategy strives to distinguish the effects of IP boxes on M&A activity

[4]Note that the statutory language surrounding nexus requirements does not explicitly target *legal* changes in ownership of IP assets. However, the incentive effect for M&A is the same: When a country disallows preferential tax treatment to acquired IP by introducing nexus requirements, the country does so because it wants to reward creators—not *owners*—of IP assets. When enforcing these requirements, countries are expected to treat the acquisition of a company owning IP assets the same as the direct acquisition of the IP assets. Otherwise, nexus rules would be ineffective because they could be easily circumvented (Merrill (2016), OECD (2015)). OECD (2015) also notes that acquisitions include any transfer of IP rights. The statutory language surrounding the United Kingdom's IP box regime stipulates that IP acquired as part of the acquisition of a company must meet its nexus requirements. See https://www.gov.uk/hmrc-internal-manuals/corporate-intangibles-research-and-development-manual/cird210200.

[5]Historically, European Union (EU) member states—which serve as the focus of our analysis and include 12 IP box countries—were constrained by the EU Treaty in their ability to condition preferential tax treatment on strictly *domestic* R&D activity. Nevertheless, different regimes in the EU have imposed more or less stringent nexus requirements, and many of these provisions have been modified in recent years at the behest of the Organization of Economic Cooperation and Development (OECD).

via these channels by exploiting cross-sectional and time-series variation in regime and firm characteristics. Specifically, our tests quantify the extent to which reductions in the corporate tax rate on IP income relative to the ordinary corporate income tax rate (i.e., the "IP box tax savings rate") affect the volume of M&A deals and the likelihood that a target firm will be acquired.Using financial statement information for a large sample of European manufacturing-sector firms over the period 1994-2014, we apply country- and firm-level panel difference-in-differences (DD), triple-differencing (DDD), and event study methodologies to estimate deal counts and the probability of target acquisition as a function of country-level characteristics (including the characteristics of any applicable IP box regimes) and firm-level characteristics (including measures of IP holdings). Our sample firms come from sectors with high IP intensity (EPO and OHIM (2013)), for which IP boxes can be expected to have their strongest incentive effects. We use patent holdings as a proxy for IP ownership, consistent with previous studies (e.g., Griffith et al. (2006), Griffith et al. (2014), Bradley et al. (2015), Stiebale (2016), Alstadsæter et al. (2018)). This choice has the additional virtue that patents—unlike other IP assets—are considered qualifying IP across all IP box regimes. Our estimation strategy thus focuses on interactions of patent ownership, IP box tax savings rates, and nexus requirements in the context of either international or domestic M&A deals, allowing us to distinguish among the three hypothesized channels summarized above.

Strict nexus requirements, our empirical analyses show, unambiguously weaken M&A incentives. Reductions in the tax rate on IP income have significant negative effects on acquisitions of patent-owning target firms in IP box countries where acquisitions risk triggering the loss of preferential taxation of acquired IP. A 1 percentage point increase in IP box tax savings is thus associated with a 2.7 percent reduction in overall deal volume and a 1.3-2.4 percent reduction in the probability of being acquired for patent-owning firms in strict nexus regimes. In countries with no nexus requirements, these effects are reversed; greater IP box tax savings yield higher M&A transaction volume

and acquisition probabilities. Moreover, the negative (positive) effects of IP box tax savings in countries with strict nexus (no nexus) requirements are more pronounced for international (domestic) deals. We attribute the latter pattern to a lower cost of satisfying the nexus requirements (and hence remaining eligible for preferential taxation of IP income), along with a greater combined after-tax value of synergistic gains accruing to both the target and the acquiring firm when both entities have a pre-existing physical presence in the IP box country. Conversely, we find no evidence of important tax rate arbitrage effects, even in countries without nexus requirements.

Evaluating the normative implications of the effects of IP box regimes on M&A activity requires balancing fiscal revenue needs and R&D investment spillovers against the possibility of tax-induced distortions to capital ownership. Viewed through the lens of capital ownership neutrality (Desai et al. (2003, 2004), Weisbach (2014)), assets should be owned—independent of any tax considerations—by those firms with the highest reservation prices. Tax policies which distort asset ownership necessarily imply suboptimal exploitation of productive assets and, thus, economic inefficiency.[6] A risk implied by our results is that restrictive nexus requirements may prevent productivity-enhancing deals from taking place if the associated transaction costs outweigh the potential value of synergistic gains. From a national welfare perspective, nexus requirements ensure that IP boxes spur *domestic* innovation, and preventing owners of acquired IP from enjoying IP box advantages without further development reduces foregone IP box revenue costs. However, insofar as nexus requirements also discourage shifting IP assets into the IP box, the net effect on domestic corporate tax revenues is ambiguous. It may prove advantageous for countries with limited R&D capacity to welcome foreign-developed IP without imposing nexus rules. Yet from a global welfare perspective, the latter motive

[6]Consistent with this prediction, Todtenhaupt et al. (2017) find that tax incentives to engage in M&As distort the subsequent allocation of productive factors and thereby mitigate any potential productivity improvements resulting from the M&A transactions. Otherwise, Devos et al. (2009) report that over 80 percent of deal synergies are attributable to efficiencies in resource allocation, rather than to welfare-reducing increases in market concentration or tax planning.

for adopting an IP box clearly constitutes harmful tax competition (Merrill, 2016).

Our finding that strict nexus requirements unambiguously weaken M&A incentives is important in light of the OECD's report on Action 5 of the Base Erosion and Profit Shifting (BEPS) project (OECD, 2015). This report, which post-dates the period of our analysis, has resulted in OECD member countries agreeing to require some link between the location of R&D expenditures and IP income for their IP boxes. The OECD's so-called "modified nexus approach" can be viewed as a middle-ground reconciliation of the competing incentives to promote domestic innovation and to deter income shifting, while avoiding any sharp impediments to capital ownership neutrality.

The remainder of the paper is organized as follows: Section 2 describes the origins and general characteristics of IP box regimes, Section 3 presents a simple model of target acquisition and defines distinct channels through which to view the effects of tax and non-tax motives on M&A activity in relation to the adoption of an IP box, Section 4 describes our data and basic estimation methodology, Section 5 lays out our main results, and Section 6 concludes.

2. IP Box Regimes

2.1. Literature on Tax Policy and Investment

Economists have long explored ways in which tax policy impacts investment (Hall et al. (1967), Cummins et al. (1995), Goolsbee (1998), House et al. (2008)). The vast literature on this interaction covers many different taxes (e.g., individual, capital gains, corporate, etc.) and many different kinds of investments (i.e., fixed asset, domestic, international, portfolio, etc.). In a cross-border setting, a large number of studies examine the impact of taxes on foreign direct investment (FDI). Surveys and meta-analyses such as de Mooij et al. (2008) and Feld et al. (2011) find a substantial impact of taxation; the latter, for example estimate the semi-elasticity of FDI with respect to the corporate tax rate to be around 2.5.

The studies most closely related to ours look at the role taxation plays in mergers and acquisitions, focusing particularly on the corporate tax system in the target firm's country. For example, Ayers et al. (2007) explore the role of shareholder-level capital gains tax policy on corporate acquisition activity in a domestic U.S. setting. They find evidence of a lock-in effect, whereby periods of higher U.S. shareholder-level capital gains taxation result in higher transaction costs and hence fewer M&A deals. Focusing instead on the effect of corporate capital gains tax rates on acquisition activity in an international setting, Todtenhaupt et al. (2020) similarly find that acquiring firms are less likely to acquire targets located in countries with higher capital gains tax rates. In both studies, higher capital gains tax rates raise the sellers' reservation prices without altering the potential acquirers' willingness to pay, thereby reducing the buyers' bid premia and hence, the probability of a successful acquisition.

Xie et al. (2017) provide an overview of the literature on country-specific determinants of cross-border M&As. They propose that corporate income taxes in the target's host country will reduce the after-tax value of the additional income generated by the target as a result of the acquisition, such that a higher statutory tax rate in the target country should reduce the probability of acquisition. Arulampalam et al. (2019) test and confirm this proposition. Applying a multinomial logit specification, they report that a 1 percentage point increase in the statutory corporate tax rate of the target's host country is associated, on average, with a 1.2 to 1.7 percent reduction in the probability of an acquisition taking place. Hebous et al. (2011) instead use a binary logit and differentiate between M&A and greenfield investments. They find that the choice of locating an M&A investment in a specific host country has an elasticity of -0.278, with respect to the statutory corporate tax rate. Using a Poisson estimation technique, Herger et al. (2016) consider the effect of taxation on cross-border acquisitions based on aggregate count data. Taking multiple relevant taxes into account (except for the preferential taxation of IP) they find an elasticity of -0.40. We extend this strand of the literature by focusing

on the impact of preferential tax rates for IP income, while controlling for the impact of ordinary corporate income tax rates. This extension is particularly instructive, given the growing importance of IP in tax policy design and in firms' own M&A investment considerations.

2.2. Literature on Tax Policy and Innovation

Tax policy, given its perceived role as a key driver of productivity and economic growth, has historically been used to promote innovation by subsidizing investment in R&D. A large literature examines the effects of such policies on the location of R&D (e.g., Hines (1997)).[7] In addition to other important determinants of R&D activity—such as the presence of an educated labor force and high quality infrastructure—generous policies concerning the tax deductibility or creditability of R&D expenditures are found to attract R&D activity to certain locations (e.g., Bloom et al. (2002), Ernst et al. (2011)). More recently, concerns about profit shifting have led policymakers and researchers to turn their attention to the effects of tax policy on the location of IP *ownership* (Dischinger et al. (2011), Karkinsky et al. (2012), Griffith et al. (2014)), rather than R&D in general. Ultimately, where IP is created versus owned depends on multiple factors, including investment subsidies, R&D labor costs, the strength of IP protection, and the ease of relocating IP in relation to tax incentives and anti-avoidance provisions (Ernst et al. (2011), De Simone et al. (2018)).

By imposing a lower tax rate on IP income, IP box regimes promote *domestic* R&D investment in a way that is relatively indirect, when compared to investment subsidies.[8] Notwithstanding findings of real effects on patenting activity (Bradley et al. (2015), Alstadsæter et al. (2018), Bornemann et al. (2019), Gaessler et al. (2021)),[9] it is commonly

[7] See European Commission (2014) for a literature review.

[8] In concept, IP boxes may increase domestic R&D investment if they include binding nexus requirements, or if the related-party transfer of ownership of R&D outputs (e.g., patents) are subject to costly transfer pricing regulations (Griffith et al., 2014).

[9] IP box regimes generally grant preferential tax treatment to other types of IP income in addition to patents; yet, as patent application data is the most accessible measure of IP activity, researchers have

argued that IP boxes are poorly designed for stimulating new innovation (Gravelle (2016), Merrill (2016)). Nevertheless, the popularity of these regimes as a complement to traditional up-front R&D investment subsidies and as a tool to protect and expand the domestic tax base has grown extensively over the past decade, particularly in Europe.

2.3. IP Box Regimes

Table 1 describes the salient characteristics of the 12 IP box regimes adopted in the EU prior to 2016.[10] The single unifying feature across these regimes is the application of a lower preferential tax rate for patent income, albeit with considerable variation in these rates. IP box regimes otherwise differ widely in the breadth of other types of IP income that may qualify for the preferential tax rate, the treatment of acquired IP (and nexus requirements more broadly), and the treatment of related R&D expenses.

The most important point of divergence, in the context of M&A deals, is the regimes' treatment of acquired IP. Although the OECD's Action 5 Report post-dates our period of analysis—and hence, the nexus requirements we study—it is instructive to consider the OECD's framing: "[t]he basic principle underlying the treatment of acquired IP by the nexus approach is that only the expenditures incurred for improving the IP asset after it was acquired should be treated as qualifying expenditures. In order to achieve this, the nexus approach excludes acquisition costs from the definition of qualifying expenditures, and only allows expenditures incurred after the acquisition to be treated as qualifying expenditures. Acquisition costs would, however, be included in overall expenditures." Note that this last point characterizes the acquisition cost as a proxy for the target's overall R&D expenditures as of the date of acquisition.

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only recently begun looking at alternative measures (e.g., Pfeiffer et al. (2016)).

[10] Given the recent introduction of these regimes, researchers and practitioners disagree as to what constitutes an IP box. Thus, for example, Merrill (2016) excludes Cyprus but includes Israel, whereas most other lists of IP boxes do the reverse (e.g., Chen et al. (2018)). China's preferential tax rate for "high-tech" firms has many features of an IP box, but is generally not classified as one. We take the consensus view regarding IP box regime classifications, and focus on EU member states only. Non-EU countries with IP boxes (outside the realm of our analysis) include Israel, Liechtenstein, South Korea, Switzerland (Nidwalden Canton), and Turkey.

Nexus requirements then decide whether the acquirer's qualifying expenditures are "substantial" by looking to the ratio of qualifying expenditures to overall expenditures, called the "participation rate." In countries that allow acquired IP to qualify for the preferential tax rate without restrictions, this participation rate is 0. Conversely, in countries that disallow acquired IP, this participation rate is 100. Countries that place some limitations on acquired IP fall between 0 and 100. Thus, a simple way to think about the strictness of nexus requirements is to look at how the IP box regime defines "substantial." As both the numerator and the denominator of the participation rate are additive, we can see that in strict nexus regimes the acquirer would never qualify for IP box tax benefits; by definition, an acquiring firm could never incur qualifying expenditures equal to 100 percent of the overall expenditures needed to create the acquired IP. Though limited nexus regimes relax this requirement, taxpayers still face some uncertainty regarding what is a "qualifying" expenditure and what is "substantial"; from an operational perspective, they may be forced to make expenditures they would not otherwise make.[11] As of the writing of this paper, nexus requirements are continuing to evolve in response to the OECD's 2015 recommendations. Jurisdictions with IP box regimes are expected to ensure that taxpayers cannot circumvent nexus requirements by acquiring entities that own IP assets.[12]

The 12 IP box regimes also differ according to the treatment of existing IP (i.e., IP that existed prior to the date of IP box implementation), the breadth of qualifying forms of IP, and the tax deductibility of current R&D expenses, all of which are briefly defined in Table 1. We will return to a discussion of the latter two provisions below, given their relevance to other dimensions of regime generosity. Importantly, none of these provisions

[11]The UK regime, for instance, provides the following vague guidance to taxpayers: "The definition of qualifying development requires i) creating, or significantly contributing to the creation of, the patented invention; or ii) performing a significant amount of activity to develop the patented invention." and "Whether activity is significant will be determined in the light of all relevant circumstances"; see https://www.gov.uk/hmrc-internal-manuals/corporate-intangibles-research-and-development-manual/cird210190.

[12]See OECD (2015) note 18 and Merrill (2016).

overlap precisely with the treatment of acquired IP across countries, thereby allowing us to avoid conflating their effects with the impact of nexus rules.

3. M&A Incentives

3.1. Model

The premia that rival bidders are willing to pay for a target company, over and above the target's reservation price (i.e., the target's outside option), are a function of the extent to which the acquisition will generate incremental after-tax cash flows through deal-specific synergies. Deal incentives—and the role of tax and non-tax considerations—can be readily understood through the following model of target firm valuations. A numerical example in Appendix A.1 corroborates the model's intuition.

Target i's period-0 reservation price, RP_{i0}, equals the present value of its expected stream of after-tax profits, discounted at the world after-tax rate of return:

$$RP_{i0} = E\left[\sum_{s=0}^{\infty} \frac{(1-\tau_{is})(P_{is}Q_{is} - C_{is}(Q_{is}))}{(1+r_s(1-\tau_{is}^*))}\right], \tag{1}$$

where τ_{is} represents i's average effective tax rate (ETR); P_{is} and Q_{is} represent i's profit-maximizing output price and quantity; $C_{is}(\cdot)$ captures i's total cost of production; r_s is the real interest rate on a risk-free asset (common to all firms); τ_{is}^* measures i's marginal (statutory) tax rate on passive income; and s is the time subscript. Acquirer j's reservation price for target i, Bid_{ji0}, incorporates the target's own valuation, RP_{i0}, plus an acquirer-specific bid premium which reflects the expected changes in the target's after-tax

profitability resulting from the change of ownership.[13]

$$Bid_{ji0} = RP_{i0} + E\left[\sum_{s=0}^{\infty} \frac{(1-\tau_{is}) \cdot \Delta_j\big(P_{is}Q_{is} - C_{is}(Q_{is})\big) - \Delta_j(\tau_{is}) \cdot \big(P_{is}Q_{is} - C_{is}(Q_{is})\big)}{\big(1 + r_s(1-\tau^*_{is})\big)}\right], \tag{2}$$

where the Δ_j terms serve as shorthand notation denoting changes in the relevant determinants of target profitability brought about by acquirer j.[14,15] Decomposition of the second term in Equation (2) illustrates the primary mechanisms affecting bid premia ($E[\cdot] = Bid_{ji0} - RP_{i0}$):[16]

(I) *Synergies*: $\Delta_j\big(P_{is}Q_{is} - C_{is}(Q_{is})\big) > 0$; $\Delta_j(\tau_{is}) < 0 \Rightarrow Bid_{ji0} > RP_{i0} \Leftrightarrow$

i. Competition: $\Delta_j(P_{is}) > 0$ and/or

ii. Volume: $\Delta_j(Q_{is}) > 0$ and/or

iii. Efficiency: $\Delta_j\big(C_{is}(Q_{is})\big) < 0$ and/or

(II) *Tax Rate Arbitrage*: $\Delta_j(\tau_{is}) < 0 \Rightarrow Bid_{ji0} > RP_{i0}$

(III) *Transaction Costs*: $\Delta_j(\tau_{is}) > 0$; $\Delta_j\big(C_{is}(Q_{is})\big) > 0 \Rightarrow Bid_{ji0} < RP_{i0}$

Ultimately, an M&A deal between acquirer j and target i must necessarily yield the largest bid premium, net of transaction costs, relative to any other possible transaction involving either firm. Thus, acquirer j is the firm that can extract the largest tax savings from target i via tax rate arbitrage, for example, or that provides the most cost-effective distribution network, reduces market competition to the greatest degree, etc., or some

[13] In our model, as in tax studies more generally, the impact of taxation on forward-looking business decisions arises through changes in *anticipated* future after-tax cash flows. With the possible exception of net operating loss carryforwards—which our empirical analysis explicitly excludes from consideration—taxes paid or avoided in the past are sunk costs and are therefore irrelevant.

[14] More formally, one can think of P, Q, $C(Q)$, and τ as *functions* of the identity of the firm owner, and the Δ_j terms as denoting total derivatives with respect to the identity of owner j of the associated expressions. E.g., $\Delta_j\big(P_{is}Q_{is} - C_{is}(Q_{is})\big)$ measures the total change in pre-tax cash flow in period s resulting from acquisition by firm j.

[15] This formulation attributes all benefits of the acquisition to target cash flows. A more general formulation would also recognize the impacts of the acquisition on the profitability of the acquirer's pre-merger operations. For brevity, we do not model these here, but they carry similar implications.

[16] Unfortunately, we observe bid premia for only 3 percent of target firms in our sample, and so we are not able to evaluate empirically the effect of IP boxes on bid premia.

combination of these benefits. Conversely, any policy or regulation which diminishes acquirer j's tax advantages or which limits the exercise of market power, for instance, will reduce j's willingness to pay and, hence, reduce the probability of a successful acquisition. For an illustration of the opposing effects on bid premia (and hence deal probabilities) of transaction costs and synergies in all deal types, see the numerical example in Appendix Table A.1.[17]

3.2. Channels

As noted in Section 1, we hypothesize that IP box regimes alter patterns of M&A activity through three different channels. These channels, which we designate the *synergy* channel (I), the *tax rate arbitrage* channel (II), and the *transaction cost* channel (III), highlight incentives or motives common to all M&A decisions.

The *synergy* channel (I) encompasses all changes in the market environment that contribute to increased *pre-tax* cash flows, e.g., through higher prices ((I).i), higher sales volume ((I).ii), or lower costs ((I).iii) (Devos et al., 2009). In practice, ((I).i) arises when the consolidation of market power reduces competition and enables the merged entities to raise prices in an imperfectly competitive manner; ((I).ii) represents opportunities for market expansion, e.g. by expanding distribution and sales networks; and ((I).iii) reflects the various ways in which an acquiring firm confers costs savings on its target, e.g., through improvements to processes, management best practices, supply chain integration, elimination of redundant operations, economies of scale in production and distribution, etc. While cross-border M&A deals may produce larger synergistic gains because of the greater "gains from trade" (Ernst and Young (EY), 2015), it is also possible that target assimilation is more difficult. Gains attributed specifically to qualifying IP are likely to be larger for domestic deals, where increased returns to both the target and the acquirer

[17] We assume that the acquirers are able to retain at least a portion of the bid premium (deal surplus) and do not pay their full reservation price. In cases where targets are able to extract the full deal surplus, the potential acquirers would be indifferent to tax changes affecting the target firm (Arulampalam et al., 2019).

are eligible for a reduced tax rate on IP income.

Although numerous empirical studies document substantial improvements in target firm productivity following domestic acquisitions (e.g., Maksimovic et al. (2001), Wang et al. (2015)), most studies fail to find evidence of further positive effects resulting specifically from foreign acquisitions (Harris et al. (2002), Wang et al. (2015)). None of these papers has a specific focus on tax issues. We thus state our hypothesis concerning the *synergy* channel (I) as follows:

Hypothesis 1 (H1): *Synergy channel An expected increase in the after-tax value of deal synergies arising from the introduction of an IP box increases the likelihood of a potential target being acquired.*

The *tax rate arbitrage* channel (II) captures the idea that a tax-sophisticated acquirer may be able to effect reductions in a target firm's ETR by extending its superior tax minimization strategies to its target (Belz et al., 2017) as a result of acquirers and targets being subject to different tax systems and statutory rates (Huizinga et al. (2009), Voget (2011), Feld et al. (2016), Hanlon et al. (2015)).[18] The tax rate arbitrage argument is not unique to M&As; it extends to all opportunities for strategic income reallocation between affiliates of multinational groups, for which IP and intangible assets play a major role (Grubert, 2003). However, the complexity of an M&A transaction facilitates the relocation of IP (and related income) by masking the arm's length price of the underlying asset(s). Cross-border M&A transactions thus present special opportunities for restructuring operations in a tax-efficient manner. To the extent that the maximum bid prices of rival (foreign) bidders differ solely due to differences in the expected incremental *after-tax* cash flows, cross-border deals could fail to maximize pre-tax returns, in violation of the

[18]Tax planning strategies that are not related to a rate difference between acquirer and target, such as reductions in tax expense involving loss offsets, special deductions, private letter rulings, etc., are also applicable to domestic deals and so cannot be separated from other cost advantages. We therefore attribute those tax planning strategies to the *synergy* channel ((I).iii). For the *tax rate arbitrage* channel (II), tax-related cost reductions can therefore only occur in the case of international deals.

principle of capital ownership neutrality (Desai et al. (2003, 2004), Weisbach (2014)).

An IP box weakens the acquisition incentives related to tax rate arbitrage in the following way: by lowering the tax rate on IP-related income and thus lowering the ETR of a potential target, the IP box makes it more difficult for a foreign acquirer to exploit sophisticated income reallocation strategies to extract further tax reductions in relation to the target's assets.[19] Empirical evidence for the relevance of this argument is presented in Figure 1. As expected, average firm-level ETRs decline significantly after the introduction of an IP box regime. The coefficients in Figure 1 are estimated from a firm fixed effects regression with parsimonious controls for the ordinary corporate income tax rate and lagged pre-tax returns on assets, and they are allowed to vary according to the treatment of current R&D expenses across IP box countries (see Table 1), as well as by patent ownership.[20] The graph depicts the estimated firm-level ETR effects of a 1 percentage point reduction in the preferential tax rate on IP income following the adoption of an IP box regime.

As shown, average firm-level ETRs decline significantly in all cases—even among patentless firms—yet they decline further among patent-owning firms,[21] especially if current R&D expenses are deductible against gross income (i.e., at the standard corporate tax rate). Belgium's 27.2 percentage point reduction in the tax rate on IP income, for instance, is thus associated with an average post-IP box ETR reduction of roughly 9 percentage points among patent-owning firms.[22] Naturally, these tax savings should be

[19] On the other hand, the introduction of an IP box could conceivably render target firms more attractive to foreign bidders for purposes of shifting IP income *into* the targets, which could increase the likelihood for such targets to be acquired. On balance, this appears relatively unlikely given the existence of alternative solutions involving tax haven affiliates to achieve similar tax outcomes, but our analysis nevertheless allows for this possibility.

[20] The use of firm fixed effects in this analysis implies that identification revolves around within-firm changes in ETRs in response to changes in the taxation of IP income.

[21] Evidence of small, yet non-zero, reductions in ETRs for patentless firms corroborates the general point that patents are not the only source of eligible IP income in most IP box regimes.

[22] Evers et al. (2015) discuss various IP box provisions and calculate the combined theoretical impact on ETRs for IP income. Our estimates fall well below their theoretical calculations, but this is to be expected given our (obligatory) calculation of ETRs based on all sources of income and the wide variation across firms in terms of the share of income attributed to qualifying IP. For comparison, Bornemann

immediately capitalized into the firms' own higher reservation prices, thereby reducing the likelihood that they will be acquired by a more tax-efficient firm for the purpose of increasing target after-tax profitability through tax rate arbitrage. In domestic deals, which have no such opportunities for tax rate arbitrage, we should observe no effect of this channel.[23,24] We thus state our hypothesis concerning the *tax rate arbitrage* channel (II) as follows:

Hypothesis 2 (H2): *Tax rate arbitrage channel A reduction in tax planning opportunities arising from the introduction of an IP box decreases the likelihood of a potential target being acquired, specifically in international deals.*

The *transaction cost* channel (III) encompasses costs that arise as a direct consequence of changes in legal ownership. With respect to IP boxes, the application of nexus requirements to acquired IP imposes significant costs to completing a deal. They deny preferential tax treatment to IP income following an acquisition or—at a minimum—require the acquirer to engage in costly further development, even for fully-developed and commercialized technologies. As described in Section 2.3, IP box regimes differ in the extent to which R&D investment by the taxpaying entity constitutes a pre-condition for IP box eligibility. Permissive regimes grant preferential tax treatment to acquired IP, others require further development of acquired IP, while strict regimes exclude acquired IP altogether.

In our model, not allowing acquired IP raises the ETR for a target firm whose IP pre-

et al. (2019) report an average reduction in Belgian patent-owning firms' ETRs of 7.2 to 7.9 percentage points due to implementation of Belgium's IP box, but their analysis does not examine other regimes.

[23]Our definition of domestic deals excludes cases 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.

[24]In practice, to the extent that we are able to link targets' and acquirers' pre-deal tax rates for the set of M&A deals in our firm sample, it can be shown that acquirers face *statutory* tax rates that are 1.3 percentage points *higher*, on average, in their host country than do their targets, yet acquirers' *effective* tax rates are on average 4.5 (3.2) percentage points lower over the 3-year (1-year) pre-deal horizon; this spread widens to over 20 percentage points when considering the ETR of the lowest-taxed subsidiary within an acquirer's group. As expected, foreign acquirers' tax advantages relative to their targets are more pronounced than for domestic acquirers.

viously qualified for the IP box (i.e., $\Delta_j(\tau_{is}) > 0$) or raises unit costs ($\Delta_j\big(C_{is}(Q_{is})\big) > 0$). This threat of a *loss* of tax advantages or of increased costs as a result of being acquired should unambiguously reduce M&A activity, with the effects being more negative where nexus requirements are more restrictive. Domestic deals may be less negatively impacted than cross-border ones, since further development conditions may be easier to satisfy when both the acquirer and the target already have a physical presence in the IP box country. We thus state our hypothesis concerning the *transaction cost* channel (III) as follows:

Hypothesis 3 (H3): *Transaction cost channel An increase in the transaction costs of completing a deal arising from the introduction of an IP box with nexus requirements decreases the likelihood of a potential target being acquired.*

Table 2 summarizes our predictions about the effects of preferential taxation of IP income on acquisition probabilities via the synergy (I), tax rate arbitrage (II), and transaction cost (III) channels. Distinguishing between domestic and international deals highlights the variation in the role of these three different channels. We assume for purposes of illustration that all potential targets own eligible IP; however, in our analyses below, we explicitly account for patent ownership and exploit it as a source of identification (with the caveat that patent ownership does not perfectly capture all eligible IP). Naturally, higher (lower) probabilities of acquisition at the firm-level should be reflected in higher (lower) M&A transaction volumes at the country-level; hence, we begin our analysis in Section 5.1 with an evaluation of deal counts. As highlighted in Section 4, this approach has the virtue of allowing us to consider a much larger set of M&A deals than we can in our firm-level analysis of acquisition probabilities (Section 5.2), but it sacrifices our ability to condition on a wide array of firm characteristics.

4. Data and Methodology

4.1. Data Sources

The data for our analyses combine unconsolidated firm-level financial statement and M&A transaction data from Bureau van Dijk's (BvD) Orbis and Zephyr databases for the period 1994-2014, and we link these with patent application information from PATSTAT using BvD's assignment of 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 2016; of these, 14.7 million are recorded as granted (i.e., awarded legal protection). We then merge these granted patents according to the identity of the patent applicant(s)[25] with the universe of actual and potential M&A target and acquiring firms covered by the BvD data.[26]

We complement the firm-level data with a set of country-level macroeconomic control variables drawn from the World Bank's World Development Indicators database. 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. As a measure of non-tax sources of government support for R&D, we use data from the European Commission on block-exempted state-aid for innovation. Evers et al. (2015) and Merrill et al. (2012) serve as our main sources of information on preferential IP box tax rates and special provisions. We compile additional corporate and withholding tax rate data from several sources, including corporate tax guides from EY and PwC, as well as Comtax.

[25] As discussed in Quick et al. (2006), legal patent ownership generally accrues to the applicant(s) registering the patent and need not bear any relationship to the patent office from which the protection is sought. We hence refer to patent applicants and owners interchangeably.

[26] Based on the World Intellectual Property Organization's definition of the duration of patent protection, which reaches a maximum of 20 years in a wide range of countries, we exclude patents granted prior to 1978. Where applicable, we assume that firms benefit from patent protection for 20 years from the grant date.

4.2. Sample Restrictions and Distribution

The statutory requirements for filing unconsolidated financial statements vary across countries, giving rise to a wide variation in the number of useable observations available through Orbis. As a result, U.S. firms, for instance, would be vastly underrepresented in our matched Orbis-Zephyr-PATSTAT sample for purposes of our firm-level analysis. Adding the fact that IP box regimes remain predominantly an EU phenomenon, we consequently restrict our analysis to the EU-28 member states. To exploit patent ownership as a source of identification, we emphasize directly-owned patents and disregard indirectly-owned patents (for which the owner-applicant is a subsidiary of the firm under consideration) given that indirectly-owned patents are unlikely to be eligible for preferential taxation in the parent firm's home country. 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 terminate our sample estimation period in 2014. This excludes from possible consideration the initial impacts of the most recent IP 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 IP boxes that were in effect as of 2014.

In order to improve the power of our firm-level analysis of the probability of being acquired, we focus exclusively on manufacturing-sector firms, where patent ownership is most heavily concentrated and where IP boxes are consequently most likely to constitute a relevant consideration. Concretely, we select firms in sectors 32 and 33 of the North American Industry Classification System (NAICS). 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 percent of M&A targets over our sample period.[27]

[27]Consistent with our sectoral selection criterion, 97.2% of observations in our final sample come

After applying these country, year, and industry restrictions to our data set, we preserve only those firms whose financial statements meet minimal data quality requirements for three consecutive years. Firms must report non-missing and non-zero information for total assets, earnings before interest and taxes (EBIT), and taxes paid over a three-year period. We exclude any remaining firms that never report more than $1 million in total assets (which is near the median value of firm size in our sample).[28] Firms that report being in a net loss position over at least three prior years are likewise omitted.

Our final firm-level sample consists of just over 1.2 million observations, representing nearly 230,000 individual firms. These firms collectively own just under 8 percent (870,000) of all granted patents held by manufacturing-sector firms in the BvD data as of 2014. Patent ownership is nevertheless highly concentrated, and M&A transactions constitute rare events. Only 12.6 percent of the firms in our sample ever own patents, and a mere 0.19 percent of firms are acquired in any given year. Among those firms that are acquired, however, 28.7 percent were patent owners at the time of acquisition, consistent with the notion that IP ownership is an important determinant of M&A activity.

The distribution of M&A transactions by country—without conditioning on industry or the availability of complete firm-level financials—is reported in the first column of Table 3, followed by the number of observations, unique firms, and M&A deals in our firm-level estimation sample.[29] Our deal count sample encompasses 95,000 M&A deals over the period 1997-2014 involving targets in the EU-28 with known patent ownership.

from high IP intensity sectors, as defined by the industry-level analysis and classification system of the European Union's Office for Harmonization in the Internal Market and the European Patent Office (EPO and OHIM, 2013).

[28] When we restrict our analysis to the largest 20 percent of firms, as measured by total assets, our results (not shown) are qualitatively unchanged.

[29] For a complete tabulation of country-year observations for IP box and non-IP box countries, see Appendix Tables A.2 and A.3, respectively. The data offer spotty coverage for a small number of countries and years, but there is no reason to expect this to constitute a threat to identification since these data availability issues are unrelated to the timing or location of IP box implementation. We confirm that our main results are not unduly influenced by these missing data by performing a series of sensitivity tests involving dropping all observations for the period 1994-1996; all observations for firms located in BG, CZ, DK, FI, HR, RO, and SK; or both. These results are available upon request.

To the extent that BvD provides estimates of a deal value for these transactions, the total sample is valued at $6.5 trillion, of which $1.7 trillion accrues to patent owners. As shown, the distribution of M&A transactions in our full sample roughly mirrors the scale of economic activity across EU member states, although this pattern is somewhat distorted by conditioning on the availability of three consecutive years of clean financial statement information. Whereas Italy, Spain, and France thus account for more than half of the observations in our firm-level sample,[30] the concentration of M&A activity is more diffuse. Consistent with more general patterns of business dynamism, northern EU member states thus show generally higher rates of M&A activity than the more southern or eastern member states. Conversely, there is no clear evidence of higher or lower rates of M&A activity in IP box regime countries, except insofar as this group includes several of the smallest EU countries (i.e., Cyprus, Luxembourg, and Malta). These small countries—along with Hungary and Ireland—are unlikely to have much influence on our firm-level analyses, but we include them for completeness.

4.3. Empirical Model and Variable Definitions

Following the set of predictions discussed in Section 3, we model (1) the number of acquisitions and (2) the probability of a firm being acquired as functions of target country and firm characteristics, exploiting cross-sectional and time-series variation in the implementation of IP box regimes and ownership of innovative assets (i.e. patents) to identify their effects on M&A activity through three different channels.

At the country level, the number of targets in country c that are acquired in year t

[30]The (over)representation of Italian or Spanish firms (relative to German firms, for example) largely reflects the set of countries for which financial statement information is most widely available through Orbis, whether because of country-specific requirements pertaining to financial statements, variation in the prevalence of privately-held businesses, or simple variation in BvD's data collection effort and technology. Lack of a representative distribution across countries would be problematic only if acquired firms were differentially more or less likely to be included in the sample due to unobserved factors related to international taxation, which is unlikely. While our firm-level analyses reflect greater (implicit) weighting of certain countries by virtue of the greater prevalence of observations from those countries, this issue does not affect our country-level analysis of M&A volume.

in our most basic specification is thus:

$$TargetCount_{ct} = \alpha + \vec{\beta} \cdot \mathbf{I\vec{P}Box_{ct}} + \vec{\theta} \cdot \mathbf{\vec{Tax_{ct}}} + \vec{\psi} \cdot \mathbf{\vec{W}_{ct}} + \eta_c + \zeta_t + \varepsilon_{ct}, \tag{3}$$

where $\mathbf{I\vec{P}Box_{ct}}$ represents a vector of IP-specific country-level tax characteristics featuring interactions of our categorical nexus requirement indicators, $I[LimitedNexus]$ and $I[NoNexus]$, with $IPBoxSavings$, a measure of the generosity of IP box taxation relative to the treatment of other sources of income (defined as the difference between the statutory corporate income tax rate, CIT, and the preferential tax rate applied to IP income). $\mathbf{\vec{Tax_{ct}}}$ represents a vector of country-level tax characteristics unrelated to IP boxes, while $\mathbf{\vec{W}_{ct}}$ includes additional time-varying target country non-tax characteristics. Time-invariant country fixed effects are captured by η_c, and year fixed effects by ζ_t.

To extend this panel difference-in-difference count data model, we differentiate deal counts by the patent holdings of the target firm in the pre-deal period, thus splitting the country-year counts into two observations:

$$\begin{aligned} TargetCount_{ct} = \alpha + \vec{\beta} \cdot \mathbf{I\vec{P}Box_{ct}} + \gamma \cdot I[OwnPatent]_{ct} + \vec{\delta} \cdot \mathbf{I\vec{P}Box_{ct}} \times I[OwnPatent]_{ct} \\ + \vec{\theta} \cdot \mathbf{\vec{Tax_{ct}}} + \vec{\psi} \cdot \mathbf{\vec{W}_{ct}} + \eta_c + \zeta_t + \varepsilon_{ct}, \end{aligned} \tag{4}$$

where $I[OwnPatent]_{ct} = 1$, denotes the subset of deals involving targets with at least one directly-held patent prior to acquisition. Poisson maximum likelihood estimation of $\vec{\delta}$ thereby allows us to test for differential effects of IP box taxation on the number of acquisitions involving patent-owning firms, while controlling for a large set of other tax and non-tax determinants of M&A activity at the country level.

At the firm level, we model the probability that firm i in industry j and country c is

acquired in year t in a very similar manner:

$$Pr(Acquired_{ijct} = 1) = \alpha + \vec{\beta} \cdot \mathbf{\vec{IPBox_{ct}}} + \gamma \cdot I[OwnPatent]_{ijct-1} + \vec{\delta} \cdot \mathbf{\vec{IPBox_{ct}}} \times I[OwnPatent]_{ijct-1} + \vec{\theta} \cdot \mathbf{\vec{Tax_{ct}}} + \vec{\psi} \cdot \mathbf{\vec{W}_{ct}} + \vec{\rho} \cdot \mathbf{\vec{X}_{ijct-1}} + \mu_j + \eta_c + \zeta_t + \varepsilon_{ijct}, \quad (5)$$

In addition to the regressors described above, $I[OwnPatent]_{ijct-1} = 1$ for target firms with at least one directly-owned patent as of the prior year, and $\mathbf{\vec{X}_{ijct-1}}$ represents a vector of lagged firm-level financial characteristics. Time-invariant target industry fixed effects (defined at the NAICS 4-digit level) are captured by μ_j.

In practice, $\mathbf{\vec{Tax_{ct}}}$ consists everywhere of the statutory corporate income tax rate (alone and interacted with the corresponding country- or firm-level indicator of patent ownership) which should affect "ordinary" tax motives for M&A activity. We also include $I[HighRoyaltyTax]$, an indicator for whether royalties received by the target firm would be taxed abroad at a rate in excess of the tax rate on IP income. Any preferential tax treatment of IP income in the target would be negated by high withholding taxes on royalty payments to the target, and thus be less likely to yield benefits from foreign market expansion following the acquisition. $\mathbf{\vec{X}_{ijct-1}}$ and $\mathbf{\vec{W}_{ct}}$ consist of a large set of firm- and country-level controls common to the literature on M&A activity.[31] These include lagged measures of a firm's 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, contemporaneous country-level controls also include measures of economic output; the size of the labor force; unemployment; the importance of aggregate stock market capitalization, exports, and block-exempted state aid for innovation relative to GDP; inflation; the real

[31] See Harford (1999) for a list of typical financial factors affecting acquisition decisions. Our analysis closely follows the set of controls included in Arulampalam et al. (2019) and Belz et al. (2017).

effective exchange rate; and an index of economic freedom. Definitions of these and all other regression variables appear in Tables 4 and 5.

Beyond the inclusion of these numerous controls, it is important to note that our use of country, year, and industry fixed effects implies that the source of identification for our main analyses is based on inter-temporal within-country variation in the tax treatment of IP income, combined with cross-sectional variation in firm-level patent holdings. Our empirical strategy thus consists of panel DD and DDD specifications, whereby target firms are differentiated by the timing and country of their eligibility for preferential treatment of patent income *and the applicability thereof*, which hinges on patent ownership. We formalize our DDD strategy by extending Equation (5), replacing $\eta_c + \zeta_t$ with a set of country-year *pair* fixed effects. We report these results alongside our main firm-level tests in Section 5.2. This latter fixed effects strategy necessarily precludes estimating separate baseline country-level tax effects for patent-less firms (as well as any other country-level variables), while emphasizing the differential effects of IP box taxation on patent-owning firms. Although there is no evidence from policy discussions to suggest that European IP boxes were adopted in response to patterns of M&A activity, this narrower identification strategy has the additional virtue of eliminating possible bias resulting from tax policy endogeneity and provides assurance that our main results are not unduly influenced by violations of the Stable Unit Treatment Value Assumption that may arise in cross-country policy analyses (Armstrong et al., 2018).

4.4. Descriptive Statistics

The mean values of the regression variables used in our firm-level analysis of acquisition probabilities are presented in Table 6, with sample means computed separately depending on whether firms were acquired in the corresponding period. Columns 1-3 compare variable means over the full sample period between the set of firms that were not acquired (Column 1) and those that were acquired, either as part of an international deal (where the acquirer or its corporate ultimate owner was located in a different coun-

try from the target, in Column 2) or a domestic deal (Column 3). Statistically-significant differences in means between non-acquired and acquired firms of each type are designated in the conventional manner. Columns 4-6 present comparable information exclusively for firms at the end of our sample period.

As the table shows, target firms—especially those acquired in international deals—differ from non-acquired firms in many significant ways. Focusing on 2014 values (to avoid compositional effects related to historical variation in M&A activity in the full-sample summary statistics), target firms are nearly twice as likely to hold patents and more than twice as likely to have applied for a new patent in the last five years. These target firms also face lower effective tax rates, earn higher rates of return, and are generally larger and less leveraged. Targets acquired through international deals are significantly more likely to be multinationals themselves; they 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 way in terms of capital expenditures or growth, or in the probability of being publicly-listed.

Among the subset of firms located in IP box countries, target firms are disproportionately concentrated in regimes that offer *less* generous treatment of IP income (as measured by $IPBoxSavings$), especially for international deals. This loosely suggests that tax rate arbitrage opportunities may play a role in motivating cross-border M&A transactions (i.e., since more favorable IP taxation leaves less scope for further deal-driven reductions in target ETRs), but this characterization fails to account for the impact of additional provisions related to the treatment of acquired IP or other firm- and country-level determinants of M&A activity. To the extent that any of the characteristics in Table 6 may be spuriously correlated with the temporal or geographic distribution of IP box regimes and M&A activity, these statistics confirm the importance of controlling for

these attributes in our analyses of M&A deal counts and acquisition probabilities using panel estimation methods.

5. Results

5.1. Country-Level Deal Volume

Columns 1, 2, 4, 5, 7, and 8 of Table 7 present the Poisson maximum likelihood coefficient estimates from our basic country-level specification (3), which involves interactions of IP box tax savings rates ($IPBoxSavings$) and patent-owning firms ($I[OwnPatent]$).[32] Standard errors are clustered at the country level. For brevity, we report the coefficient estimates only for the key tax and IP box interaction terms; complete results are reported in Appendix Table A.4.

As shown in Table 7, without differentiating among nexus requirement types, the adoption of a reduced tax rate on IP income has a marginally significant positive impact on the number of acquisitions in the full deal sample (Column 1), and the magnitude of this effect is statistically indistinguishable between patent-less and patent-owning targets (Column 2). The coefficient of 1.184 in Column 1 thus implies that a 1 percentage point increase in $IPBoxSavings$ is associated with a 1.2 percent increase in acquisition volume at the country level.[33] By way of comparison, a 1 percentage point across-the-board reduction in the CIT is associated with a 2.6 percent increase in M&A activity, consistent with the broader applicability of such a tax change to all sources of corporate income.

Columns 3, 6, and 9 of Table 7 show the results of our augmented model (4). This specification allows for differentiated effects of $IPBoxSavings$ as a function of both patent ownership and nexus regime type by including indicators of the strictness of

[32] Discrepancies in observation counts between paired specifications in Table 7 reflect the fact that some country-years in our sample involve no acquisitions of known patent-owning targets.

[33] Transforming the estimated Poisson coefficient into the partial effect of a 0.01 unit increase in $IPBoxSavings$ yields $(e^{(1.184*0.01)} - 1) * 100 = 1.19\%)$.

nexus requirements, $I[LimitedNexus]$ and $I[NoNexus]$. IP box regimes with strict nexus requirements constitute the reference group. These interactions—along with the comparisons across deal types in the different columns—tease out the various effects hypothesized in Table 2. The results in Column 3 highlight the importance of nexus requirements, especially as they pertain to patent-owning targets. A higher IP box tax savings rate in countries with strict nexus requirements, where acquisitions risk triggering a loss of preferential tax treatment for patent income, is associated with a significantly lower number of M&A deals involving patent-owning firms, as evidenced by the coefficient on the $IPBoxSavings \times I[OwnPatent]$ interaction term. This effect is partially or fully undone in regimes with limited or no nexus requirements, as shown in the corresponding triple interactions.

The results in Table 7 thus suggest a modest net positive impact of IP box regime adoption on the volume of M&A activity occurring at the country level, and these impacts are more pronounced in IP boxes with no restrictions on the eligibility of acquired IP where patent-owning target firms are involved. Absent nexus requirements, the synergy channel (I) thus appears to dominate the tax rate arbitrage channel (II). Indeed, comparing the results in Columns 4 through 9 across subsets of cross-border and domestic M&A deals emphasizes that the all-deals results are largely driven by the greater number of transactions in the domestic M&A market. In contrast, the adoption of IP box regimes appears to have no significant *net* effect on cross-border deal activity. This lack of effect hints at a countervailing negative impact of tax rate arbitrage, but domestic deals may also afford larger synergistic gains due to the IP box eligibility of increased profits flowing from operations of *both* the target and acquiring firms. Alternatively, this result may also reflect the broader finding in the literature that larger target productivity gains follow domestic acquisitions (Maksimovic et al. (2001), Wang et al. (2015)).

Naturally, insofar as IP box characteristics may be spuriously-correlated with firm-level determinants of M&A activity (e.g., due to industry consolidation trends, firm-

specific tax planning and investment opportunities, etc.), these could coincidentally give rise to the appearance of negative (positive) impacts of $IPBoxSavings$ on deal volume in countries with strict (limited or no) nexus requirements for reasons unrelated to preferential IP taxation. Having established general patterns of M&A activity in relation to the characteristics of IP box regimes—including the importance of nexus requirements—over a large sample of M&A deals at the country level, we next turn to our evaluation of acquisition probabilities in our more limited sample of manufacturing-sector firms where these underlying firm-specific characteristics can be taken into account.

5.2. Firm-Level Acquisition Probabilities

Table 8 presents the ordinary least squares regression estimates for our main firm-level specification. Here we assess the combined impact of IP box tax savings, nexus provisions, and a firm-specific indicator of (lagged) patent ownership, $I[OwnPatent]_{t-1}$, on a firm's likelihood of being acquired.[34] For purposes of legibility, the dependent variable is set equal to 100 for firms acquired in an M&A deal and zero otherwise.[35] Columns 1 through 3 reflect our primary panel DD identification strategy involving the use of country and year fixed effects. Since unobserved country $\times$ year-specific factors could theoretically influence our results (e.g., Spain's adoption of its IP box regime immediately prior to the global financial crisis), we extend our primary analysis to incorporate country $\times$ year *pair* fixed effects in Columns 4 through 6. This latter approach imposes an even narrower DDD identification strategy which explicitly leverages variation in patent ownership while absorbing all country-year-specific influences on M&A activity for patent-less firms. With this narrower approach, however, we cannot separately identify IP box effects on patent-

[34] We estimate equation (5) as a linear probability model to allow for consistent estimation of fixed effects as well as 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 readily-interpretable marginal effects for interacted regressors. Linear probability models generally perform well in these types of applications (Wooldridge (2010); p. 563).

[35] Multiplying our binary dependent variable by 100 re-scales our coefficient estimates so that they can be directly interpreted as *percentage point* impacts on the probability of acquisition.

less firms which could arise for a variety of reasons: most notably, the eligibility of other forms of IP for preferential taxation. We hence view both sets of specifications as instructive.

For brevity, we report the coefficient estimates for the key interaction terms in the upper half of Table 8 followed by their implied marginal effects, expressed as the relevant sum of partial effects attributable to a one unit change in $IPBoxSavings$; these are scaled by the corresponding unconditional probability of acquisition for patent-less and patent-owning firms, as appropriate. The latter semi-elasticities measure the effect of a one percentage point change in $IPBoxSavings$ as a percent change in the predicted probability of acquisition. Robust standard errors are calculated allowing for two-way clustering at the country and year levels. The full set of coefficient estimates, including those of our numerous control variables, is shown in Appendix Table A.5. These estimates generally have the predicted sign, but given the rarity of M&A transactions, overall model fit remains low.

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 effects of the synergy channel (I), the tax rate arbitrage channel (II), and the transaction cost channel (III), summarized in Table 2. In contrast, looking at Column 1 of Table 8, we see that—holding ordinary corporate tax rates fixed—lower tax rates on IP income (i.e., larger $IPBoxSavings$) have a negative impact on the probability of a target firm being acquired in an M&A deal when acquired IP is disallowed preferential tax treatment (i.e., $I[LimitedNexus]$ and $I[NoNexus]$ are both zero). This negative effect is significantly more pronounced when the target is also a patent owner, consistent with the idea that IP-owning target firms become less attractive in IP box countries where acquisition risks triggering a loss of IP box eligibility for IP income or may require costly further development. The addition of country-year pair fixed

effects in Column 4 yields very similar point estimates of $IPBoxSavings$ effects among patent-owning firms, thereby rebutting concerns related to the potential confounding influence of unobserved country-year-specific determinants of M&A activity or tax policy endogeneity in our primary specification.

Our theory predicts that the transaction cost channel (III) has a negative effect on deal probabilities for IP-owning target firms in countries which, through nexus requirements, may limit preferential tax treatment to acquired IP. The significant negative coefficient on the uninteracted $IPBoxSavings$ term in Column 1 (-0.473; p-value < 0.05) is indicative of patent ownership being an imperfect proxy for IP box eligibility. As shown in Table 1 and discussed previously, most IP boxes apply to various forms of IP besides patents, which we do not observe. Furthermore, our ability to identify patent-owning firms is constrained by BvD'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, be on the verge of receiving patent protection for a prior application, or simply own other forms of qualifying IP. Depending on the prevalence of mismeasured IP box eligibility, this will result in smaller estimates of the differential effects of patent ownership without inasmuch sacrificing the full benefits of differentiating firms in this manner for the purposes of identification and policy relevance.[36]

In terms of economic magnitude, the combined coefficients on $IPBoxSavings$ and $IPBoxSavings \times I[OwnPatent]_{t-1}$ in Column 1 imply that a 1 percentage point increase

[36]To test this conjecture, we repeat our main analyses for the subset of IP box regimes that extend preferential taxation only to income derived from patents and supplementary protection certificates (Belgium, France, Ireland, and the UK; see Table 1). As reported in Appendix Table A.6, IP box tax savings have an insignificant effect on the probability of acquisition for patent-less firms in this select set of regimes, regardless of nexus provisions, but the effects are large and statistically significant among patent owners. Moreover, the differential effect of $IPBoxSavings$ for patent owners is relatively larger in both the negative direction (in regimes with more restrictive nexus requirements) and the positive direction (in regimes with no nexus requirements) than in the full-sample specifications—precisely as expected from this narrower delineation of IP box eligible and ineligible firms. In a similar vein, when we broaden our definition of IP box eligibility to include recent patent *applicants* in the full country sample, we find marginally weaker baseline IP box tax savings effects among patent-less firms and stronger differential tax savings effects among patent owners/applicants (results available upon request).

in IP box regime generosity in countries with strict nexus requirements is associated with an overall reduction in the probability of a patent-owning firm being acquired of 2.428 percent (p-value < 0.01). The comparable figure in Column 4 (identified solely from within-country-year variation due to patent ownership) implies an $IPBoxSavings$ semi-elasticity of 1.311 percent (p-value < 0.05). Assuming an average level of $IPBoxSavings$ of 18.5 percentage points, the complete *exclusion* of acquired IP from preferential taxation by countries with strict nexus rules is thus associated with a 24 to 45 percent reduction in the probability of acquisition among patent-owning firms.[37]

When we further differentiate among countries extending preferential treatment to acquired IP, the negative effect of IP box regimes on the likelihood of being acquired dissipates, especially in the most permissive regimes, as indicated by the positive coefficient across all deal types on the triple interaction, $I[NoNexus] \times IPBoxSavings \times I[OwnPatent]_{t-1}$. The net effect on deal probabilities for IP-owning targets resident in IP box countries with either limited or no nexus requirements is not significantly different from zero in Columns 1 through 5, while it is positive and significant in the case of domestic deals occurring in countries with no nexus requirements (Column 6).[38] Thus, we find strong evidence that the transaction cost channel (III) acts as a deterrent to M&A activity in countries with strict nexus requirements. Comparing international and domestic deals (Columns 2 and 5, versus 3 and 6) reveals that the negative effect of nexus requirements arises primarily in cross-border deals, consistent with the idea that

[37] Our estimated $IPBoxSavings$ semi-elasticities translate to elasticities of 0.24 to 0.45 with respect to tax reductions resulting from preferential taxation of IP income. For comparison, Hebous et al. (2011) report that a 1 percent increase in targets' host-country CIT is associated, on average, with a 0.3 percent reduction in the probability of an acquisition taking place in that country; Arulampalam et al. (2019) report comparable elasticities of -1.2 to -1.7. In their meta-analysis, Feld et al. (2011) report an average semi-elasticity of foreign direct investment with respect to tax rates of -2.5. As such, the size of our estimated IP box effects fall well within the range of related investment elasticities.

[38] The overall effect on international deals for patent-less firms in countries without nexus requirements, however, remains negative in Column 2 (p-value < 0.1), perhaps suggesting a disincentive for foreign acquirers to purchase targets with "yet-to-be-patented" technologies. Given OECD recommendations (and eventual agreement to adopt the OECD's modified nexus approach for the calculation of qualifying income), potential acquirers may have expected nexus requirements to strengthen over time, meaning that acquired in-process IP might fail to qualify for preferential taxation in the future.

requirements to further develop acquired IP may be more easily satisfied in domestic deals.

The transaction cost channel (III)—even in the absence of nexus requirements—is insufficient to justify *increased* M&A activity, however. The positive and significant coefficient on the interaction term $I[NoNexus] \times IPBoxSavings \times I[OwnPatent]_{t-1}$ in Columns 3 and 6 provides evidence of the relative importance of the synergy channel (I) for domestic deals, consistent with the results of our country-level deal volume analysis in Section 5.1. In contrast to international deals, in domestic deals all synergistic gains attributable to both the target and the acquirer's original IP are potentially eligible for preferential taxation, and these incentives are particularly strong in countries that extend preferential treatment to acquired IP ($I[NoNexus] = 1$). The point estimates in Columns 3 and 6 for 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, with implied semi-elasticities for patent-owning firms of 3.602 (p-value = 0.164) and 2.177 (p-value$<$ 0.05), respectively.

5.3. Heterogeneous Firm-Level Acquisition Probabilities

To test the importance of the synergy channel (I) and further corroborate the preceding interpretation, we perform several additional tests of firm-level heterogeneity (which we describe in greater detail in Appendix A.2). First, we differentiate firms according to their growth opportunities, as measured by firms' (lagged) capital expenditures (Appendix A.2.1). Capital expenditures serve as a leading indicator of firms' own expected growth, and thus presumably the value of potential synergistic gains that may be attributed to faster-growing target firms' incremental pre-tax cash flow in the post-deal period. We hence extend the specifications shown in Columns 4 through 6 of Table 8 with appropriate interactions of capital expenditure growth and IP box terms; our results appear in Appendix Table A.7. As expected, the effects documented in the previous section (both positive and negative) are generally amplified among faster-growing patent-owning

firms. High growth patent-owning targets face a significantly higher (lower) probability of acquisition in countries with no (strict) nexus requirements than do their lower growth counterparts. This result is consistent with the notion that higher growth potential is associated with commensurately larger synergistic gains and hence, a greater impact of preferential taxation on M&A incentives.[39]

A similar argument holds that the strength of IP box incentive effects on M&A activity should be increasing in the amount of a income that is attributable to firms' IP holdings. Differentiating firms according to a binary indicator of patent ownership draws a sharp distinction between those with and without access to this source of qualifying IP income but also masks potentially important variation in patent value. We check this prediction using two different measures of firm-level patent quality. These tests are described in greater detail in Appendix A.2.2, and their results are reported in Appendix Tables A.8 and A.9. These results largely bear out the foregoing prediction and help to corroborate our main findings as reflecting a direct consequence of IP box adoption.

5.4. Intertemporal Firm-Level Acquisition Probabilities

To the extent that the important characteristics of IP box regimes could be learned before formally going into effect, firms may have acted in *anticipation* of their implementation by either accelerating or delaying M&A transactions to best exploit the relevant IP box tax advantages or disadvantages. For example, firms may have sought to pre-empt the imposition of nexus requirements by acquiring IP prior to regime implementation. Anticipation effects of this sort would violate the parallel trends assumption underlying our panel DD/DDD identification strategy and would tend to bias our estimated IP box effects toward zero. More broadly, simple pre-/post-IP box comparisons—as the pre-

[39]This pattern is especially pronounced in international deals. The absence of stronger differential effects of target capital expenditures for domestic deals is indicative of the relative value of synergistic gains accruing to the *acquirer's* own operations, as well as the possibility—documented in Wang et al. (2015)—of greater scope for *post-deal* target firm growth in domestic acquisitions. See Appendix A.2.1 for further discussion.

ceding analysis implicitly emphasizes—might correspondingly fail to pick up important trends in firms' responses both before and after IP box adoption.

We consequently extend our previous analyses from Section 5.2 by applying an event study design, which allows us to test explicitly for leads and lags of IP box incentive effects. For each IP box country, we define period $t = 0$ as the year of regime adoption and construct a full set of binary indicator variables flagging periods $t = -2$ through $t = 2$. Two additional endpoint indicators take on values of 1 for all periods at least 3 years before or after regime adoption. We then use each of these indicators to construct interactions with our measures of period $t = 0$ IP box tax savings and nexus requirements.[40] As a final normalization, we constrain our estimates of IP box effects in period $t = -3$ (including earlier years) to be zero, such that our remaining estimates for periods $t = -2$ through $t = 3+$ are interpreted as differential effects relative to this base period.[41] This approach yields a modified empirical model in which each component of the vector of IP box characteristics from Equation (5), $\mathbf{IP\vec{B}ox_{ct}}$, is replaced with 6 period-specific regressors. As before, each of these terms is further interacted with $I[OwnPatent]_{t-1}$ to differentiate intertemporal IP box effects as a function of patent ownership. This procedure yields a total of 36 period-specific IP box-related regressors in a single specification. All other elements of our main empirical specifications including controls and fixed effects remain unchanged.

The results from these event study analyses are depicted graphically in Figure 2. Panels (a), (c), and (e) on the left report the estimated effects of regime adoption on interna-

[40] Spain introduced an IP box in 2008. 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 an IP box, all of these terms are uniformly zero. For IP box regimes that change provisions over time, we use the set of provisions that were in effect at the time of initial regime adoption.

[41] This normalization implicitly assumes that firms could not have anticipated the effects of IP 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 IP box enactment (France).

tional deals, assuming an IP box tax savings rate near the median level of regime generosity (i.e. $IPBoxSavings = 0.15$). Our results for domestic deals are split across the three panels on the right. Panels (a) and (b) depict the baseline IP box effect *in countries with strict nexus requirements*, while the panels in the middle and bottom rows report the comparable effects in countries with limited nexus requirements and no nexus requirements, respectively (i.e. summing the coefficients for $IPBoxSavings_{cts} + IPBoxSavings_{cts} \times I[LimitedNexus]_{cts}$ (middle row) and $IPBoxSavings_{cts} + IPBoxSavings_{cts} \times I[NoNexus]_{cts}$ (bottom row), with the tax savings rate set to 0.15). Whisker bars extending around each point estimate denote 95 percent confidence intervals.

Figure 2 brings additional nuance to our results, as discussed in Section 5.2. First, it appears that anticipation effects, though present in some cases, are not enormously influential, thereby offering reassurance regarding the validity of our general panel DD and DDD approaches. Significant IP box effects are thus concentrated primarily around the period of regime adoption. Second, the trends in IP box effects shown here corroborate many of the patterns seen in our DD and DDD results. Panels (a) and (b) confirm the general negative effects of IP box adoption on the probability of a firm being acquired in countries with strict nexus requirements, especially for patent-owning firms. However, we also see that this negative effect is felt most strongly in the year of IP box adoption and the following two years, partially dissipating by the end of the event period. Comparing panels (e) and (f), international deals appear to be more suddenly and more significantly affected upon the adoption of an IP box regime than domestic deals.

A similar pattern of temporal adjustment between international and domestic deals manifests itself in IP box regimes that impose limited or no nexus requirements on acquired IP, albeit with a one-year delay for domestic deals relative to international deals. Anticipation effects appear to play a more important role in countries where preferential tax treatment for acquired IP is subject to certain further development conditions (panels (c) and (d)), as evidenced by spikes in IP box-driven acquisition probabilities prior to the

year of regime adoption. These peak effects arise a year earlier for international deals (p-value > 0.1) than for domestic deals, and they also arise a year or more sooner than in the most permissive regimes. This pattern suggests that firms were more likely to seek to pre-empt the loss of IP box eligibility for acquired IP in countries where at least some nexus requirements were expected to be imposed and where acquirers could devote the requisite 12 months of further development (as in the UK, for instance) to secure the preferential taxation of acquired IP. Earlier responses in the context of international deals—which typically involve larger firms—may be due to the more sophisticated tax expertise of international acquirers. Coupled with the stronger financial incentives associated with larger deals, international acquirers may react more quickly to new IP box incentives.

Irrespective of the timing of firm responses, it is also noteworthy that the impact of implementing an IP box—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 more pronounced positive effects of IP box tax savings in our general DD analysis. This is consistent with the synergy channel (I) triggering a short-lived spike in M&A activity as marginal transactions whose restructuring costs previously outweighed the expected after-tax value of any synergistic gains suddenly become attractive. Despite the heightened ongoing tax 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, resulting in an apparent zero effect of IP box provisions on the probability of a firm being acquired in the medium term.

Translated into percent changes in the probability of acquisition, the estimates depicted in Figure 2 for international and domestic deals are of a similar magnitude (i.e. given that the unconditional probability of being acquired is roughly twice as high for international deals as for domestic deals). To the extent that the tax rate arbitrage chan-

nel (II) ought to impact international and domestic deals differently, a final implication of Figure 2 is to reinforce our conclusion that this channel does not play an important role in modulating the effects of IP box regimes on the probability of a firm being acquired. Instead, the significant positive impact of IP box tax savings on acquisitions of patent-owning firms in countries without nexus requirements in the period immediately surrounding regime adoption emphasizes the importance of the synergy channel (I) for all deals.

6. Conclusion

Countries adopt IP boxes to achieve two different policy objectives: to spur domestic innovation and to improve their position in the global competition for corporate income. IP is at the core of this global competition. The widely debated tax planning activities of Google and Amazon, for example, rely in large part on shifting valuable IP to tax havens and attributing their global profits accordingly. Introducing an IP box to tax IP income at a preferential rate allows a country to compete with tax havens, while continuing to tax less mobile forms of economic activity at ordinary corporate income tax rates. Which of the two policy objectives a country pursues has a direct effect on the form of R&D participation (nexus) requirements embedded in the country's IP box regime, and this in turn can have a profound influence on business incentives to acquire IP. Placing more emphasis on the first policy objective (i.e., promoting domestic innovation) will lead a country to try to restrict tax benefits to real innovative activity, thus limiting the tax revenue losses caused by the IP box. By extension, IP acquired as part of an M&A deal should not be eligible for preferential taxation since the IP no longer constitutes new innovative activity. To be effective, this rule should apply to share as well as to asset deals; otherwise it is easy for a firm to circumvent strict nexus requirements by acquiring entities that own IP (Merrill (2016)), OECD (2015)). A country intent on prioritizing the second policy objective (i.e., improving its position in the competition for global income)

has no interest in implementing nexus rules, since these would hinder multinationals' efforts to shift their IP into the new IP box. In practice, IP box regimes span the full range of nexus requirements during our period of analysis.

In our study, we consider the potential effects of IP box regimes on the M&A market. M&A transactions represent one of the primary means through which IP changes hands, and IP constitutes an ever-growing share of deal value. We examine how the features of IP boxes affect the traditional M&A incentives documented in the academic literature, i.e., through deal synergies and tax rate arbitrage. We overlay on these traditional M&A incentives the extent to which IP boxes affect deal transaction costs by placing restrictions on the eligibility of acquired IP. Strict nexus requirements, for example, deny the use of IP box tax benefits for all acquired IP. Limited nexus requirements deny these benefits only if the acquired IP is not further developed by the acquirer. Some IP boxes, however, impose no nexus requirements at all.

We find that IP box regimes differentially impact M&A incentives through these varied approaches to treating acquired IP. Our results show that strict nexus requirements significantly decrease the volume of deal activity and the underlying probability of acquisition for patent-owning firms due to the potential loss of eligibility for the preferential taxation of future earnings. This effect of IP box regimes on M&A activity dissipates when nexus requirements are relaxed. In regimes with no nexus requirements, we see a general positive impact of IP 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 increased after-tax valuations of merger-driven synergies, which may confer larger benefits to the merging parties when both the acquirer and the target are directly eligible for the IP box. Opportunities for tax rate arbitrage (in the context of cross-border deals), meanwhile, appear to play a negligible role.

From an efficiency standpoint, strict nexus requirements may consequently discourage precisely the wrong types of M&A deals: namely, those which might otherwise generate

important synergies and productivity improvements. Our findings thus point to a potential downside of IP box nexus requirements. By distorting the optimal ownership of IP, they may lead to distortions in M&A markets and thereby violate the principle of capital ownership neutrality. The most efficient owner of the IP may not succeed in acquiring it, since she has to compensate the initial owner for the lost IP box tax advantage.

The OECD's BEPS project to counter harmful tax practices has, since 2015, required IP box regimes to implement new nexus rules to deter the shifting of existing IP from one country to another (at the cost of corporate tax revenues in the IP-producing country). Since our period of analysis ends in 2014, nexus requirements implemented to comply with these OECD rules are not reflected in our study. Our empirical findings with respect to nexus rules under the OECD's proposed "modified nexus approach" could therefore differ. We suspect, however, that countries introducing nexus requirements only because of OECD pressure may interpret them generously in favor of the taxpayers, especially in the case of share deals. For countries looking to modify their IP box regimes in response to the OECD recommendations, our results demonstrate the importance of explicitly differentiating the treatment of IP acquired via M&A deals versus asset purchases (with appropriate guardrails to prevent re-characterization of the latter as the former). Having brought to light the importance of nexus requirements in IP tax policy, we posit that future work could examine the impact of the foreign-derived intangible income (FDII) provisions of the recent U.S. tax reform on the U.S. M&A market.[42] By not imposing any nexus requirements, FDII rules may encourage tax-motivated changes in ownership of U.S. IP assets. On the other hand, strict nexus rules could discourage otherwise productivity-enhancing M&A deals. How these IP tax policies evolve in response to OECD guidance will prove important for economic efficiency and growth.

[42]FDII, described by commentators as a "stingy patent box" (Sheppard (2018)), encourages U.S. companies to export services and products related to intangible income owned in the U.S. by allowing a preferential tax rate on a portion of that income. Because the FDII provisions do not require linking the income to specific IP assets, the rules effectively lack nexus requirements.

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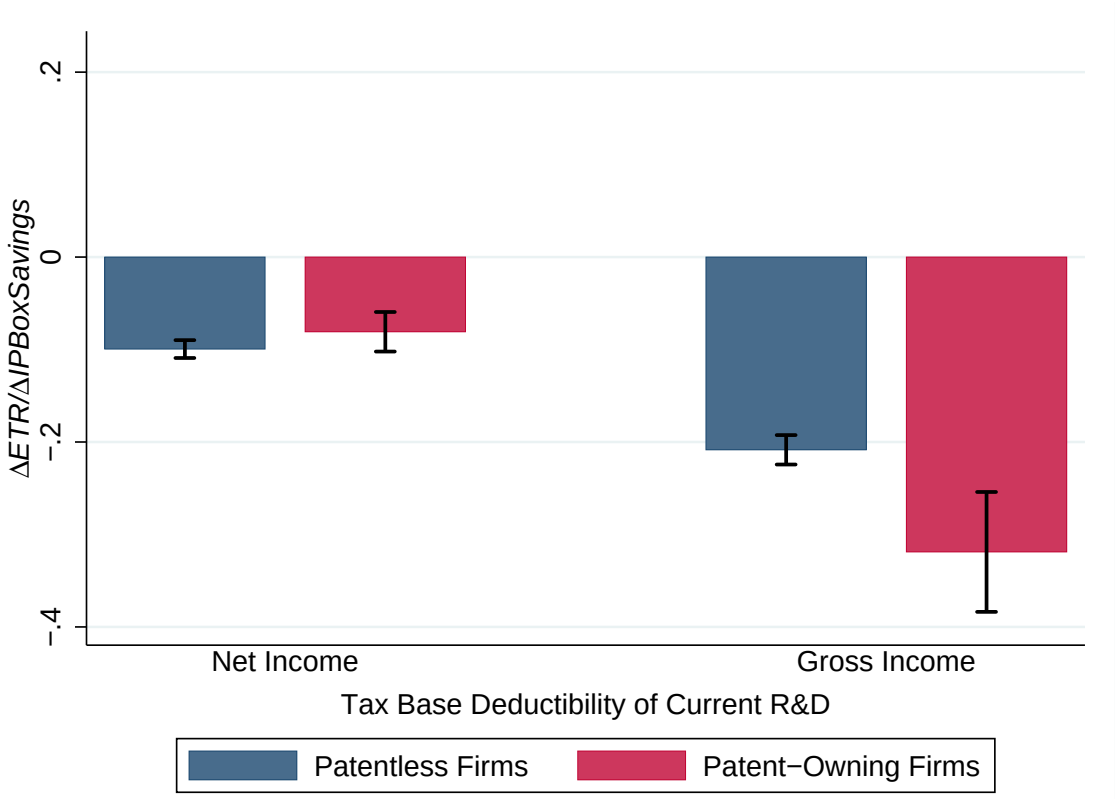
Figure 1. Effect of IP Box Tax Savings on Firm ETRs

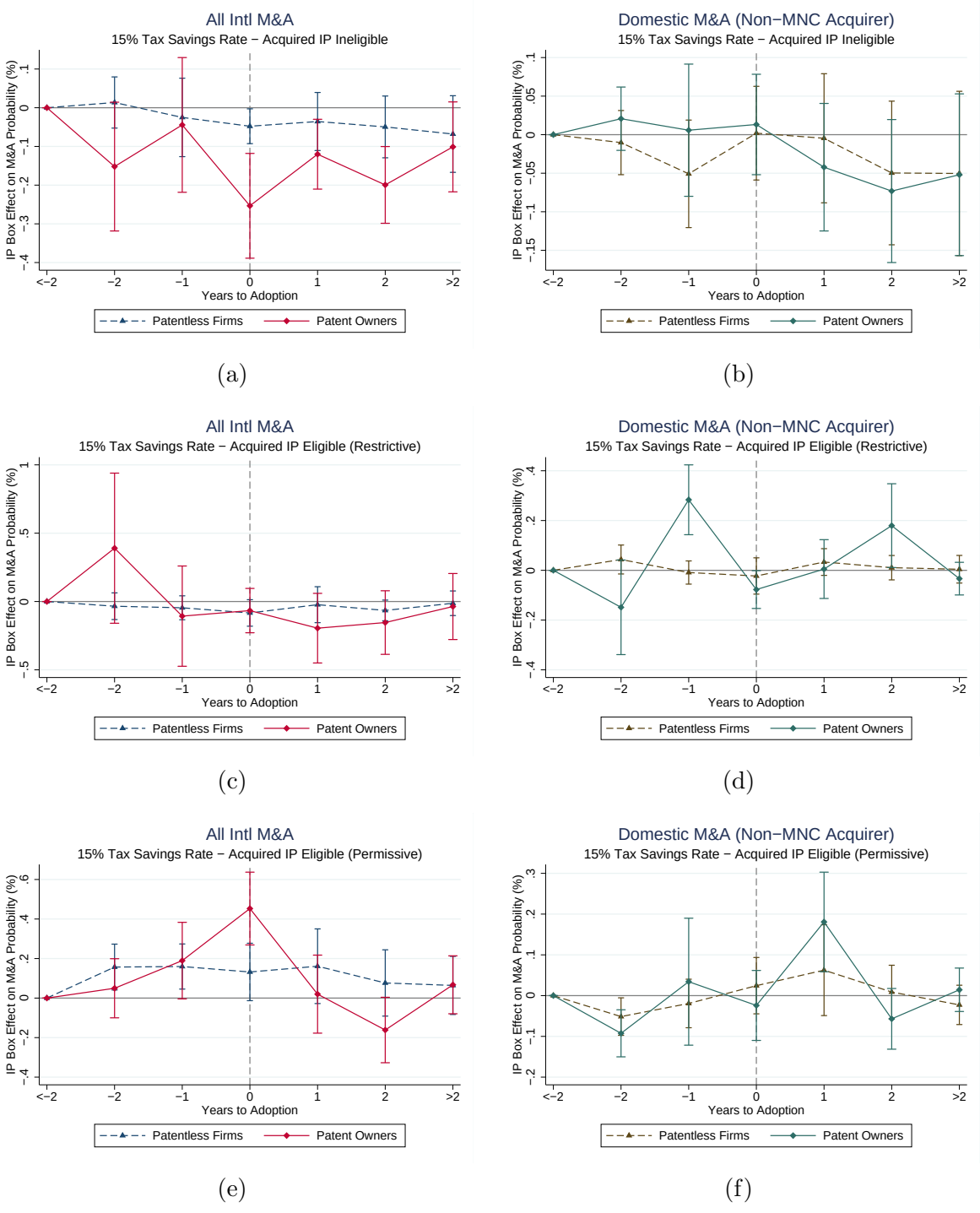


Reported coefficient estimates and 95% confidence intervals (whisker bars) are drawn from a firm fixed effects regression, using ordinary corporate income tax rates and lagged pre-tax returns on assets as controls. The graph depicts the estimated firm-level ETR effects of a 1 percentage point reduction in the preferential tax rate on IP income following adoption of an IP box regime. We exclude acquired firms from this analysis to avoid confounding effects due to (endogenous) changes in firm ownership.
Concretely, we model the effective tax rate for firm i in country c in year t as

$$ETR_{ict} = \alpha + \vec{\beta} \cdot IPBoxSavings_{ct} \times (1 + I[OwnPatent]_{ic,t-1} + I[OwnPatent]_{ic,t-1} \times I[GrossIncDeductibility]_{ct}) + \rho_1 CIT_{ct} + \rho_2 ROA_{ic,t-1} + \nu_i + \zeta_t + \varepsilon_{ict}$$

where ETR, $IPBoxSavings$, and other key regression terms are as defined in Table 5, and ν_i and ζ_t are firm and year fixed effects, respectively. $I[GrossIncDeductibility] = 1$ in IP box regimes which allow deductibility of current R&D expenses against ordinary (gross) income. See Table 1 for the corresponding categorization of IP box regimes.

Figure 2. IP Box Effects on the Likelihood of Target Acquisition:
Event Study Estimates



Acquired IP Ineligible denotes countries with strict nexus requirements, Acquired IP Eligible (Restrictive) denotes countries with limited nexus requirements, and Acquired IP Eligible (Permissive) denotes countries with no nexus requirements. For each IP 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 $t = -3$ (including earlier years) through $t = 3$ (including later years). Each of these indicators is then interacted with the IP box tax savings rate and nexus requirement indicators. The IP box effects in period $t = -3$ are constrained to be zero. We report estimated effects assuming $IPBoxSavings = 0.15$ (the sample median). Whisker bars represent 95% confidence intervals.

Table 1. Selected Characteristics of EU IP Box Regimes

Country	Years	Tax Rate (Percent) IP Income	Main	Eligible IP Acquired IP?[a]	Existing IP?[b]	Qualifying Income IP Types[c]	Tax Base Deductibility of Current R&D[d]
BE	2007 -	6.8	34	Limited	No	Narrow	Gross income
CY	2012 -	2.5	12.5	Yes	Yes	Broad	Net income
ES	2008 -	12	30	No	Yes	Broad	Net income
FR	2000 -	16.76	38	Yes	Yes	Narrow	Net income
HU	2003 -	9.5	19	Yes	Yes	Broad	Gross income
IE[e]	1973 - 2010	0	12.5	Yes	Yes	Narrow	Net income
IT	2015 -	15.65	31.3	Limited	Yes	Broad	Net income
LU	2008 -	5.84	29.3	Limited	No[f]	Broad	Net income
MT	2010 -	0	35	Yes	No	Broad	Not deductible
NL[g]	2007 -	5	25	Limited	No	Broad	Net income
PT	2014 -	11.5	30	No	No	Broad	Gross income
UK[h]	2013 -	10	21	Limited	Yes	Narrow	Net income

Sources: Merrill et al. (2012); Evers et al. (2015); PwC (2015); Schwab et al. (2018); and Chen et al. (2018). 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 IP box provisions (e.g. NL, IT, UK).

[a] Our characterization of the treatment of acquired IP treats divergent classifications in Schwab et al. (2018) and Chen et al. (2018) as constituting an intermediate (i.e., "limited") regime. Specific provisions vary widely between countries. Pursuant to the OECD's 2015 Action 5 report, all new and existing IP box regimes are required to institute new nexus provisions. These requirements post-date our analysis and are not reflected here.

[b] "Existing IP" refers to IP (e.g., granted patents) whose creation pre-dates regime implementation.

[c] "Narrow" qualifying IP is limited to patents and may extend to protected inventions such as supplementary protection certificates (SPCs). "Broad" qualifying IP encompasses a range of forms of IP including software, trademarks, copyrights, know-how, business secrets, business formulas, and designs/models.

[d] Current R&D expenses are generally either deductible against ordinary corporate income ("gross income") or limited to eligible IP income ("net income"). Accordingly, the value of these deductions reflects the (main) corporate income tax rate or the preferential tax rate for IP income, respectively. [e] Prior to enacting a new IP box regime in 2016, Ireland had an IP 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 IP box regimes). Irish nexus requirements under its original regime were terminated in 2008.

[f] In Luxembourg, IP created before the introduction of the regime qualifies if it has been acquired after the date of implementation (subject to further development).

[g] The Netherlands lowered its IP box tax rate from 10 to 5 percent in 2010.

[h] The UK regime was 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.

Table 2. Channels through Which IP Box Regimes Could Impact M&A

Probability of being acquired:	Channel		
	Nexus	Tax Rate Arbitrage	Synergies
Domestic deal	-	No effect	+
International deal	−	±	+

Table 3. Geographic Sample Composition

	Count Analysis	Acquisition Analysis		
	M&A Deals	Firm-Year Observations	Unique Firms	M&A Deals
IP Box Countries:				
BE	2456	42387	7103	67
CY	286	94	29	1
ES	8827	240470	31039	172
FR	8076	209594	29035	408
HU	634	11882	2908	6
IE	1097	2489	712	3
IT	3642	334771	80800	133
LU	278	630	158	2
MT	52	227	59	0
NL	8203	11517	2416	43
PT	723	35884	6119	35
UK	26411	69256	12956	451
Non IP Box Countries:				
AT	1070	4302	1052	17
BG	3526	6913	1892	9
CZ	1356	27431	5660	77
DE	8169	63434	14176	255
DK	2470	15391	4225	102
EE	1380	0	0	0
FI	5959	24643	3717	117
GR	497	9503	2205	4
HR	271	6905	1903	4
LT	515	0	0	0
LV	713	0	0	0
PL	2290	31622	6289	107
RO	634	29363	4579	53
SE	5170	54970	8084	309
SI	179	0	0	0
SK	297	8860	2060	16
Total	95181	1242538	229176	2391

Table 4. 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 granted patent	1-year lag
$PatentStock_{t-1}$	Stock of directly-owned granted patents	1-year lag
$GrantedShare_{t-1}$	Share of patent applications resulting in granted patent(s)	1-year lag
$AdjustedCites_{t-1}$	Average vintage-adjusted patent citation counts	1-year lag
$\bar{ETR}_{-3}$	Effective tax rate: equal to taxes paid divided by pre-tax income (EBIT) and winsorized to [0,1]	Lagged 3-year average
$\bar{ROA}_{-3}$	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	Lagged 1-year difference
$CapitalSpend_{-1}$	Capital expenditures: equal to the change in fixed assets divided by total assets	Lagged 1-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 5. Country-Level Variable Names and Definitions

Variable Name	Description
$I[IPBox]$	Binary indicator equal to 1 in IP box regime countries
CIT	Statutory corporate income tax rate
$IPBoxSavings$	IP box tax savings: equal to CIT minus tax rate on IP income (IP box rate or CIT)
$I[LimitedNexus]$	Binary indicator equal to 1 in IP box countries that grant preferential treatment to acquired IP (modestly restrictive)
$I[NoNexus]$	Binary indicator equal to 1 in IP 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 IP 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
$R\&DStateAid$	Block-exempted state aid for innovation as a share of GDP

Table 6. Variable Means by Deal Type (Firm Sample)

Variable Name	Full Sample			2014 Only		
	No Deal	Intl	Domestic	No Deal	Intl	Domestic
	(1)	(2)	(3)	(4)	(5)	(6)
Firm-Level Characteristics:						
$I[OwnPatent]_{t-1}$	0.120	0.315***	0.216***	0.158	0.279***	0.188
$PatentStock_{t-1}$	8.340	14.70*	7.270	9.200	7.540	6.560
$I[NewApplication]_{-5}$	0.098	0.290***	0.182***	0.122	0.286***	0.208
$GrantedShare_{t-1}$	0.059	0.140***	0.097***	0.074	0.121***	0.076
$I[MNC]$	0.093	0.243***	0.185***	0.100	0.305***	0.083
$I[HavenSubs]$	0.016	0.048***	0.038***	0.017	0.033	0.021
$\bar{ETR}_{-3}$	0.384	0.304***	0.302***	0.386	0.312***	0.281***
$\bar{ROA}_{-3}$	0.102	0.127***	0.119***	0.090	0.123***	0.125**
$\log(\bar{Assets})_{-3}$	8.240	9.830***	9.140***	8.540	9.890***	9.090***
$\bar{Intan}_{-3}$	0.028	0.038***	0.027	0.026	0.044***	0.017
$\bar{Cash}_{-3}$	0.115	0.110	0.129	0.131	0.111*	0.201**
$I[HighGrowth]_{t-1}$	0.530	0.530	0.501	0.504	0.506	0.458
$CapitalSpend_{-1}$	0.001	0.007	0.014*	-0.069	0.008	-0.003
$Listed_{t-1}$	0.011	0.032***	0.075***	0.008	0.020	0.063
$\bar{Leverage}_{-3}$	0.610	0.567***	0.559***	0.586	0.559*	0.476***
$\bar{Tangibility}_{-3}$	0.281	0.284	0.285	0.280	0.249**	0.253
Country-Level Characteristics:						
CIT	0.310	0.297***	0.295***	0.299	0.274***	0.290
$I[HighRoyaltyTax]$	0.073	0.035***	0.034***	0.113	0.058***	0.063
$MarketCap$	63.80	76.90***	83.40***	54.30	72.80***	83.10***
$\Delta MarketCap$	0.114	0.239***	0.216***	0.363	0.382	0.379
$\log(LaborForce)$	16.70	16.60***	16.40***	16.80	16.80	16.60
$Unemp$	0.100	0.083***	0.084***	0.119	0.096***	0.094***
$Exports$	0.338	0.379***	0.370***	0.377	0.388	0.399
$\log(GDP)$	10.40	10.50***	10.50***	10.50	10.50***	10.50***
CPI	0.023	0.023	0.022	0.003	0.006***	0.006***
$REER$	0.994	1.020***	1.020***	0.996	1.020***	1.010*
EFI	7.360	7.520***	7.540***	7.360	7.500***	7.500***
$R\&DStateAid$	0.008	0.008	0.006***	0.022	0.025***	0.022
IP Box Characteristics:[a]						
$IPBoxSavings$	0.185	0.175***	0.181	0.182	0.141***	0.177
Observations	1,240,177	1,706	685	94,798	154	48

Sample means are computed separately depending on whether firms were acquired in the corresponding period. 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.

[a] IP box characteristics are for the subset of observations in IP box countries only and consist of 350644, 426, 188, 39581, 62, and 30 firms, respectively.

Table 7. IP Box Effects on Country-Level Deal Counts

	Deal Type								
	All Deals			International			Domestic		
$Y = DealCount$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Poisson Coefficient Estimates									
CIT	-2.587**	-2.590**	-2.716**	-2.598***	-2.629***	-2.611***	-2.705**	-2.722**	-2.895*
	(1.143)	(1.142)	(1.233)	(0.817)	(0.817)	(0.799)	(1.352)	(1.346)	(1.518)
$IPBoxSavings$	1.184*	1.314*	2.832	0.160	0.294	-0.827	1.777*	1.876*	2.666
	(0.694)	(0.700)	(2.741)	(0.229)	(0.318)	(0.990)	(1.010)	(1.015)	(3.968)
$I[LimitedNexus] \times IPBoxSavings$			-1.688			1.277			-0.993
			(2.682)			(0.965)			(3.871)
$I[NoNexus] \times IPBoxSavings$			-0.980			0.854			0.137
			(2.806)			(0.913)			(4.090)
$IPBoxSavings \times I[OwnPatent]$		-2.147	-5.549***		-1.380	-1.806*		-2.323	-5.262***
		(1.814)	(1.339)		(1.172)	(1.059)		(1.996)	(1.386)
$I[LimitedNexus] \times IPBoxSavings$			2.555***			-0.343			1.405*
$\times I[OwnPatent]$			(0.830)			(0.291)			(0.719)
$I[NoNexus] \times IPBoxSavings$			5.731***			1.195			5.914***
$\times I[OwnPatent]$			(0.312)			(0.780)			(0.092)
Observations	368	650	650	368	631	631	368	593	593
Pseudo R-squared	0.936	0.940	0.941	0.913	0.895	0.895	0.923	0.930	0.930

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

All specifications include a full set of time-varying country-level controls along with country and year fixed effects. Complete results are reported in Appendix Table A.4.

Table 8. IP Box Effects on the Likelihood of Target Acquisition

	Deal Type					
	All Deals	Intl	Domestic	All Deals	Intl	Domestic
$Y = Pr(Acquired = 1), Y \in \{0, 100\}$	(1)	(2)	(3)	(4)	(5)	(6)
$IPBoxSavings$	-0.473**	-0.570***	0.098			
	(0.213)	(0.166)	(0.179)			
$I[LimitedNexus] \times IPBoxSavings$	0.378	0.460*	-0.083			
	(0.311)	(0.246)	(0.184)			
$I[NoNexus] \times IPBoxSavings$	0.012	-0.039	0.050			
	(0.414)	(0.306)	(0.319)			
$IPBoxSavings \times I[OwnPatent]_{t-1}$	-0.637**	-0.559*	-0.078	-0.600**	-0.523*	-0.077
	(0.293)	(0.292)	(0.087)	(0.262)	(0.264)	(0.069)
$I[LimitedNexus] \times IPBoxSavings$	0.301	0.323	-0.022	0.084	0.111	-0.027
$\times I[OwnPatent]_{t-1}$	(0.476)	(0.474)	(0.140)	(0.328)	(0.352)	(0.098)
$I[NoNexus] \times IPBoxSavings$	0.798**	0.511	0.287**	0.899***	0.607*	0.292**
$\times I[OwnPatent]_{t-1}$	(0.346)	(0.337)	(0.133)	(0.275)	(0.294)	(0.117)
	⋱	⋱	⋱	⋱	⋱	⋱
Unconditional Pr(Acquired = 1) (Percent):						
All firms	0.192	0.137	0.055	0.192	0.137	0.055
Patent-less firms	0.156	0.107	0.049	0.156	0.107	0.049
Patent-owning firms	0.457	0.359	0.099	0.457	0.359	0.099
Marginal Change in Predicted Pr(Acquired = 1)[a]*:*						
Patent-less firms						
Acquired IP disallowed	-3.029**	-5.331***	1.983			
Limited nexus	-0.609	-1.028	0.303			
No nexus	-2.955	-5.692*	3.003			
Patent-owning firms						
Acquired IP disallowed	-2.428***	-3.15***	0.192	-1.311**	-1.458**	-0.776
Limited nexus	-0.944	-0.966	-0.866	-1.128	-1.148	-1.052
No nexus	-0.658	-1.832	3.602	0.654	0.235	2.177**
Controls and Fixed Effects:						
Firm Characteristics	X	X	X	X	X	X
Macroeconomic variables[b]	X	X	X			
Industry FE	X	X	X	X	X	X
Country FE	X	X	X			
Year FE	X	X	X			
Country × Year FE				X	X	X
Observations	1242538	1242538	1242538	1242538	1242538	1242538
R-squared	0.004	0.003	0.001	0.004	0.004	0.002

Significance levels are designated as *** p<0.01, ** p<0.05, and * p<0.1.
Standard errors (in parentheses) are clustered by country and year.

[a] Marginal changes in $Pr(Acquired = 1)$ 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.
E.g. $\left\{ \frac{\partial Pr(Acquired=1)}{\partial IPBoxSavings} \cdot \frac{1}{\bar{Y}} \right\}_{|I[OwnPatent]=0, I[LimitedNexus]=0, I[NoNexus]=0} = -\frac{0.473}{0.156} = -3.029.$

[b] Inclusion of country-year pair fixed effects precludes estimation of country-year specific variables. All specifications still include $CIT_{ct} \times Patent_{ijct-1}$. Complete results are reported in Appendix Table A.5

Appendix A. For Online Publication

Appendix A.1. Deal Premia - A Numerical Example

Table A.1 illustrates the potential deterrent effect of limited or strict nexus rules on the probability that a firm will be acquired. Column 1 sets the baseline value of the target for a given set of assumptions about constant sales growth, profit margins, tax rates, the discount rate (6.5%), and the share of the pre-tax profit margin subject to the statutory tax rate versus the preferential IP box rate. Under these assumptions, the present discounted value of the target's after-tax cash flow—and therefore its own reservation price—is \$4,675. As a stand-alone firm, it enjoys preferential tax treatment on its IP income.

In Column 2, the expected pre-tax profit margin is assumed to increase from 55% to 70% as a result of the synergy channel (I) in our model. Accordingly, the value of the target increases to \$5,950. We assume here that 50% of the increase in pre-tax profits are taxed at a preferential rate. If more than 50% of this increase is eligible for the preferential rate (for instance, if the synergies can be allocated exclusively to IP income), the after-tax value of deal synergies will be further magnified.

Next we consider two potential effects of our model's transaction cost channel (III). In Column 3, the deal renders the target's IP income ineligible for the preferential tax rate. The nexus requirements of Spain and Portugal during our sample period, for example, could generate this very unfavorable tax outcome for both parties to the deal. Except for these two countries, the OECD in 2015 considered most countries to be too lax with their nexus requirements, rather than too harsh (and advised countries to not let acquired IP be unconditionally eligible for the preferential rate). As shown, when the share of qualifying income drops to 0%, the value of the target drops to \$4,125. This sets a lower bound on the non-tax deal synergies that need to be created in order for the acquirer to value the target above its own reservation price of \$4,675 and decreases the probability of successful deals involving substantial IP.

In Column 4, we contemplate a second potential effect of nexus requirements. In this scenario, to qualify for the preferential tax rate for IP income, the acquirer has to make substantial qualifying expenditures that improve the acquired IP. These expenditures may or may not be warranted or otherwise desirable. In many cases acquirers purchase proven technologies with the intention of continuing to commercialize them rather than to perform what the tax code refers to as "further development." The additional R&D essentially serves as window-dressing for purposes of preserving tax benefits; it offsets the potential acquirer's bid premium and thereby reduces the probability of acquisition. Moreover, under the strictest nexus requirements, to be considered "substantial" these R&D expenditures have to be far more than the total value of the IP at the time of the deal. In our example, these expenditures kill any potential for improvements in the pre-tax profit margin such that the value of the target falls back to the target's own reservation price of $4,675.

Using a plausible set of assumptions, this numerical example illustrates that nexus requirements could cause the acquirer's willingness-to-pay to fall below the target's own reservation price. It highlights the importance of separating out countries with a "further development requirement," such as the UK, from those that do not, such as Spain and Portugal. The simple loss of IP box tax benefits has a much harsher and clearer negative effect on the deal premium than does the requirement to make undesirable levels of R&D expenditures to retain tax benefits.

Appendix A.2. Heterogeneous Firm-Level Acquisition Probabilities

Appendix A.2.1. Growth Opportunities

Given that a target firm's pre-deal capital expenditures serve as a proxy for the ex-ante expectations of deal synergies attributable to that target, the acquisition of a patent-owning high-growth-target firm in an IP box country without nexus requirement should be particularly attractive. Starting from the country-year pair fixed effects specification shown in Table 8 (Columns 4 through 6), we test this prediction by interacting all

our variables of interest with firm-specific lagged capital expenditure growth. Our results appear in Table A.7. While there is little discernible impact of IP box adoption on patentless firms, we observe a similar pattern of firm-level $IPBoxSavings$ effects to those described in Section 5.2, *except that these effects are amplified (in both directions) for faster-growing firms*. As evidenced by the coefficients on $IPBoxSavings \times I[OwnPatent]_{t-1}$ and $IPBoxSavings \times I[OwnPatent]_{t-1} \times CapitalSpend_{-1}$ in Column 1 of Table A.7, we again observe significant negative effects of IP box tax savings on the probability of being acquired for patent-owning firms in countries with strict nexus requirements; the magnitude of this effect increases with $CapitalSpend_{-1}$. However, this effect is again offset in countries with no nexus requirements, and the degree to which it is offset increases along with the targets' pre-deal capital expenditures. Evaluated at the 90^{th} percentile of the distribution of target capital expenditures and taking all relevant coefficients into account, a 1 percentage point increase in $IPBoxSavings$ is thus associated with a statistically significant 2.270 percent reduction in the probability of acquisition for "high-growth" patent-owning firms in strict nexus regimes and with an overall 1.455 percent increase in the probability of acquisition for similar "high-growth" targets in countries with no nexus requirements. "Low-growth" firms are more modestly affected, with implied $IPBoxSavings$ semi-elasticities that are not statistically distinguishable from zero.

International deals (Column 2) reflect similar patterns of $IPBoxSavings$ effects as in the full deal sample, while domestic deals (Column 3) appear less sensitive to target capital expenditures. The fact that the overall effect of $IPBoxSavings$ in countries with no nexus requirements remains positive and significant in a manner that is largely independent of (target) capital expenditures for domestic deals points to the importance of synergistic gains that may be attributed specifically to the *acquirer's* own operations when both the acquirer's and the target's IP are eligible for the preferential IP box tax rates. Furthermore, the target's pre-deal growth potential may be less important for domestic

deals; Wang et al. (2015), for instance, find substantial deal-driven incremental improvements in target firm productivity following domestic—but not foreign—acquisitions. At the same time, the absence of significant negative effects of $IPBoxSavings$ on domestic deals in countries with strict nexus requirements again corroborates the idea that the transaction cost channel (III) of our model plays a weaker role when both targets and acquirers have a pre-existing physical nexus in the IP box.

Appendix A.2.2. Patent Quality

M&A incentive effects due to IP box adoption should be increasing in patent *quality*, assuming that higher quality translates to higher levels of IP income being eligible for preferential taxation. In Tables A.8 and A.9, we report the results of tests involving two different measures of firm-level average patent quality. These results lend credence to this hypothesis and further corroborate our main findings regarding the consequences of IP box adoption.

The first measure, $GrantedShare_{t-1}$, uses information on all patent *applications* and computes the fraction of each firm's applications that are eventually granted (allowing for at least a two-year delay between application and publication dates). As shown in Table A.8, a higher granted share is generally associated with an amplification of the effects reported for patent owners in Table 8—negative or positive. Thus, for instance, in the scenario where we expect deal synergies to play the strongest role,[43] a 1 percentage point increase in $IPBoxSavings$ in a country with no nexus requirements yields a 5.404 percent increase in the probability of acquisition for a firm whose patent applications have all been granted ($GrantedShare_{t-1} = 1$) as part of a domestic M&A deal (p-value < 0.1). Despite its appealing simplicity, however, $GrantedShare$ fails to distinguish highly innovative firms with a high patent success rate across multiple applications versus

[43]The strongest effect should occur for patent-owning firms resident in patent box countries without nexus requirement. ($I[NoNexus] \times IPBoxSavings \times GrantedShare_{t-1}$) indicates the economic effect of the patent box tax savings rate for such firms. The corresponding semi-elasticities are shown in the last row of Table A.8.

firms with a single (successfully-granted) patent application.[44]

Our second proxy for patent quality, $I[HighCites]_{t-1}$, differentiates among firms with the highest quality patents based on a vintage-adjusted count of patent citations, $AdjustedCites_{t-1}$, and is equal to 1 for those firms in the top 95$^{\text{th}}$ percentile of the adjusted citation count distribution.[45] Table A.9 reports the coefficients for the key $IPBoxSavings$, nexus, patent ownership, and high-quality patent indicator interactions, with estimates of marginal changes in predicted probabilities of acquisition among patent-owning firms below. Among firms with $I[HighCites]_{t-1} = 0$ (i.e., all but the highest-quality patent-owning firms), we see very similar implied marginal effects as in the more general results from Table 8. This result is unsurprising given the close similarity between the samples. Among firms with $I[HighCites]_{t-1} = 1$, however, we see even more marked amplification of the negative effects which we attribute to the transaction cost channel (III) and—to a lesser degree—the positive effects which we attribute to the synergy channel (I).[46] Overall, these results confirm that IP box regimes have especially large effects on M&A activity when "blockbuster" patents are involved.

Regardless of our measurement of IP box eligibility, comparisons of outcomes between international versus domestic deals yield little conclusive evidence about the importance of the tax rate arbitrage channel (II). Nexus requirements appear to yield stronger disincentives for international acquisitions, whereas the synergy channel (I) appears to play

[44]Similarly, $GrantedShare_{t-1} = 0$ conflates firms with zero patents with those whose applications have never been granted.

[45]Adjusted citation counts are defined at the patent level by subtracting the average citation count across all patents granted in the same year; we average these across all patents held at the firm level. Skewness in the citation distribution produces a large mass of patent owners with an average adjusted citation count of ≤ 0 (i.e. at or below the vintage average) below the 85$^{\text{th}}$ percentile. High-citation firms thus account for 14,826 observations and 95 acquisitions, which translates to just over 1 percent of all observations in the estimation sample, but 4 percent of all M&A deals. The average vintage-adjusted citation count among high-citation firms is 5.7, with a median of 2.4 and a minimum and maximum of 0.5 and 277.8, respectively.

[46]The estimated 6.805 percent increase in the probability of domestic acquisition of high patent citation firms in countries without nexus requirements resulting from a 1 percentage point increase in $IPBoxSavings$ is marginally insignificant at conventional levels (p-value = 0.11). Only 11 of the 81 acquisitions of high-citation patent owners in our estimation sample are domestic, hence the relatively low power for tests of domestic deal probability effects.

a stronger role in promoting domestic deals. Absent stronger evidence of a significant negative effect of IP box tax savings on international deals in countries without nexus requirements, the relative strength of the transaction cost (III) and synergy (I) channels across deal types masks any effects attributable to tax rate arbitrage incentives.

Table A.1. Numerical Example of Equity Value (Reservation Price)
with IP Box Nexus Requirements

	Model Scenario			
Assumptions	Baseline	Synergies	Nexus - Tax Rate	Nexus - Added Costs
Sales growth	5%	5%	5%	5%
Pre-tax profit margin	55%	*70%*	55%	*55%*
Statutory tax rate	25%	25%	25%	25%
IP box tax rate	5%	5%	5%	5%
Share of qualifying income	50%	50%	*0%*	50%
Equity value	4675	5950	4125	4675
Target projections				
Year:	1	2	∞	
Revenue	150	158		
Expense (including R&D)	(68)	(71)		
Pre-tax income (cash flow)	83	87		
Tax expense	(12)	(13)		
After-tax income (cash flow)	70	74		
Free cash flow	70	74		
Discounted cash flow	66	65		
Sum of DCF	66	131		
Equity value	**4675**			

Table A.2. Geographic Distribution of Sample Observations
IP Box Countries

	Country											
	BE	CY	ES	FR	HU	IE	IT	LU	MT	NL	PT	UK
Observations:												
1994	1	0	0	2	0	0	0	0	0	0	0	6
1995	3	0	13	3	0	0	0	0	0	8	0	24
1996	5	0	253	6	0	0	0	0	0	47	0	73
1997	60	0	7653	39	0	0	0	0	0	322	0	1195
1998	434	0	9951	3810	0	0	0	0	0	567	0	2723
1999	495	0	11976	5950	0	0	0	0	0	654	0	3039
2000	555	0	13492	7265	0	9	0	1	0	753	10	3194
2001	644	0	14845	8779	0	15	0	1	0	807	719	3269
2002	701	0	15593	10046	0	21	19162	1	0	869	944	3349
2003	789	0	15696	11159	0	111	20779	4	0	823	1204	3550
2004	919	0	15763	12250	0	133	21910	2	0	592	1376	3610
2005	2726	0	17897	16025	41	235	23782	28	0	556	1919	4707
2006	3966	0	17661	17868	17	217	23582	33	2	446	2317	5045
2007	3674	0	12357	15372	20	131	8186	37	9	263	2141	4105
2008	3553	0	13595	14906	35	202	6080	55	18	325	3030	3894
2009	4177	12	14307	15596	1944	284	34869	67	26	482	3673	4236
2010	4040	16	13502	14921	1964	272	34687	70	28	562	3711	4212
2011	3858	21	12810	14282	1897	246	34504	72	35	679	3743	4263
2012	3819	19	11646	13890	1885	215	34783	73	37	887	3780	4644
2013	3934	17	11009	14134	1983	194	36364	96	42	938	3719	4984
2014	4034	9	10451	13291	2096	204	36083	90	30	937	3598	5134
Firms	7103	29	31039	29035	2908	712	80800	158	59	2416	6119	12956
Deals	67	1	172	408	6	3	133	2	0	43	35	451

Table A.3. Geographic Distribution of Sample Observations
Non IP Box Countries

	Country											
	AT	BG	CZ	DE	DK	FI	GR	HR	PL	RO	SE	SK
Observations:												
1994	1	0	0	3	1	0	0	0	0	0	3	0
1995	1	0	0	12	1	1	0	0	0	0	4	0
1996	2	0	0	18	1	2	0	0	0	0	7	0
1997	3	0	33	59	2	96	0	0	0	0	7	17
1998	18	0	26	179	27	1109	0	4	254	783	48	27
1999	22	0	21	230	31	1479	0	30	478	955	64	38
2000	35	0	38	275	39	1789	0	58	670	1127	2184	39
2001	43	111	64	350	35	2004	0	402	733	1404	3687	43
2002	46	273	318	458	70	2140	0	427	846	1583	3722	73
2003	49	192	668	623	2184	2203	0	474	1033	1744	3719	135
2004	42	219	1121	1059	2099	1936	6	480	1318	1908	3666	191
2005	30	0	2115	1988	2165	946	28	465	1814	2321	3720	350
2006	33	390	2495	3041	2592	108	120	489	2131	2389	3867	488
2007	64	341	2470	3506	2505	116	172	30	1832	2115	3902	550
2008	228	363	3101	5816	1468	188	1180	46	2271	2222	3787	670
2009	527	1027	3665	7189	24	1770	1581	982	2869	2653	4408	1135
2010	566	1327	3731	7240	24	1795	1609	1005	2956	2744	4292	1185
2011	567	1351	3768	7474	22	1748	1488	1022	2988	2717	3933	1190
2012	594	1319	3797	7862	24	1704	1281	991	3058	2698	3596	1322
2013	695	0	0	8795	29	1768	1049	0	3170	0	3287	1407
2014	736	0	0	7257	2048	1741	989	0	3201	0	3067	0
Firms	1052	1892	5660	14176	4225	3717	2205	1903	6289	4579	8084	2060
Deals	17	9	77	255	102	117	4	4	107	53	309	16

Table A.4. IP Box Effects on Country-Level Deal Counts

	Deal Type								
	All Deals			International			Domestic		
$Y = DealCount$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CIT	-2.587**	-2.590**	-2.716**	-2.598***	-2.629***	-2.611***	-2.705**	-2.722**	-2.895*
	(1.143)	(1.142)	(1.233)	(0.817)	(0.817)	(0.799)	(1.352)	(1.346)	(1.518)
$IPBoxSavings$	1.184*	1.314*	2.832	0.160	0.294	-0.827	1.777*	1.876*	2.666
	(0.694)	(0.700)	(2.741)	(0.229)	(0.318)	(0.990)	(1.010)	(1.015)	(3.968)
$I[LimitedNexus] \times IPBoxSavings$			-1.688			1.277			-0.993
			(2.682)			(0.965)			(3.871)
$I[NoNexus] \times IPBoxSavings$			-0.980			0.854			0.137
			(2.806)			(0.913)			(4.090)
$IPBoxSavings \times I[OwnPatent]$		-2.147	-5.549***		-1.380	-1.806*		-2.323	-5.262***
		(1.814)	(1.339)		(1.172)	(1.059)		(1.996)	(1.386)
$I[LimitedNexus] \times IPBoxSavings$			2.555***			-0.343			1.405*
$\times I[OwnPatent]$			(0.830)			(0.291)			(0.719)
$I[NoNexus] \times IPBoxSavings$			5.731***			1.195			5.914***
$\times I[OwnPatent]$			(0.312)			(0.780)			(0.092)
$I[OwnPatent]$		-2.542***	-2.542***		-1.871***	-1.872***		-2.909***	-2.907***
		(0.241)	(0.240)		(0.190)	(0.190)		(0.251)	(0.249)
$I[HighRoyaltyTax]$	0.787***	0.786***	0.525	0.135	0.130	0.317*	0.896**	0.901**	0.741
	(0.283)	(0.284)	(0.520)	(0.090)	(0.090)	(0.174)	(0.386)	(0.388)	(0.778)
$MarketCap$	-0.004**	-0.005**	-0.005**	-0.000	-0.000	-0.000	-0.005***	-0.005***	-0.006***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
$\Delta MarketCap$	0.018	0.017	0.016	-0.011	-0.010	-0.010	0.030	0.029	0.027
	(0.025)	(0.025)	(0.025)	(0.018)	(0.017)	(0.017)	(0.030)	(0.030)	(0.031)
$\log(LaborForce)$	0.173	0.154	0.222	1.244*	1.163	1.177	-0.823	-0.859	-0.706
	(1.544)	(1.545)	(1.564)	(0.707)	(0.714)	(0.729)	(2.098)	(2.114)	(2.245)

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$Unemp$	0.025	0.026	0.026	0.008	0.009	0.009	0.031	0.031	0.032
	(0.027)	(0.026)	(0.027)	(0.009)	(0.008)	(0.008)	(0.031)	(0.031)	(0.032)
$Exports$	-0.003	-0.003	-0.002	0.009***	0.008***	0.008***	-0.010	-0.011	-0.009
	(0.009)	(0.009)	(0.009)	(0.003)	(0.003)	(0.002)	(0.013)	(0.013)	(0.013)
$\log(GDP)$	0.600	0.622	0.711	0.117	0.133	0.121	1.070	1.056	1.179
	(1.158)	(1.162)	(1.156)	(0.660)	(0.623)	(0.580)	(1.415)	(1.443)	(1.425)
CPI	0.011	0.011	0.011	0.001	0.001	0.001	-0.010	-0.008	-0.009
	(0.016)	(0.016)	(0.016)	(0.004)	(0.004)	(0.004)	(0.062)	(0.067)	(0.067)
$REER$	-0.001	-0.001	-0.000	-0.006***	-0.006**	-0.006**	-0.000	-0.000	0.000
	(0.005)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)	(0.006)	(0.006)	(0.006)
EFI	0.794**	0.784**	0.754**	0.320***	0.301***	0.316***	1.003*	0.991*	0.958*
	(0.377)	(0.378)	(0.372)	(0.116)	(0.110)	(0.104)	(0.520)	(0.523)	(0.515)
$R\&DStateAid$	-5.766*	-5.838*	-6.291*	1.240	1.099	1.343	-9.412**	-9.484**	-9.799**
	(3.378)	(3.373)	(3.398)	(1.370)	(1.320)	(1.333)	(4.709)	(4.705)	(4.755)
Observations	368	650	650	368	631	631	368	593	593
Pseudo R-squared	0.936	0.940	0.941	0.913	0.895	0.895	0.923	0.930	0.930

Significance levels are designated as *** p<0.01, ** p<0.05, and * p<0.1. Standard errors (in parentheses) are clustered by country.
All specifications include a full set of country and year fixed effects.

Table A.5. IP Box Effects on the Likelihood of Target Acquisition

$Y = Pr(Acquired = 1), Y \in \{0, 100\}$	All Deals (1)	Deal Type International (2)	Domestic (3)
$IPBoxSavings$	-0.4729**	-0.5703***	0.0975
	(0.2130)	(0.1660)	(0.1789)
$I[LimitedNexus] \times IPBoxSavings$	0.3777	0.4603*	-0.0826
	(0.3111)	(0.2458)	(0.1843)
$I[NoNexus] \times IPBoxSavings$	0.0116	-0.0385	0.0501
	(0.4141)	(0.3059)	(0.3194)
$IPBoxSavings \times I[OwnPatent]_{t-1}$	-0.6374**	-0.5589*	-0.0784
	(0.2933)	(0.2921)	(0.0874)
$I[LimitedNexus] \times IPBoxSavings$	0.3007	0.3227	-0.0220
$\times I[OwnPatent]_{t-1}$	(0.4756)	(0.4742)	(0.1401)
$I[NoNexus] \times IPBoxSavings$	0.7978**	0.5110	0.2868**
$\times I[OwnPatent]_{t-1}$	(0.3455)	(0.3368)	(0.1330)
$I[OwnPatent]_{t-1}$	0.0099	-0.0285	0.0384
	(0.2973)	(0.2915)	(0.0727)
$CIT \times I[OwnPatent]_{t-1}$	0.2666	0.3885	-0.1219
	(0.9857)	(0.9991)	(0.2298)
$E\bar{T}R_{-3}$	0.0251	0.0113	0.0138
	(0.0239)	(0.0170)	(0.0113)
CIT	0.7298	0.2753	0.4545**
	(0.5913)	(0.5165)	(0.1826)
$I[MNC]$	0.0473*	0.0387*	0.0086
	(0.0267)	(0.0196)	(0.0087)
$I[HavenSubs]$	-0.3288**	-0.1772*	-0.1516***
	(0.1338)	(0.0993)	(0.0507)
$R\bar{O}A_{-3}$	0.0936	0.0834	0.0102
	(0.0867)	(0.0748)	(0.0139)
$\log(As\bar{s}ets)_{-3}$	0.0986***	0.0809***	0.0176***
	(0.0182)	(0.0139)	(0.0053)
$In\bar{t}an_{-3}$	0.1174	0.1438*	-0.0265
	(0.0716)	(0.0821)	(0.0219)
$C\bar{a}sh_{-3}$	0.0000***	0.0000***	0.0000**
	(0.0000)	(0.0000)	(0.0000)
$I[HighGrowth]_{t-1}$	0.0141	0.0165*	-0.0024
	(0.0109)	(0.0090)	(0.0042)
$CapitalSpend_{-1}$	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
$Listed_{t-1}$	0.0771	-0.1841	0.2612**

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	(0.2089)	(0.1541)	(0.1003)
$\bar{Leverage}_{-3}$	0.0009	-0.0029	0.0038
	(0.0057)	(0.0053)	(0.0027)
$\bar{Tangibility}_{-3}$	-0.0134	-0.0074	-0.0059
	(0.0121)	(0.0081)	(0.0046)
$HavenSubsShare$	0.3333	0.1810	0.1523**
	(0.1960)	(0.1482)	(0.0684)
$I[HighRoyaltyTax]$	0.1309	0.1800*	-0.0491
	(0.1390)	(0.0881)	(0.0641)
$MarketCap$	0.0001	0.0001	-0.0000
	(0.0005)	(0.0003)	(0.0003)
$\Delta MarketCap$	0.0098	0.0133**	-0.0034
	(0.0082)	(0.0051)	(0.0039)
$\log(LaborForce)$	-0.8776*	-0.9277**	0.0501
	(0.4397)	(0.3457)	(0.1845)
$Unemp$	0.3070	0.2370	0.0700
	(0.7401)	(0.4317)	(0.3709)
$Exports$	-0.5332	-0.5137	-0.0195
	(0.4549)	(0.3518)	(0.1845)
$\log(GDP)$	-0.1116	-0.1626	0.0511
	(0.4658)	(0.3097)	(0.2156)
CPI	-0.3646	-0.0196	-0.3450
	(0.4885)	(0.4426)	(0.2585)
$REER$	0.0536	-0.0157	0.0693
	(0.5941)	(0.4607)	(0.1601)
EFI	-0.1811**	-0.1142*	-0.0669*
	(0.0754)	(0.0647)	(0.0364)
$R\&DStateAid$	-0.7056	0.0444	-0.7501*
	(0.8691)	(0.6509)	(0.3732)
Observations	1,242,568	1,242,568	1,242,568
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 and year levels.
All specifications include a full set of country, year, and industry fixed effects.

Table A.6. IP Box Effects on the Likelihood of Target Acquisition
"Narrow" (Patent-Only) IP Boxes

	Deal Type					
	All Deals		Intl		Domestic	
$Y = Pr(Acquired = 1), Y \in \{0, 100\}$	(1)	(2)	(3)	(4)	(5)	(6)
$IPBoxSavings$	-0.1740	-0.3650	-0.1824	-0.3044	0.0084	-0.0606
	(0.2624)	(0.3082)	(0.2289)	(0.2327)	(0.0841)	(0.1038)
$I[NoNexus] \times IPBoxSavings$	-0.0383	-0.0580	-0.2410	-0.3049	0.2026	0.2469
	(0.4416)	(0.5594)	(0.3343)	(0.3932)	(0.1836)	(0.2580)
$IPBoxSavings \times I[OwnPatent]_{t-1}$	-0.8798***	-1.0793***	-0.8205***	-1.0654***	-0.0593	-0.0140
	(0.2782)	(0.3515)	(0.2654)	(0.2916)	(0.1422)	(0.1397)
$I[NoNexus] \times IPBoxSavings$	1.0815***	0.9144***	0.7932***	0.5867***	0.2884**	0.3277**
$\times I[OwnPatent]_{t-1}$	(0.3078)	(0.3086)	(0.2284)	(0.1881)	(0.1273)	(0.1415)
Observations	1,133,925	941,834	1,133,925	941,834	1,133,925	941,834
R-squared	0.0036	0.0036	0.0029	0.0030	0.0012	0.0012

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

All specifications replicate those in columns 1-3 of Table 8. Columns 1, 3, and 5 omit all observations from firms subject to IP box taxation except for those located in BE, FR, IE, and the UK. Columns 2, 4, and 6 further drop all observations from countries that *ever* adopt an IP box with a broad definition of forms of qualifying IP, even those regimes not yet enacted. Strict nexus regimes are hence not included in the analysis, and the baseline effects of $IPBoxSavings$ and $IPBoxSavings \times I[OwnPatent]_{t-1}$ are instead those that apply to the set of regimes with "limited" nexus requirements.

Table A.7. IP Box Effects on the Likelihood of Target Acquisition - High Growth Firms

$Y = Pr(Acquired = 1), Y \in \{0, 100\}$	All Deals (1)	Deal Type International (2)	Domestic (3)
LPM Coefficient Estimates			
$IPBoxSavings \times CapitalSpend_{-1}$	0.1545	-0.0189	0.1734
	(0.2393)	(0.2314)	(0.1344)
$I[LimitedNexus] \times IPBoxSavings$	-0.4088	-0.1011	-0.3077
$\times CapitalSpend_{-1}$	(0.6104)	(0.3258)	(0.4134)
$I[NoNexus] \times IPBoxSavings$	-0.1525	0.0213	-0.1738
$\times CapitalSpend_{-1}$	(0.2395)	(0.2312)	(0.1345)
$IPBoxSavings \times I[OwnPatent]_{t-1}$	-0.5604*	-0.4847*	-0.0757
	(0.2881)	(0.2797)	(0.1033)
$I[LimitedNexus] \times IPBoxSavings$	0.0418	0.0719	-0.0300
$\times I[OwnPatent]_{t-1}$	(0.5568)	(0.4785)	(0.1080)
$I[NoNexus] \times IPBoxSavings$	0.8228**	0.5324	0.2905
$\times I[OwnPatent]_{t-1}$	(0.3548)	(0.3179)	(0.1725)
$IPBoxSavings$	-3.9960***	-3.8872***	-0.1088
$\times I[OwnPatent]_{t-1} \times CapitalSpend_{-1}$	(0.6754)	(0.6658)	(0.1545)
$I[LimitedNexus] \times IPBoxSavings$	4.2552***	4.0103***	0.2449
$\times I[OwnPatent]_{t-1} \times CapitalSpend_{-1}$	(1.0930)	(0.8225)	(0.4308)
$I[NoNexus] \times IPBoxSavings$	7.2339***	7.0919***	0.1420
$\times I[OwnPatent]_{t-1} \times CapitalSpend_{-1}$	(0.5318)	(0.6088)	(0.4479)
	⋱	⋱	⋱
Marginal Change in Predicted Pr(Acquired = 1)[a]*:*			
Patent-owning low-growth firms; Acquired IP disallowed	-0.688	-0.655	-0.808
Patent-owning low-growth firms; Limited nexus	-1.135	-1.152	-1.071
Patent-owning low-growth firms; No nexus	0.120	-0.439	2.152*
Patent-owning high-growth firms; Acquired IP disallowed	-2.270***	-2.707***	-0.685
Patent-owning high-growth firms; Limited nexus	-1.133	-1.150	-1.068
Patent-owning high-growth firms; No nexus	1.455*	1.245	2.215**
Observations	1,242,528	1,242,528	1,242,528
R-squared	0.0043	0.0035	0.0019

Significance levels are designated as *** p<0.01, ** p<0.05, and * p<0.1. Standard errors (in parentheses) are clustered by country and year.
All specifications include a full set of time-varying firm-level controls along with country × year and industry fixed effects (not shown).
[a] Marginal changes in $Pr(Acquired = 1)$ are computed as the effect of a 1 unit (100 percentage point) change in $IPBoxSavings$, assuming $CapitalSpend_{-1}$ is equal to its 10^{th} (low-growth) or 90^{th} (high-growth) percentile, summing coefficients over relevant interaction terms and scaling by the unconditional mean probability of acquisition among patent-owning firms.

Table A.8. IP Box Effects on the Likelihood of Target Acquisition
Patent Quality - Share of Granted Patents

$Y = Pr(Acquired = 1), Y \in \{0, 100\}$	All Deals (1)	Deal Type International (2)	Domestic (3)
LPM Coefficient Estimates			
$IPBoxSavings$	-0.5428**	-0.6336***	0.0908
	(0.2373)	(0.1756)	(0.1828)
$I[LimitedNexus] \times IPBoxSavings$	0.4033	0.4657	-0.0624
	(0.3299)	(0.2763)	(0.1929)
$I[NoNexus] \times IPBoxSavings$	-0.0139	-0.0441	0.0301
	(0.4324)	(0.3234)	(0.3277)
$IPBoxSavings \times GrantedShare_{t-1}$	-0.7106*	-0.6642*	-0.0464
	(0.3724)	(0.3675)	(0.1411)
$I[LimitedNexus] \times IPBoxSavings$	0.5244	0.8790	-0.3546*
$\times GrantedShare_{t-1}$	(0.8318)	(0.8027)	(0.1879)
$I[NoNexus] \times IPBoxSavings$	1.5078***	1.0484***	0.4594*
$\times GrantedShare_{t-1}$	(0.3543)	(0.2956)	(0.2483)
	⋱	⋱	⋱
Marginal Change in Predicted Pr(Acquired = 1):[a]			
$GrantedShare_{t-1} = 0$;*Acquired IP disallowed*	-3.581**	-6.153***	1.868
$GrantedShare_{t-1} = 0$;*Limited nexus*	-0.92	-1.63	0.584
$GrantedShare_{t-1} = 0$;*No nexus*	-3.673	-6.581**	2.488
$GrantedShare_{t-1} = 0.5$; *Acquired IP disallowed*	-1.964***	-2.694***	0.684
$GrantedShare_{t-1} = 0.5$; *Limited nexus*	-0.509	-0.169	-1.742
$GrantedShare_{t-1} = 0.5$; *No nexus*	-0.346	-1.354	3.314
$GrantedShare_{t-1} = 1$; *Acquired IP disallowed*	-2.741**	-3.62***	0.449
$GrantedShare_{t-1} = 1$; *Limited nexus*	-0.712	0.131	-3.771**
$GrantedShare_{t-1} = 1$; *No nexus*	0.526	-0.819	5.404*
Observations	1,227,684	1,227,684	1,227,684
R-squared	0.0034	0.0028	0.0012

Significance levels are designated as *** p<0.01, ** p<0.05, and * p<0.1. Standard errors (in parentheses) are clustered at the country and year levels.
All specifications include a full set of time-varying firm- and country-level controls along with country, year, and industry fixed effects.
[a] Marginal changes in $Pr(Acquired = 1)$ 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.

Table A.9. IP Box Effects on the Likelihood of Target Acquisition
Patent Quality - High Vintage-Adjusted Citations

$Y = Pr(Acquired = 1), Y \in \{0, 100\}$	All Deals (1)	Deal Type International (2)	Domestic (3)
LPM Coefficient Estimates			
$IPBoxSavings$	-0.4781*	-0.5622***	0.0842
	(0.2317)	(0.1908)	(0.1847)
$I[LimitedNexus] \times IPBoxSavings$	0.3859	0.4576*	-0.0717
	(0.3366)	(0.2607)	(0.1947)
$I[NoNexus] \times IPBoxSavings$	0.0070	-0.0563	0.0633
	(0.4194)	(0.3368)	(0.3207)
$IPBoxSavings \times I[OwnPatent]_{t-1}$	-0.6121*	-0.5222	-0.0899
	(0.3078)	(0.3080)	(0.1082)
$I[LimitedNexus] \times IPBoxSavings$	0.3039	0.3242	-0.0203
$\times I[OwnPatent]_{t-1}$	(0.5574)	(0.5059)	(0.1493)
$I[NoNexus] \times IPBoxSavings$	0.7979**	0.4973	0.3006*
$\times I[OwnPatent]_{t-1}$	(0.3730)	(0.3656)	(0.1529)
$IPBoxSavings \times I[OwnPatent]_{t-1}$	-1.7594***	-2.0665***	0.3071
$\times I[HighCites]_{t-1}$	(0.5860)	(0.5927)	(0.2119)
$I[LimitedNexus] \times IPBoxSavings$	1.2900	1.6373*	-0.3473*
$\times I[OwnPatent]_{t-1} \times I[HighCites]_{t-1}$	(0.7981)	(0.9339)	(0.1952)
$I[NoNexus] \times IPBoxSavings$	1.7983**	2.0044**	-0.2061
$\times I[OwnPatent]_{t-1} \times I[HighCites]_{t-1}$	(0.7427)	(0.8803)	(0.3644)
	⋱	⋱	⋱
Marginal Change in Predicted Pr(Acquired = 1):[a]			
Patent-less firms; Acquired IP disallowed	-3.062**	-5.256***	1.713
Patent-less firms; Limited nexus	-0.59	-0.978	0.254
Patent-less firms; No nexus	-3.018	-5.782*	3.001
$I[HighCites]_{t-1} = 0$; *Acquired IP disallowed*	-2.459***	-3.145**	-0.058
$I[HighCites]_{t-1} = 0$; *Limited nexus*	-0.903	-0.878	-0.991
$I[HighCites]_{t-1} = 0$; *No nexus*	-0.644	-1.866	3.636
$I[HighCites]_{t-1} = 1$; *Acquired IP disallowed*	-4.14***	-5.076***	4.466
$I[HighCites]_{t-1} = 1$; *Limited nexus*	-1.264	-1.179	-2.043
$I[HighCites]_{t-1} = 1$; *No nexus*	-0.358	-1.137	6.805
Observations	1,242,265	1,242,265	1,242,265
R-squared	0.0035	0.0029	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 and year levels.
All specifications include a full set of time-varying firm- and country-level controls along with country, year, and industry fixed effects.
[a] Marginal changes in $Pr(Acquired = 1)$ 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 low-citation versus high-citation patent-owning firms, as appropriate.